**Risk factors for SARS-CoV-2 infection and hospitalization in children and adolescents in Norway:**

**A nation-wide population-based study.**

*Ketil Størdal1,2,3, Paz Lopez-Doriga Ruiz3, German Tapia3, Margrethe Greve-Isdahl3, Pål Surén3, Hanne Løvdal Gulseth3.*

*1Department of pediatric research, University of Oslo, Oslo, Norway*

*2Oslo University Hospital, Division of Pediatric and Adolescent Medicine, Oslo, Norway*

*3Norwegian Institute of Public Health, Oslo, Norway*

The disease burden caused by the SARS-CoV-2 virus in the population <20 years is low compared to other age groups. Age is the main predictor of disease severity as shown by the proportion of hospitalization and death by age categories.(1) A lower prevalence of antibodies in young children demonstrated in serology studies indicates that not only severity but also the risk of infection is age dependent.(2-4)

The risk of being infected clearly depends on exposure to infected household members as the primary source of infection,(5) but also exposure from other sources in the environment including peers in daycare/school and leisure activities(6). Little is known regarding socio-economic factors such as household crowding, household size and family income as risk factors for infections in young people.(5) In the US, Afro-American or mixed race was associated with increased hospitalization risk, but underlying socio-economic factors for being infected is likely the driver for this association.(7)

Underlying chronic illnesses that affect children may be associated with increased risk of being infected, particularly children in special care with a high number of contacts. Some of the chronic conditions may also be associated with increased risk of a more severe disease course. A recent review summarized the findings regarding comorbidities in severe SARS-CoV-2.(8) In a hospital-based multicenter study across Europe, 25% of those included had underlying medical conditions. These were identified as risk factors for admission to an intensive care unit (ICU, odds ratio 3.2), with chronic cardiopulmonary disease, neurological conditions and malignancy being the most common.(9) Furthermore, the prevalence of complex morbidity or neuromuscular disease was high among children admitted for ICU care in the US.(10) The data are however unclear due to missing information regarding the baseline occurrence of these conditions in the population. In a large study from the US, underlying medical condition were predictors for hospitalization.(7) However, 88% were excluded due to missing data, which could bias the findings and associations. Risk factors for severity of disease may be biased if underlying factors as chronic disease were part of the test criteria, which to some extent occurred during the early phases of the pandemic.

Improved knowledge of risk factors for being infected or hospitalised is relevant for mitigation and future vaccine strategies. In this nation-wide study covering the first year of the pandemic, we aimed to determine risk factors for infections and for hospitalisation in the population <20 years.

We investigate the epidemiology of SARS-CoV-2 infections in a nation-wide, population-based study covering all individuals < 20 years living in Norway. In an open cohort we include inhabitants <20 years on March 1st 2020 and children immigrated or born between March 1st 2020 and February 28th 2021. End of follow-up is February 28th 2021, age 20 years, death or emigration whichever occurs first. Non-residents (tourists, temporary workers and asylum applicants) are excluded.

Individual-level data are available from the BEREDT C19 registry, developed specifically for emergency preparedness to provide knowledge of the spread of the SARS-CoV-2 virus.(11) In the registry the unique national identification number given to all citizens upon birth or immigration to link is used to link vital sources of information:

* The National Population Registry includes information on household size and country of birth for parents and grandparents.
* The Norwegian Surveillance System for Communicable Diseases (MSIS) includes all positive and negative polymerase chain reaction (PCR) tests for SARS-CoV-2 as well as rapid antigen tests of every resident in Norway. Dates of testing and test result are legally required to be reported from all laboratories to the MSIS. Some negative results could be missing the before April 1st 2020, but all positive results are included. Serology results were not included, except for suspected cases of MIS-C.
* The Norwegian Patient Registry (NPR) is an administrative database that contains data on activity at all publicly funded hospitals and clinics. Reporting to NPR is mandatory and forms the basis for reimbursement in the specialist health service. The registry contains identity and ICD-10 codes (International Classification of Diseases). Listing and grouping of ICD-10 codes relevant for this study is provided in Table 1.
* The Norwegian Registry for Primary Health Care (NRPHC) covers other claims for reimbursement from primary health service therapists to the state. The ICPC-2 (International Classification for Primary Care) code system is used for claims for reimbursement. Listing and grouping of ICPC-2 codes relevant for this study is provided in Table 1.

The main outcome is infection by SARS-CoV-2 as confirmed by a polymerase chain reaction (PCR) test or lateral flow (rapid test) for SARS-CoV-2. To capture severe SARS-CoV-2 infection, hospitalisation with a primary diagnosis of SARS-CoV-2 and/or MIS-C was is used.

To characterize risk factors for infection and severity, we study sex and age (at time of a test or discharge from hospital) as a continuous variable (years) and categorized in age groups. We further study the size of the household (≤2, 3, 4, 5 and ≥6 members) and size of the municipality (categories with <5000, 5-20,000, 20-100,000 and >100,000 residents). The family income is categorized.

To study the potential impact of immigrant status, we classify by the individuals’ country of birth (first generation immigrant), parental country of birth (second generation immigrant) or grandparents (third generation immigrant).

Underlying chronic illnesses are categorized according to type and frequency. With a relatively low proportion of infected children in the society (~1%), we *a priori* decide to study rare conditions grouped in broader categories with a minimum of ~1 000 children (10 infected) to avoid chance findings. The impact of multimorbidity is assessed by adding diagnoses from separate groups as indicated in Table 1.

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