Survival of health workers infected by SARS-CoV-2 in the context of vaccination against COVID-19 in Peru

Supervivencia de los trabajadores de salud infectados por SARS-CoV-2 en el contexto de la vacunación contra la COVID-19 en el Perú

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Abstract

Objectives. To evaluate the survival of health personnel infected by SARS-CoV-2 in the context of the vaccination process against COVID-19 in Peru. **Methods:** A survival analysis was performed using data from national health databases. Data from people between 18 and 59 years old infected with SARS-CoV-2 as evidenced by molecular or antigenic tests were included. Kaplan Meier graphs were produced to compare the survival of health personnel and the rest of the population during 2021 and health personnel during the first and second wave of mortality in Peru in 2020 and 2021, respectively. **Results.** Data from 998 295 people were included. The average age was 41.2 years (SD 15.8) and 485 167 (48.6%) were women. A higher level of survival of health workers after vaccination was found compared to the general population and to the population of health workers before vaccination. It was evidenced that, at the beginning of the second wave, the risk of dying for health workers was twice that of the first wave (HR = 2). After vaccination (in the sixth month of the second wave), the risk of dying decreased to 87.5% less than in the first wave (HR = 0.125). **Conclusions.** A positive change has been evidenced in the level of survival of health personnel infected by SARS-CoV-2 during the context of vaccination against COVID-19 in Peru.

Keywords: Survival; Health Personnel; Vaccination; COVID-19; Peru (source: MeSH NLM).

Resumen

Objetivos. Evaluar la supervivencia de los trabajadores de salud infectados por SARS-CoV-2 en el contexto del proceso de vacunación contra la COVID-19 en el Perú. **Métodos.** Se realizó un análisis de supervivencia a partir de datos provenientes de las bases nacionales en salud. Se incluyó datos de personas entre 18 y 59 años infectadas por SARS-CoV-2 evidenciada por prueba molecular o antigénica. Se elaboraron gráficos de Kaplan Meier para comparar la sobrevida de los trabajadores de salud y el resto de la población durante el año 2021 y el trabajador de salud durante la primera y segunda ola de mortalidad en el Perú en el 2020 y 2021, respectivamente. **Resultados.** Se incluyeron datos de 998 295 personas. La edad promedio fue 41,2 años (DE 15,8) y 485 167 (48,6%) fueron mujeres. Se encontró un mayor nivel de sobrevida de los trabajadores de salud después de la vacunación con respecto a la población en general y a la población de los trabajadores de salud antes de la vacunación. Se evidenció que, al inicio de la segunda ola, el riesgo de morir de los trabajadores de salud era el doble del que tenían en la primera ola (HR=2). Después de la vacunación (en el sexto mes de la segunda ola), el riesgo de morir disminuyó hasta 87,5% menos que en la primera ola (HR=0,125). **Conclusiones.** Se ha evidenciado un cambio positivo en el nivel de sobrevida de los trabajadores de salud infectado por SARS-CoV-2 durante el contexto de la vacunación contra la COVID-19 en el Perú.

Palabras clave: Sobrevida; Trabajadores de Salud; Vacunación; COVID-19; Perú (fuente: DeCS BIREME).

INTRODUCTION

COVID-19, a disease caused by the SARS-CoV-2 virus, has generated a significant impact on the health of the world population not only due to its ability to spread but also due to the risk of causing death in the population [1]. Peru is currently one of the countries with the highest mortality rate from this disease worldwide [2]. In this context, the Peruvian government approved the national vaccination plan against COVID-19 on October 16, 2020 [3] and began its implementation on February 9, 2021, given its recognition as one of the main resources to combat the pandemic in the population [4]. The scheme of the Vaccination Plan against COVID-19 in Peru, prioritized the vaccination of health workers because it is one of the populations most exposed to this virus, which has suffered a significant number of deaths. In the first 100 days of the pandemic alone, 1867 doctors were infected, of whom 65 died [5].

Some reports at the national level have preliminarily evaluated the potential effect of the vaccination process on health workers, showing a reduction in hospitalization and mortality rates of medical personnel during the first months of the vaccination period in Peru [6]. However, to date it is not yet known whether there has been any variation in the level of survival of health workers infected by SARS-CoV-2, during the vaccination period compared to last year or with respect to the rest of the year. Adult population, which, up to the moment of the present analysis, had not yet been vaccinated, according to the proposed national scheme. Additionally, it is important to know if these comparisons vary according to sex, given the evidence that indicates the difference in risk of mortality from COVID-19 between these subgroup [7,8].

In Peru, various national health information systems include nominal information on people who underwent laboratory tests for the diagnosis of COVID-19 (NETLAB and SICOVID), health care and administrative personnel (INFORHUS) and deceased persons (SINADEF). Based on this information, this study aims to evaluate the survival of health workers infected by SARS-CoV-2 during the context of the vaccination process against COVID19 in Peru.

METHODS

Study design

A secondary data analysis was performed using the databases of SINADEF (registry of deceased), INFORHUS (registry of health workers), SICOVID (registry of antigen tests for the diagnosis of SARS-Cov 2) and NETLAB (registry of molecular tests for the molecular diagnosis of SARS-Cov 2); which contain information about the people examined to determine their infection status by the SARS-CoV-2 virus through molecular tests, antigenic tests, their occupation to be classified as health workers and deceased persons at the national level respectively.

Population

Records of people between 18 and 59 years old with a positive test for SARS-CoV-2 evidenced by molecular test (MT) or antigenic test (AT) registered in the NETLAB or SICOVID databases until June 30, 2021, were included; in the case of people with more than one test, only the last test was considered. Those observations that did not allow the identification of the subjects, the date of obtaining the sample was after the date of death, or whose date of death was later than 60 days from the date of obtaining the sample were excluded (for molecular or antigenic testing). The probability that a death is attributed to COVID-19 after 60 days from the diagnosis of the disease is very low [9]. To obtain estimates at the national level, no sampling was carried out and all records that met the selection criteria were included.

Based on this, they were defined in 2 study subpopulations: people with a positive test for SARS-CoV-2 by MT or AT in Peru in 2021; and health workers with a positive test for SARS-CoV-2 by MT during the first wave and health workers with a positive test for MT or by AT, during the second wave of COVID-19 in Peru.

Result variable

Subjects registered in the SINADEF database and whose death occurred up to June 30, 2021, were categorized as "Deceased" and the rest as "Not deceased". Additionally, the date of death data was included to determine the survival time.

Exposure variables

Health worker

The persons registered in the INFORHUS database updated until January 31, 2021, were classified as "health workers". To optimize this classification, it was added also as health workers to those people who were not registered in INFORHUS, but who have self-reported that they have an occupation as health workers: "doctor", "nurse", "obstetrician", etc., at the time of obtaining of the sample.

Wave of COVID-19

Those patients who have been infected by SARS-CoV-2 during the first or second wave of mortality from COVID-19 in Peru were classified. The start of each wave was defined as the first day of the epidemiological week in which there was an approximate 75% increase in deaths with respect to the historical average of deaths according to SINADEF data. The beginning of the first wave was considered on April 19, 2020, and as the beginning of the second wave on January 3, 2021. Given the availability of the data, an analysis time of 180 days was considered for each wave.

Covariates

The following covariates were included: sex, classified as "male" or "female"; age, in years; insurance, "have health insurance" or "do not have health insurance" and "belong to the Lima region" or "do not belong to the Lima region".

Statistic analysis

Statistical analyzes were performed in the Stata v16.0 statistical package for Windows. Initially, a descriptive analysis was carried out to evaluate the characteristics of the health workers and the general population infected by SARS-CoV-2 included in the study. For the survival analysis, Kaplan Meier curves were elaborated to compare the survival of health workers and the general population infected by SARS-CoV-2 during the year

2021 and the survival of health workers in the first and second wave during the COVID-19 pandemic in Peru in 2020 and 2021. For this last comparison, risk ratios were estimated (Hazard Ratios, HR) and risk differences (Absolute Risk Reduction, ARR) to mortality between both waves, indicating their 95% confidence intervals. For this, Cox regressions and polynomial models were used to graph the evolution of these indicators during the period of study for both waves. To improve the visualization of the survival of the populations studied in the study period, some important milestones were defined corresponding to the date of the start of vaccination (February 9, 2021), start of the second dose application (March 1, 2021), and start of the protection period (14 days after the start of the second dose). This last period was defined based on the time of protection suggested for the Sinopharm vaccine used for the vaccination of health workers in Peru [10].

Ethical aspects

The study was approved by the Research Ethics Committee of the Facultad de Medicina de la Universidad Nacional Mayor de San Marcos, Lima, Peru. The study was based on a secondary analysis of the data contained in the databases of the routine information systems of the National Institute of Health and the Ministry of Health. The access and use of the information from the analyzed databases was approved by authorization letters from the holders of the institutions where the databases belong, in compliance with the competences of the National Institute of Health, within the framework of the surveillance of public health and in the context of the care of the COVID-19 pandemic in Peru.

RESULTS

998 295 people between 18 and 59 years old, whose last molecular or antigenic test was positive for SARS-CoV-2 since the beginning of the pandemic, were studied. The mean age was 41.2 years (SD: 15.8), 485 167 (48.6%) were women, 466 459 (46.7%) came from Lima, 34 424 (3.5%) were health work-

ers, and 35 981 (3.6%) had died according to their registration in SINADEF. Table 1 shows the characteristics between the health workers and the rest of the population included in the study.

Table 1. Characteristics of health workers and the general population, positives for COVID-19 by molecular or antigenic test in Peru, 2021. (n = 998 295)

Characteristics	Health worker, n (%) N=34.424	No Health worker, n (%) N= 963.871
Age (years)	40.0 ± 10.9	41.3 ± 16.0
Sex		
Female	22502 (65.4)	462665 (48.0)
Male	11922 (34.6)	501206 (52.0)
Provenance		
No Lima	13616 (39.6)	452843 (47.0)
Lima	20808 (60.5)	511028 (53.0)
Death*		
No death	34071 (99.0)	928243 (96.3)
Death	353 (01.0)	35628 (03.7)

* SINADEF database

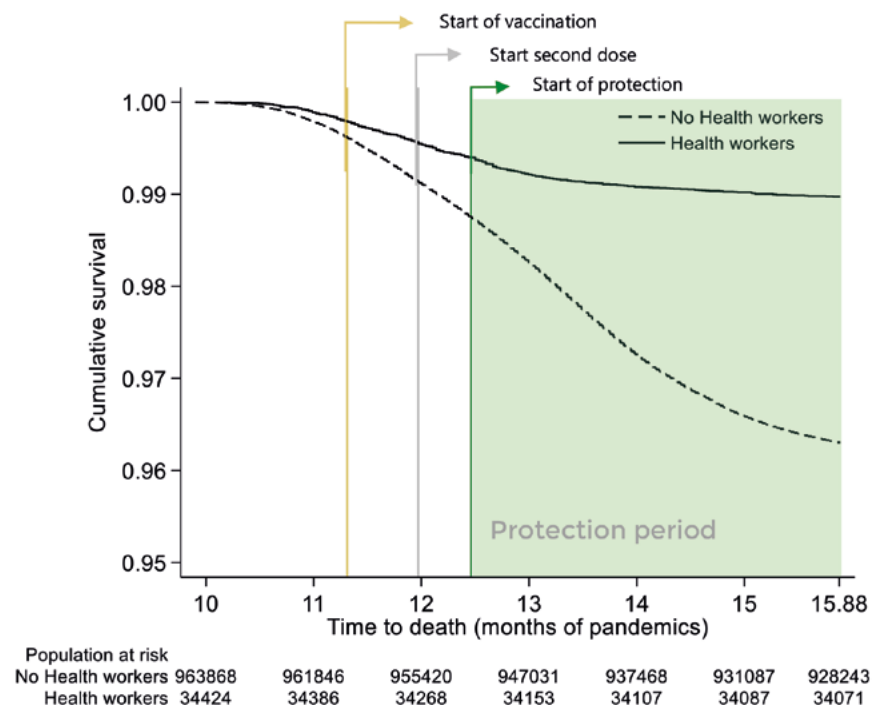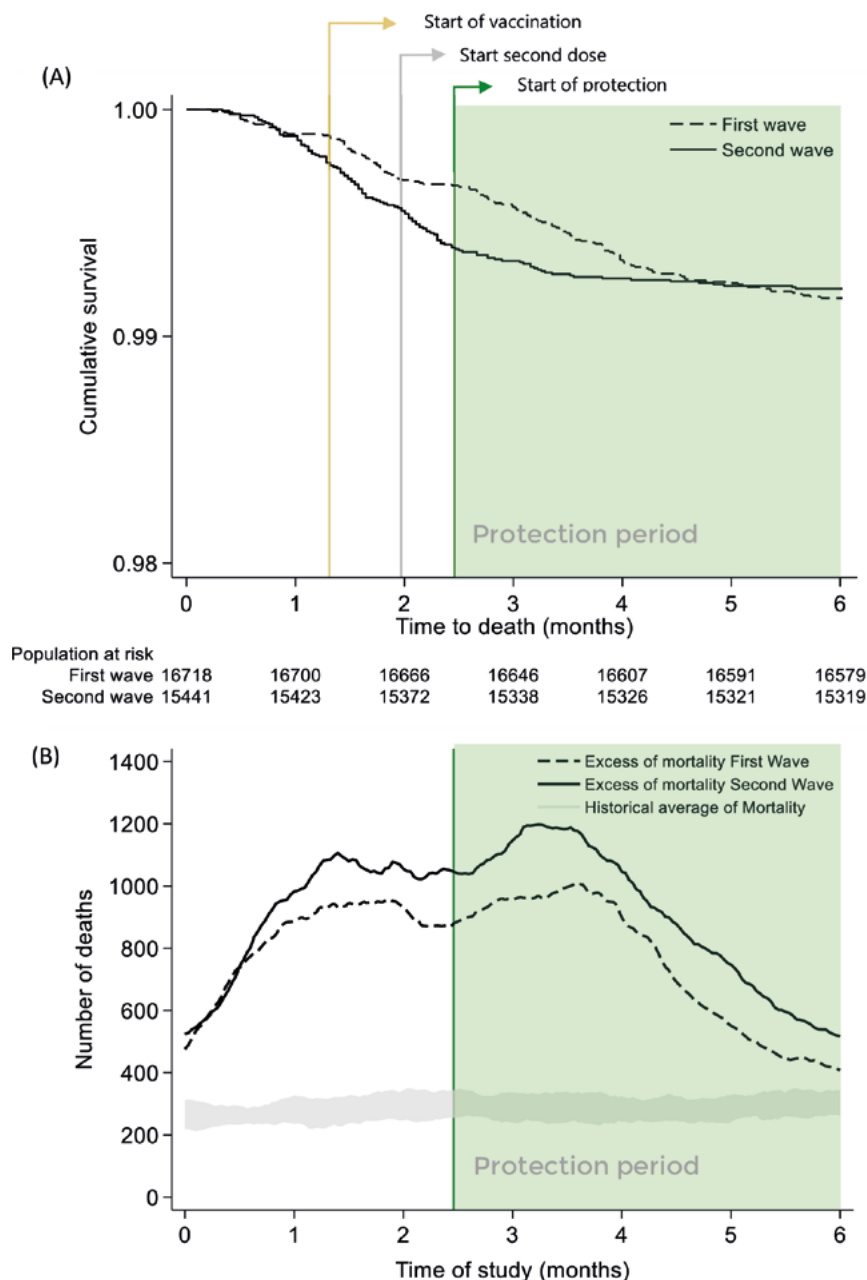### Survival of health workers compared to the general population.

Since the beginning of the second wave, the Kaplan Meier curves showed a greater survival of health workers infec-

Figure 1. Survival levels of health workers and the rest of the population infected by SARS-CoV-2, during the COVID-19 pandemic in Peru, 2021 (N = 998,292).

Population at risk							
No Health workers	963868	961846	955420	947031	937468	931087	928243
Health workers	34424	34386	34268	34153	34107	34087	34071

Figure 2. Survival levels of health workers infected by SARS-CoV-2, during the first and second wave of COVID-19 in Peru, 2020-2021. (N = 32,159)

A. Survival levels (Kaplan Meier) of health workers during the first and second wave of COVID-19 in Peru. B. Excess mortality compared to the historical average of deaths (2017-2019) during the first and second waves of COVID-19 in Peru.

ted with the SARS-CoV-2 virus compared to the rest of the population positive for SARS-CoV-2 in Peru. This difference was much more pronounced, due to a flattening of survival in health workers from March 15, 2021 (day 374 of the pandemic), date corresponding to 14 days after the start of the application of the second dose. (Figure 1).

Survival of health workers in the first and second waves

At the beginning of the second wave, the mortality of health workers was higher compared to the first wave. However, later, the survival curve during the second wave shows a flattening, specifically from the beginning of the vaccine

protection period, two weeks after the moment in which the application of the second dose began (March 15), reducing the gap of survival between the two waves. (Figure 2).

Specifically, initially a positive difference was observed in the mortality risk of the second wave with respect to the first (ARR> 0), which indicates that the risk of dying in the second wave was higher than in the first wave, the which was reduced until it was canceled towards the end of the study period (ARR = 0), which indicates that, after vaccination, the risk of dying in the second wave is equal to that of the first wave. The absolute risk reduction in the sixth month of the second wave was less than zero compared to the first wave (RAR <0), that is, the risk of dying of health workers ended up being lower in the second wave, in comparison with the first. (Figure 3).

The risk ratio (Hazard Ratio) showed a higher incidence of mortality in the second wave compared to the first. The risk of dying of health workers in the second wave was twice the risk of dying in the first wave (HR = 2), before the start of vaccination. At the beginning of the vaccination protection period, the risk of dying in the second wave is reduced until it becomes like the risk of dying in the first wave (HR = 1). Finally, six months after the second wave and after three and a half times the start of vaccination protection, the risk of dying in the second wave is 87.5% lower compared to the first wave (HR = 0.125). (Figure 4).

When comparing the mortality curves of health workers during the first wave and during the second wave, by sex, a flattening of the survival curve is also verified during the second wave, from the beginning of the protection period. However, this is much more evident among male health workers. (Figure 5 and 6).

DISCUSSION

The results of the present study show in a preliminary way the positive change

Figure 3. Differences of the risk of death ratio (Absolute Risk Reduction, ARR) of health workers infected by SARS-CoV-2, between the first and second waves of COVID-19 in Peru, 2020-2021. (N = 32,159)

Abbreviations: ARR = Absolute risk reduction; CI 95%: 95% Confidence interval
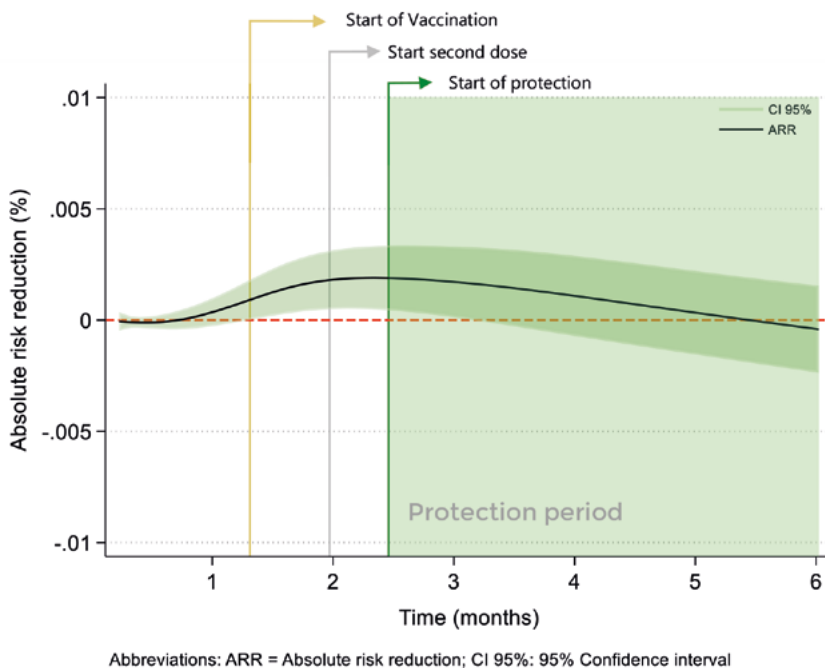
in the survival of adult health workers in the context of the first phase of vaccination against COVID-19 in Peru. These results consistently showed that, after the vaccination period, the population of health workers improves its survival com-

Figure 4. Ratios of the risk of death (Hazard Ratio) between the first and second wave of COVID-19 on health workers infected by SARS-CoV-2 in Peru, 2020-2021. (N = 32,159)

Abbreviations: HR = Hazard ratio; 95% CI: 95% Confidence Interval
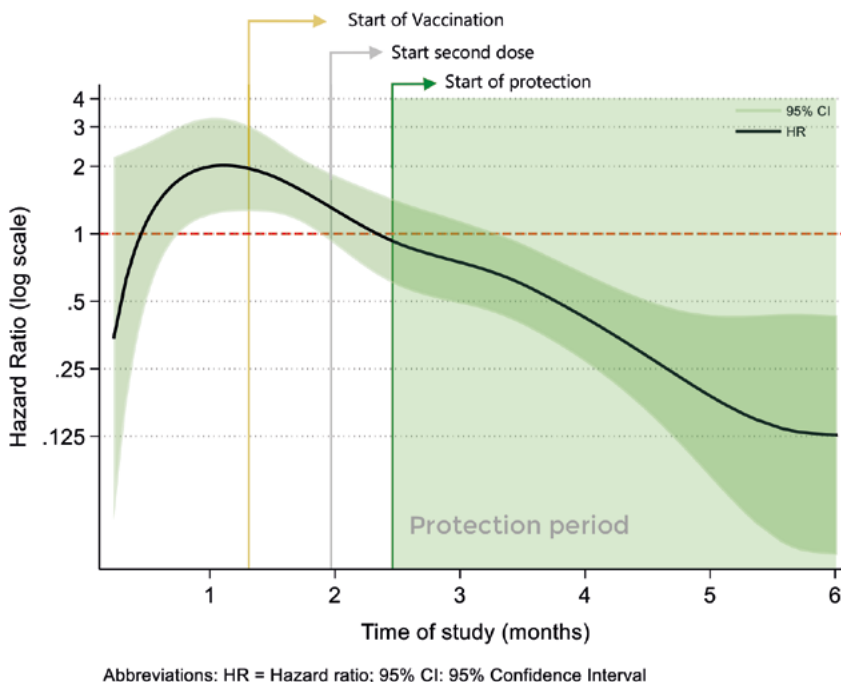
pared to the survival of the general population that is not health workers; and that health workers improves their survival during the second wave of COVID19 transmission in 2021, compared to their survival during the first wave in 2020.

In the first place, a higher level of survival of health workers was observed compared to the general population infected by SARS-CoV-2 during the first half of 2021. This situation could initially be explained by greater access to health care, higher socioeconomic level, and greater knowledge about the care regarding their illness of the health workers compared to the general population. However, the observed increase in the difference in survival between both groups increases after the period that followed the vaccination of health workers, which can be attributed to the effect of this intervention on the mortality of health workers.

Additionally, an improvement in the survival of health workers infected by SARS-CoV-2 was observed in the second wave, during the vaccination period in Peru, compared to the first. In this context, the higher mortality of health workers observed at the beginning of the second wave would be related to the higher mortality from COVID-19 that occurred at the national level. On the other hand, the comparison of risks through indicators (RAR, HR) showed that the initial increase in mortality of the second wave suffered a deceleration from the start of vaccination, turning towards a frank decrease in the period of protection, managing to cancel the difference in mortality between second and first wave. The risk of dying of workers in the second wave, before vaccination, was double compared to the first wave, and became 87.5% lower compared to the first wave, after vaccination. This suggests a possible impact of vaccination on mortality that would occur from the beginning of its application and would be consolidated after the application of the second vaccination dose.

Finally, in the sub analysis carried out by sex, it was evidenced that male health workers infected by SARS-CoV-2 showed a greater change in the level of survival after the vaccination period, achieving not only canceling the difference in mor-

Figure 5. Survival levels of male health workers infected by SARS-CoV-2, during the first and second wave of COVID-19 in Peru, 2020-2021 (N = 11,523).
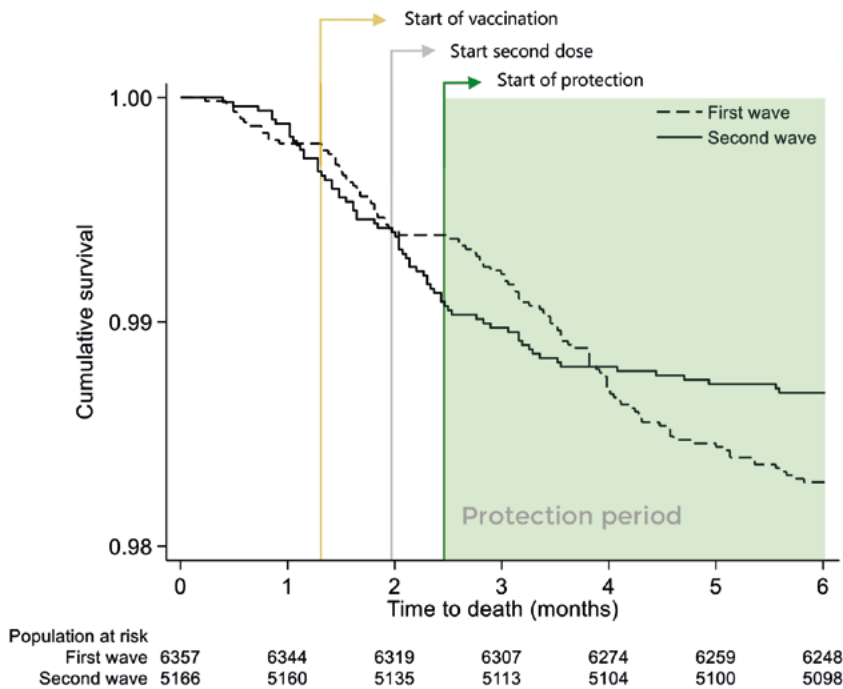
tality risk of the second wave compared to the first, but surpassing it in the end of the study period. This situation was less evident in females due to the lower overall mortality from COVID-19 of this subgroup [8].

Figure 6. Survival levels of female health workers infected by SARS-CoV-2, during the first and second wave of COVID-19 in Peru, 2020-2021 (N = 20,636).
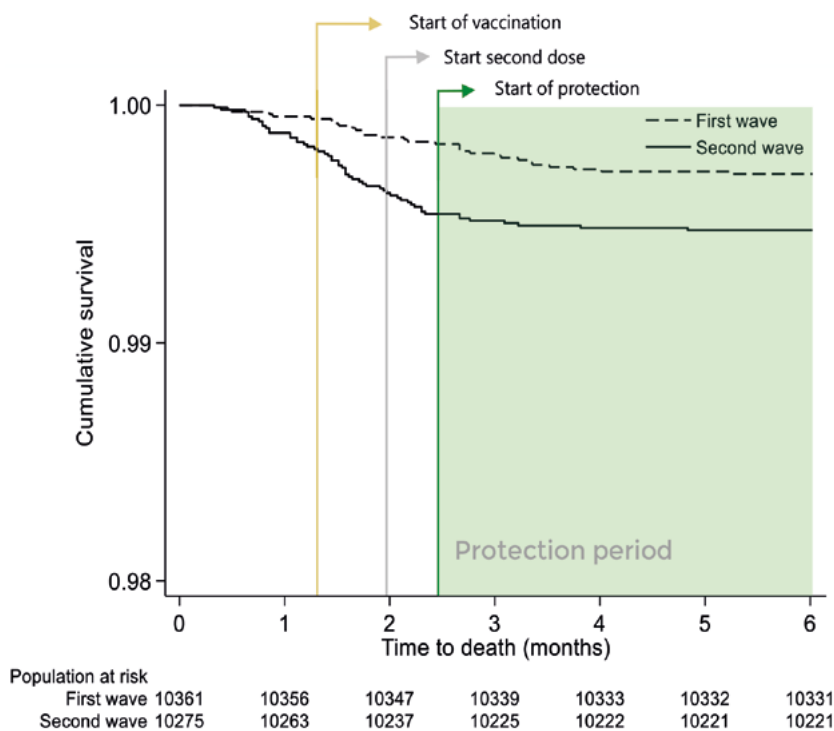
The present study has some limitations. In the first place, since we do not have nominal data on people vaccinated at the national level, it cannot be determined whether all the health workers included were finally vaccinated during the study period. However, vaccination coverage in Peru among health workers is high, only among doctors it reached 86.7% according to the "vacunómetro" of the Medical College of Peru [11], it is estimated that the percentage of unvaccinated health workers would be low, and their exclusion would not significantly modify the results found. Additionally, in comparing survival between COVID-19 waves, the use of retrospective data does not allow an accurate assessment of the 60-day prognosis of patients infected in the last weeks of the year study period. However, this bias would act by attenuating the differences in survival found between the first and second waves, which could be even greater if patient mortality data were included in the following two months. Another aspect in this analysis is the difference in the availability of Peruvian health resources to face the COVID-19 pandemic in the first and second waves. Although this situation has been able to favor the reduction of mortality in the second wave, the change in survival seen during the start of the first and second doses and the period of protection strongly suggest the contribution of the vaccination process in the change in survival of health workers.

The results found coincide with the evidence presented at the national level that suggests a potential influence of vaccination on the mortality rate in medical personnel, given the decrease in this indicator during the first months of the vaccination period in Peru [6]. In the same way, this coincides with the evidence shown in countries such as Chile, the United States and the United Kingdom that have shown a marked reduction in mortality at a general level as the development of vaccination against COVID-19 advances in their respective countries [12,13,14].

In conclusion, a positive change is shown in the level of survival of health workers during the vaccination process against COVID-19 in Peru, especially in male personnel. This result, added to

the evidence found at the national and international level, reaffirms the value of vaccination as one of the main strategies to combat the effects of the COVID-19 pandemic, especially in highly population exposed to the virus such as health workers.

Following this line, it is recommended to carry out future studies aimed at estimating the impact of vaccination against COVID-19 in Peru on the mortality of health workers in terms of effectiveness, as well as the evaluation of other indicators of interest such as infection, hospitalization, and admission to intensive care, which make it possible to assess its usefulness more precisely, as has been done in other countries [15,16,17,18].

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