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**Nationwide infection control strategy lowered seasonal respiratory infection rate: occupational health care perspective during the COVID-19 epidemic in Finland**

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Nationwide infection control strategy lowered seasonal respiratory infection rate: occupational health care perspective during the COVID-19 epidemic in Finland

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ABSTRACT

Background: Respiratory infection is the 4th most common reason for absence from work in Finland. There is limited knowledge of how social distancing affects the spread of respiratory infections during respiratory epidemics. We assessed the effect of nationwide infection control strategies against coronavirus disease in 2020 on various respiratory infections (International Statistical Classification of Diseases and Related Health Problems code J06) in occupational outpatient clinics.

Methods: We used occupational healthcare data of respiratory infection J06 diagnoses from 2017 to 2020 obtained from the largest health service provider in Finland. The data was divided into three 252-day-long pieces and was weekday-matched and smoothed by 7-day-moving average. The difference in the J06 diagnosis rate between the follow-up years was measured using Pearson correlation. Possible confounding by sex, age, and region was investigated in a stratified analysis. Confounding by respiratory syncytial virus was analysed using nationwide data of confirmed cases obtained from the national registry.

Results: In the second quarter of 2020, the trend in the daily number of J06 diagnoses was significantly different from the follow-up years 2019 and 2018. The number of J06 diagnoses peaked between March and April 2020 with roughly 2-fold higher count compared to normal. The timing of these peaks matched with the government issued infection control strategies and lockdowns. Based on stratified analysis, the increase in the number of J06 diagnoses was not confounded by region, age, or sex. Moreover, the rapid increase in the number of J06 diagnoses was not governed by the respiratory syncytial virus.

Conclusion: Nationwide infection control strategies were effective to slow down the spread of common respiratory infectious diseases in the occupational population.

KEYWORDS
Infection control strategy
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Introduction

The World Health Organisation (WHO) declared the COVID-19 outbreak as a global emergency and recommended governments to take measures to slow the worldwide spread of this coronavirus. On 12 March 2020, the government of Finland followed the recommendation of the WHO and the European Centre for Disease Prevention and Control (ECDC) to slow the spread of the novel severe acute respiratory syndrome coronavirus (SARS-CoV-2) [1,2]. The government of Finland ordered nationwide infection control strategies by recommending remote working whenever possible on March 12, limiting social gatherings to less than ten people, closing universities, high schools, and upper elementary schools, and encouraging parents to take care of their children at home on March 18, and quarantining the capital region of Uusimaa on March 28. In addition, on March 13, the Finnish Institute of Health and Welfare advised residents to stay at home for mild upper respiratory infections and avoid unnecessary visits to healthcare facilities.

The dynamics of an epidemic are not only affected by biological agents. Pathogen transmission rate depends on social, behavioural, and environmental factors as well [3]. The effectiveness of lockdown strategies in a general population has been vastly reported [4] while workplace social distancing measures alone reduced the cumulative influenza attack rate by 23% in the general population [5]. While social distancing is effective in reducing epidemics of respiratory infections as a single strategy [5–7], simultaneously issued multiple infection control strategies are less studied.

In this report, we studied the effects of the lockdown on the incidence of respiratory infections and further on the seasonal influenza and respiratory syncytial virus (RSV) epidemics among outpatients in occupational health care in Finland.

Materials and methods

Participants and data

The primary study-population and data consists of daily aggregated diagnoses and visits in outpatient care in Finland provided by Terveystalo, a Finnish private sector healthcare service provider. The dataset in question covers approximately 20% of the Finnish population, of which only patients with J06 diagnoses were included in the study. The dataset consists predominantly of working-age patients between the ages 18 and 63 years. The data covers the daily number of J06 respiratory disease diagnoses from 1 October 2017 to 14 June 2020, aggregated by age, sex, site of diagnosis, postal code, and municipality. The total number of J06 respiratory disease diagnoses during the follow-up period is 775,795. In the statistical analysis, only the time periods from October to June are considered. The time series data was divided and weekday-matched into three parts. Each part covers 252 days, starts from the first Tuesday of October, and ends in June. The follow-up years starting in 2017 and 2018 are considered as controls whereas the follow-up year starting from 2019 represents the case year.

The secondary data was obtained from the infectious disease register (IDR) maintained by the Finnish Institute of Health and Welfare [8]. The IDR provides weekly-updated data of national findings of various microbes, including respiratory syncytial virus (RSV), influenza A and B, and COVID-19. For this study, we obtained confirmed cases of influenza A, influenza B, COVID-19, and RSV between January 2017 and October 2020 from the IDR. The data was used to investigate whether any COVID-19-epidemic induced peak in J06 diagnoses is confounded by RSV, which characteristically spikes every even year in Finland. RSV epidemic seasons were defined as in previous studies [9], the weeks when RSV detections exceeded continuously 1.2% of total RSV-positive specimens per country, surveillance system, and season.

This study did not require approval by the local ethics committee since all anonymized data was obtained from the registers.

Statistical analysis

The weekday-matched raw time-series data were smoothed by applying 7-day-moving average transformation, because weekdays, weekends, and holidays display high variability in J06 diagnoses. The smoothed time-series were visualised in the same figures using same scaling, allowing direct comparative analysis and exposure of any differences. Pearson correlation coefficient [10] was used to examine the linear relationship, and to assess the statistical significance of observed differences in patterns of J06 diagnoses, between the follow-up years. For the correlation analysis, the data was sliced into follow-up quarters, October–December, January–March, and April–June to better expose differences in the correlation structure between the follow-up years. The statistical significance and 95% confidence intervals (95% CI) were estimated using Student’s t-test
The correlation coefficients and 95% CIs were visualised in a forest-plot. To analyse whether any anomalies in J06 diagnoses were confounded by sex, age group, or region, the correlation coefficients and 95% CIs were calculated (for significance) and visualised for all possible pairs of follow-up years and background factors (sex, age, or region).

Results

Weekday-matched 7 day moving average time series plot exposed a 2-fold increase in J06 respiratory disease diagnoses between early March 2020 and midway-March 2020 (Figure 1(a)). A rapid increase in J06 diagnoses began shortly after the second confirmed COVID-19-case in the capital region of Uusimaa, which is the most populated province of Finland, on 26 March 2020 (Figure 1(a)). The rapid increase was followed by a rapid decline shortly after the first major infection control strategy was issued by the Finnish government on 13 March 2020 (Figure 1(a)). The first follow-up quarter, October–December, showed a significant linear relationship between all pairs. In January–April, only the control years 2018 and 2019 displayed strong linear relationship, whereas comparing control years to 2020 showed a small negative correlation or no correlation at all (Figure 1(b)). This is a clear indication of an extraordinary surge in J06 respiratory disease diagnoses due to the COVID-19-epidemic. On the contrary, closing of the Uusimaa region on 28 March 2020 to control COVID-19 spread to areas with lower incidence did not change the rate of decline in the observed number of J06 diagnoses (Figure 1(a)). It is noteworthy that the results are representative of both the prevalence of the disease as well as of behaviour in the population, especially the general willingness to seek medical care for respiratory symptoms. All studied diseases have incubation times of several days [12], so changes in the number of cases in Finland are delayed by these times, while behavioural changes can be assumed to be instantaneous in response to governmental regulations.

In Finland, there is characteristically a surge of RS-virus infections every even year (Figure 2). Monthly time series plot displayed a RS-virus surge in early 2020 whereas COVID-19 cases began to rise when RS-virus cases had started to decline (Figure 2(a)). The observed number of COVID-19 cases decreased rapidly after Finnish government issued the Uusimaa quarantine (Figure 2(a)), and the rate of positive tests followed this with a delay of 1 week (Figure 2(b)). Neither the RS-virus nor COVID-19 displayed lags between the Uusimaa region and other parts of Finland, but the amplitudes differed. In the capital Uusimaa region, the number of COVID-19 cases was approximately 2.5 times higher than elsewhere in Finland, whereas RS-virus displayed the opposite trend being roughly 2.5 higher elsewhere in Finland (Figure 2(a)). The population of the rest of Finland is 2.3 times higher than in Uusimaa, meaning that the capital area had a disproportionate amount of

Figure 1. a) Panel displays the number of J06 respiratory diagnoses as a 7-day moving average time series. b) The grey triangles are comparisons between control years and COVID-19 inaugural year whereas black squares are comparisons between control years. Panel shows Pearson correlation coefficient and 95% CI between all follow-up years, where Y1 refers to the first follow-up year (2018), Y2 to the second (2019), and Y3 to the third (2020). The correlation structure between the control years and the COVID-19 inaugural year changes during the first annual quarter, compared to other quarters.
COVID-19 cases, while the number of RS-virus cases were in line with the general population in Finland.

**Stratified analysis**

The J06 respiratory disease diagnosis time series and correlation structure did not indicate confounding by sex (Figure 3(a)). In the second follow-up quarter (January–March), the comparisons between the control years and the COVID-19 inaugural year did not show significant linear relationships or showed minor negative correlations (Figure 3(b)). In stratified analysis, the female population displayed a systematically higher number of J06 diagnoses in all follow-up years (Figure 3(a)). However, the spikes and shapes of the time series are parallel between men and women.

The J06 respiratory disease diagnosis time series and correlation structure did not indicate confounding by region, stratified by ‘In Uusimaa region’ and ‘Not in Uusimaa region’ (Figure 4(a)). In the second follow-up quarter, the comparisons between either control year or COVID-19 inaugural year showed no significant linear
relationships or showed only slight negative correlations (Figure 4(b)). Outside the second follow-up quarter, all pairs showed significant positive correlations (Figure 4(b)).

The J06 respiratory disease diagnosis time series and correlation structure did not indicate confounding by age, although the March–April peak was not as pronounced in the above 60 years old group compared to other age groups, in agreement with the non-uniform age distribution of the data set (Figure 5(a)). In the second follow-up quarter, the comparisons between the control years and the COVID-19 inaugural year did not show linear relationship or only minor negative correlations (Figure 5(b)). Also, during the first follow-up quarter (October–December), some pairs did not show significant correlations (Figure 5(b)). The characteristic seasonal changes in the number of J06 diagnoses were approximately equal between all age categories, including the inaugural year of the COVID-19 epidemic.
Discussion

After the Finnish government issued the 2020 national lockdown to control the spread of COVID-19, visits to occupational healthcare due to respiratory tract infections decreased rapidly in the study sample from a high of 2250 daily diagnoses in mid-March 2020 to 500 daily diagnoses by the end of March 2020. The respiratory tract infection patterns of the 1st annual quarter of 2020 and the corresponding annual quarters of 2018 and 2019 showed no significant correlations, indicating the anomaly of the 1st annual quarter of 2020 compared to other quarters. The respiratory tract infection patterns displayed a significant correlation between the first annual quarter of 2018 and the first annual quarter of 2019, indicating similarity between the control years. The rapid surge and decline in respiratory illness diagnoses observed in Finland is similar to patterns observed in the US [13,14].

The timing of the surge and restraint of the respiratory tract infection pattern matched well with infection control strategies issued by the Finnish government suggesting a strong association. The data set showed behavioural changes in line with the implemented control strategies, while the rate of COVID-19 cases declined sharply with a delay corresponding to the incubation period. After the nationwide lockdown started in March 2020, the number of respiratory infection diagnoses fell more steeply than in previous years. We concluded that the changes were predominantly caused by behavioural changes in the population. In the early stages of the COVID-19 pandemic, possible causes for the increase in number of J06 diagnoses include increased patient awareness of mild respiratory system symptoms as well as the requirement for medical notes for sick leave from work. Later, after the governmental regulations and the increased knowledge of COVID-19-specific symptoms, patients were not as eager to seek medical care for respiratory symptoms. Previous studies have estimated that social restrictions, such as closing schools and timing holidays, effectively limit spread of seasonal influenza [15–17]. Moreover, workplace social distancing measures alone reduced the cumulative influenza attack rate by 23% in the general population [5]. Therefore, we suggest a causal relationship between the government issued infection control strategy and the low rate of respiratory tract infections. Moreover, our analysis showed that the difference in the patterns was not confounded by RS-virus, sex, age, or place of residence. Simultaneously, the rapid abating of the RS-virus epidemics in 2020 and 2018 are concordant. Similar observations of the impact of telework recommendations were made by the Ministry of Finance (VM) and the Ministry of Social Affairs and Health (STM).

The observed difference in the patterns of respiratory infections matches well with the special characteristics of the Finnish society and population. Finland has a so-called social democratic welfare model providing income security during sick leaves and child illness [18,19]. The attitude towards sick leaves has been more restrictive in Finland than in Sweden and Norway as Finnish workers tend to attend workplaces with the common cold [20], for example. Consequently, absence due to sickness is lower in Finland compared to Norway and Sweden [19]. However, the attitude towards sick leave changed from restrictive to more permissive after the COVID-19 outbreak, due to awareness of the risk of spreading the infection in the workplace [21,22]. According to the Eurofound ‘Living, working and Covid’ report, the trust in government (as an institution) in European countries was highest in Finland during the outbreak [23]. Therefore, we suggest that attitude change is partly facilitated by trust in national government.

In addition, a rapid expansion of teleworking after the lockdown order was possible in Finland due to a well-established digital infrastructure [24] and early adoption of teleworking culture [25]. In fact, according to Joint European Commission–Eurofound Report, in 2019, working regularly or at least sometimes from home was most frequent in Northern European countries, including Finland [25]. Along these lines, according to Eurofound data [26], Finland had one of the highest rates of teleworkers before the COVID-19 outbreak (15.2%) and the highest rate of new teleworkers in May–April 2020 in Europe.

Our study benefits from the large and reliable data set, enabling the use of statistical methods based on asymptotics rather than distributional assumptions. Our data covers historical records dating back before the inaugural year of COVID-19, thus capturing possible long-term seasonal anomalies. Moreover, the registers cover the entire nation increasing the reliability and generalisability of the analysis. As the data set was predominantly sampled from the working age population, the results shown are best applied to that demographic group. Although the data is aggregated, it enabled stratified analysis. However, our data did not include behavioural or lifestyle factors, and the response variable J06 diagnosis was only defined in general. Future studies would benefit from a more accurate definition and
diagnosis than J06 in general. Moreover, the impact of increased teleworking is unknown and it is likely that some viral lower respiratory infections in employees were not detected as usual during the lockdown, since it was more common to work via telecommunication than in workplaces while sick [27]. In parallel with J06, it seems that the seasonal influenza rate was impacted by the lockdown since the virulence of the 2019/2020 influenza was moderate to severe [28].

The first wave of COVID-19 was mild in Finland, peaking at 3600 COVID-19 cases in a week (64.9 per 100,000) according to IDR data. In our data, over 2000 daily cases with respiratory infection were diagnosed one week in a row. Therefore, the COVID-19 epidemic does not induce heavy bias into our results of rapid decline of common respiratory infections after the outbreak. However, the impact of the latest RS-virus epidemic requires more detailed consideration. In Finland and other Nordic countries, there is a biennial epidemiological variation (i.e. a high season following a low season) of RS-virus [29]. In Finland, the beginning of the high season 2019–2020 was similar to the high season of 2017–2018. Nevertheless, the decline of the RS-virus epidemic was more rapid during the high season 2019–2020 than during the high season 2017–2018 and most likely influenced by the lockdown implemented to control the COVID-19 outbreak.

Conclusions

We observed a rapid decline in the number of J06 diagnoses in occupational health care after COVID-19 control measures were issued by the Finnish government. This observation is in concordance with previous findings that employee compliance is affected by the national social security system, adoption of telework, and attitudes to work, sick leave, and recommendations by the authorities [23,26,27,30]. Occupational healthcare should promote preparatory plans for future epidemics and pandemics to mitigate spread of respiratory infection among workers. These preparatory plans include adoption of teleworking policies, encouraging remote work when sick, taking sick leaves, and introduction of sufficient sick leave benefits.

Ethical approval

This study did not require approval by the local ethics committee since all anonymized data was obtained from the registers. Ethical approval is not required for register-based research in Finland.

Author contributions

M.A., P.R., P.I., S.S. and L.V. conceived the ideas; O.N. and S.R. collected the data; P.R., P.I. S.S. and L.V. selected the data-analysis methods; P.R. conducted the data analyses and produced the corresponding tables and graphics; M.A., O.N. and S.R. were responsible of interpreting the results in the context of respiratory infections and occupational health; M.A., P.R. and O.N. led the writing; All the authors contributed to discussion and writing the final version of the manuscript.

Disclosure statement

The authors declare no conflict of interest for this article.

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Data availability statement

Data privacy was strictly followed. Only anonymized and aggregated data was used in the analysis, and no identifying data were handled in any part of the study. The primary data is privately owned by Terveystalo and is not publicly available. The access to the data can be requested upon reasonable request from Terveystalo. Parts of the data have been made public [31]. The secondary data obtained from the infectious disease register (IDR) maintained by the Finnish Institute of Health and Welfare is publicly available [8].

References


