Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Short Communication

SARS-COV-2 IgG positivity in vaccinated and non-vaccinated Chilean children: a national cross-sectional study in schools

Juan P. Torres1, Denis Sauré2,4, Leonardo J. Basso3,4, Marcela Zuñiga5, Andre Cazor6, Miguel O’Ryan7,∗

1 Department of Pediatrics, Hospital Calvo Mackenna, Facultad de Medicina, Universidad de Chile, Antonia Varas 360, Santiago, Chile
2 Department Industrial Engineering, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Beauchef 850, Santiago, Chile
3 Department of Civil Engineering, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Beauchef 850, Santiago, Chile
4 Instituto Sistemas Complejos de Ingeniería, Republica 695, Santiago, Chile
5 Ministerio de Salud, Gobierno de Chile, Santiago, Chile
6 Ministerio de Educación, Gobierno de Chile, Santiago, Chile
7 Program of Microbiology and Micology, Instituto de Ciencias Biomédicas, Facultad de Medicina, Universidad de Chile, Independencia 1027, Santiago, Chile

A R T I C L E  I N F O

Article history:
Received 27 February 2022
Revised 14 April 2022
Accepted 19 April 2022

Introduction

COVID-19 vaccination of children is gaining global support (Committee on Infectious Diseases, 2022), and data on immunogenicity and efficacy/effectiveness are increasing (Walter et al., 2022; Frenck et al., 2021; Han et al., 2021). Chile has rapidly advanced in a national vaccination campaign for children: as of February 17, 2022, 75% of children aged 3–17 years have been fully vaccinated (Ministerio de Salud Chile, 2022). Children aged 12–17 years have been vaccinated since June 22, 2021, with the mRNA Pfizer/BioNTech vaccine, followed weeks later by children aged 6–11 years, who received the inactivated Sinovac vaccine. We previously reported a national COVID-19 IgG seropositivity study in adults vaccinated with either vaccine that demonstrated the utility of large cross-sectional immunologic surveys using lateral flow tests (LFTs) (Sauré et al., 2022). In this study, we reported IgG seropositivity in vaccinated and non-vaccinated Chilean school-aged children who received the inactivated vaccine from Sinovac (CoronaVac) or the mRNA vaccine from Pfizer/BioNTech (BNT162b2) within 1–20 weeks before sample collection, or no vaccine. Data on IgG seropositivity among vaccinated children with inactivated as compared with mRNA vaccines are currently non-existent and can provide important information for decision-makers worldwide.

Methods

We performed SARS-CoV-2 IgG testing using the OnSite (CTK Biotech Inc, Poway, CA, US) LFT. This was the same LFT as the one used in adults (Sauré et al., 2022), with reported sensitivity and specificity of 96.7% and 98.1%, respectively (CTK Biotech, 2021). In conjunction with the Chilean Ministries of Education and Health, 24 schools located in the three most populated regions in Chile were invited to take part in the study. Briefly, all parent/children pairs were invited to participate through a letter sent by school authorities. Accepting parents signed informed consent, and children aged >8 years an assent. Children of every accepting parent were tested. Trained staff in each school obtained basic information from the parent/caregiver of the child participant, including type of vaccine and vaccination dates, age, gender, country of origin, general medical history, previous COVID-19 IgG or polymerase chain reaction testing, home address and usual transportation method to school. A finger-prick blood sample was obtained from children as previously described (Sauré et al., 2022). Tests were read on-site and results (positive, negative, or not conclusive) and surveillance data were instantly uploaded through a web interface to a database harbored at the Instituto Sistemas Complejos de Ingeniería, as in previous reports (Sauré et al., 2022). The study was approved by the Comité de Ética de Investigación en Seres Humanos (Universidad de Chile, Santiago, Chile).

https://doi.org/10.1016/j.ijid.2022.04.039
1201-9712/© 2022 The Author(s). Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)
Table 1
Covid-19 IgG positivity according to population characteristics and vaccine received:

| Characteristics | Total | Unvaccinated | Sinovac | Pfizer |
|-----------------|-------|--------------|---------|--------|
|                 | n/N   | IgG positivity (95% CI) | n/N   | IgG positivity (95% CI) | n/N   | IgG positivity (95% CI) |
| **Age range**   |       |              |         |        |        |                      |
| 6–11 years      | 837/1033 | 81.0% (78.6%, 83.4%) | 25/90 | 27.8% (18.5%, 37.0%) | 792/920 | 86.1% (83.9%, 88.3%) | 20/23 | 87.0% (73.2%, 100%) |
| 12–18 years     | 1136/1269 | 89.5% (87.8%, 91.2%) | 7/31 | 22.6% (7.9%, 37.3%) | 505/591 | 85.4% (82.6%, 88.3%) | 624/647 | 96.4% (95.0%, 97.9%) |
| **Gender**      |       |              |         |        |        |                      |
| Male            | 866/1001 | 86.5% (84.4%, 88.6%) | 15/62 | 24.2% (13.5%, 34.9%) | 598/678 | 88.2% (85.8%, 90.6%) | 253/261 | 96.9% (94.8%, 99.0%) |
| Female          | 1107/1301 | 85.1% (83.2%, 87.0%) | 17/59 | 28.8% (17.3%, 40.4%) | 699/833 | 83.9% (81.4%, 86.4%) | 391/409 | 95.6% (93.6%, 97.6%) |
| **Region**      |       |              |         |        |        |                      |
| Metropolitan    | 1301/1459 | 89.2% (87.6%, 90.8%) | 19/72 | 26.4% (16.2%, 36.6%) | 920/1021 | 90.1% (88.3%, 91.9%) | 362/366 | 98.9% (97.8%, 100%) |
| Valparaíso      | 374/461 | 81.1% (77.6%, 84.7%) | 12/36 | 33.3% (17.9%, 48.7%) | 238/292 | 81.5% (77.1%, 86.0%) | 124/133 | 93.2% (89.0%, 97.5%) |
| Biobío          | 298/381 | 78.2% (74.1%, 82.4%) | 1/13 | 7.7% (0%, 22.2%) | 139/197 | 70.6% (64.2%, 76.9%) | 158/171 | 92.4% (88.4%, 96.4%) |
| **Prev. pos. PCR** | 35/45 | 77.8% (65.6%, 89.9%) | 3/6 | 50.0% (10.0%, 90.0%) | 20/27 | 74.1% (57.5%, 90.6%) | 12/12 | 100% (100%, 100%) |
| **Comorbidities** |       |              |         |        |        |                      |
| Obesity         | 50/56 | 89.3% (81.2%, 97.4%) | 1/6 | 16.7% (0%, 46.5%) | 38/39 | 97.4% (92.5%, 100%) | 11/11 | 100% (100%, 100%) |
| Chronic pulmonary disease | 82/94 | 87.2% (80.5%, 94.0%) | 1/4 | 25.0% (0%, 67.4%) | 31/40 | 82.5% (70.7%, 94.3%) | 48/50 | 96.0% (90.6%, 100%) |
| Cardiovascular  | 13/14 | 92.9% (79.4%, 100%) | 0/0 | - | 6/7 | 85.7% (59.8%, 100%) | 7/7 | 100% (100%, 100%) |
| Other           | 8/9 | 88.9% (68.4%, 100%) | 0/0 | - | 0/0 | - | 8/9 | 88.9% (68.4%, 100%) |
| None identified | 1820/2129 | 85.5% (84.0%, 87.0%) | 30/111 | 27.0% (18.8%, 35.3%) | 1220/1425 | 85.6% (83.8%, 87.4%) | 570/593 | 96.1% (94.6%, 97.7%) |
| **Total**       | 1973/2302 | 85.7% (84.3%, 87.1%) | 32/121 | 26.4% (18.6%, 34.3%) | 1297/1511 | 85.8% (84.1%, 87.6%) | 644/670 | 96.1% (94.7%, 97.6%) |

CI, confidence interval; PCR, polymerase chain reaction.

a The data exclude participants with incomplete information (n=6), inconsistent vaccination status information (n=86), region other than those listed (n=1) and those vaccinated with vaccines other than Sinovac or Pfizer (n=11)

b Positive PCR previously obtained

c Includes four cases of hypertension, four cases of diabetes and one case of cancer.

Results

As of December 24, 2021, a total of 2302 children have been included, as described in Table 1. Whereas most Sinovac recipients were aged 6–11 years (920), Pfizer/BioNTech recipients were almost exclusively aged 12–18 years (647). IgG positivity was significantly higher in Pfizer than in Sinovac recipients for all study variables except comorbidities (Table 1). In 670 children receiving the Pfizer/BioNTech vaccine, seropositivity was 91.7% three to four weeks after the second dose, with figures above 90% by 20 weeks after full vaccination (Fig. 1). In 1506 children receiving Sinovac, seropositivity was 91.8% three to four weeks after the second dose, with a declining trend thereafter (Fig. 1).

Discussion

In school-aged Chilean children, SARS-CoV-2 IgG seropositivity surpassed 90% two weeks after the administration of a sec-
ond dose in the case of the inactivated vaccine (Sinovac), and up to 10 weeks after administering a second dose in the case of the mRNA vaccine (Pfizer/BioNTech). Compared with the adult population (Sauré et al., 2022), children showed a slightly weaker response to the mRNA vaccine and a slightly stronger response to the inactivated vaccine in terms of the overall proportion of seropositive individuals in the short-term period after vaccination. Nevertheless, in the case of adults, seropositivity in the inactivated vaccine recipients declines over time, suggesting that a booster dose will most likely be required for children; however, by 22–24 weeks after immunization, we reported a small sample size for the inactivated vaccine. LFTs do not differentiate IgG responses due to vaccination vs infection, which may have influenced some of the responses observed; positivity in a small number of non-vaccinated children reached 27%. Self-reporting of child characteristics reduces robustness for the comparison of comorbidities.

Chile was one of the first Western countries to begin vaccinating children (Ministerio de Salud 2021), a decision that may be relevant given the scenario of circulation of more transmissible variants. With the Omicron variant, SARS-CoV-2 infections and hospitalizations reached high levels in children, but severe clinical outcomes were less frequent than with the Delta variant in this population (Wang et al., 2022). The impact of the COVID-19 vaccines on protection against infection and especially severe disease has yet to be elucidated in children. However, immunization of children could have an impact on both direct and indirect effects of SARS-CoV-2 infection, favoring school attendance, mental health and cognitive learning, especially in vulnerable children (Fore, 2020).

Declaration of Competing Interest

The authors have no conflicts of interest relevant to this article to disclose.

Ethical approval

This study was approved by the Ethics Committee for Clinical Investigation in Humans from the Faculty of Medicine, Universidad de Chile.

Funding source

This study was supported by funds provided by the Ministerio de Salud, Gobierno de Chile. The Ministerio de Salud had no role in designing the study, provided the lateral flow tests used in the study, and funded filed work.

Acknowledgments

All authors declare no conflict of interest. This work was partially supported by a grant from the Instituto Sistemas Complejos de Ingeniería (ANID PIA AFB 180003). Field work and lateral flow tests were funded by the Subsecretaría de Redes Asistenciales, Ministerio de Salud, Chile. We appreciate the important support of all the personnel of the Ministry of Education of Chile in each school of the study.

References

Committee on Infectious Diseases. COVID-19 vaccines in children and adolescents. Pediatrics 2022:149 [E-pub ahead of print].

CTK Biotech.com. Instructions for users, 2021, https://drive.google.com/file/d/1ATHNl4ykn_XhocGZER46e9Y5Zc9oOR/view?usp=sharing; (accessed December 10th, 2021).

Fore HH. A wake-up call: COVID-19 and its impact on children’s health and wellbeing. Lancet Glob Health 2020;8:e861–2.

Frenck RJ RW, Klein NP, Kitchin N, Curtman A, Abhalon J, Lockhart S, et al. Safety, immunogenicity, and efficacy of the BNT162b2 Covid-19 vaccine in adolescents. N Engl J Med 2021;385:239–50.

Han B, Song Y, Li C, Yang W, Ma Q, Jiang Z, et al. Safety, tolerability, and immunogenicity of an inactivated SARS-CoV-2 vaccine (CoronaVac) in healthy children and adolescents: a double-blind, randomised, controlled, phase 1/2 clinical trial. Lancet Infect Dis 2021;21:1645–53.

Ministerio de Salud. Chile 2021, https://www.minsal.cl/autoridades-dan/Inicio-a-la-vacunacion-contra-el-covid-19-en-ninos-desde-los-6-anos/; (accessed January 3rd, 2022)- in spanish.

Ministerio de Salud. Chile 2022. Departamento de Estadísticas e Información de Salud, https://informesde.minsal.cl/SASVisualAnalytics?reportUrl=%2Freports%2Fp9037e283-1278-422c-84e4-16e42a7026c8&sectionIndex=1&so_guest=true&fas-welcome=false; (accessed Feburary 19, 2022).

Sauré D, ORyan M, Torres JP, Zuluaga M, Santelices E, Basso LJ. Dynamic IgG seropositivity after rollout of CoronaVac and BNT162b2 COVID-19 vaccines in Chile: a sentinel surveillance study. Lancet Infect Dis 2022;22:56–61.

Walter EB, Talata KR, Sabharwal C, Curtman A, Lockhart S, Paulsen GC, et al. Evaluation of the BNT162b2 Covid-19 vaccine in children 5 to 11 years of age. N Engl J Med 2022;386:35–46.

Wang L, Berger NA, Kaelber DC, Davis PB, Volkow ND, Xu R. Incidence rates and clinical outcomes of SARS-CoV-2 infection with the omicron and Delta variants in children younger than 5 years in the US. JAMA Pediatr 2022 [E-pub ahead of print].