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Ding, Er; Zhang, D.; Bluysen, P.M.

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# Under Pandemic: Assessment of Ventilation in Secondary Schools in The Netherlands

Er Ding<sup>1,\*</sup>, Dadi Zhang<sup>1</sup>, Philomena M. Bluysen<sup>1</sup>

<sup>1</sup> Delft University of Technology, Delft, The Netherlands

\*Corresponding email: [E.Ding@tudelft.nl](mailto:E.Ding@tudelft.nl)

## SUMMARY

To investigate the sufficiency of ventilation during the COVID-19 pandemic for school children, a field study was conducted in 37 classrooms of 11 Dutch secondary schools between October 2020 and June 2021. All the classrooms were visited twice, before and after a three-month national lockdown, when different measures against COVID-19 were taken by the schools. For each visit, both CO<sub>2</sub> concentrations and air temperature were measured during school hours, and detailed information on building/classroom characteristics, occupancy, and COVID-19 measures was collected. Results show that before the lockdown, CO<sub>2</sub> concentrations in most classrooms exceeded the threshold levels of the Dutch Fresh Schools guidelines. The significantly lower CO<sub>2</sub> concentrations measured after the lockdown, however, were mainly due to the decreased occupancy. Moreover, with windows and doors always being opened on purpose, the performance of different ventilation regimes could not be compared, while such behaviour may also lead to thermal discomfort for school children.

## KEYWORDS

Classrooms; CO<sub>2</sub> concentration; Children; COVID-19

## 1 INTRODUCTION

School classrooms as the place where children spend long hours every day, have a high risk of cross-infection of contagious respiratory diseases such as COVID-19 (Dancer et al., 2021). Since airborne transmission is recognized as one of the major transmission routes of infectious agents like SARS-CoV-2, researchers have extensively stressed ventilation as one of the primary infection control measures in indoor environments (Morawska et al., 2020). In practice, however, schools may encounter difficulties and not be able to fulfil the requirements (Fisk, 2017). Hence, with different pandemic control and prevention measures being recommended and implemented, this study is carried out to investigate the existing ventilation settings in school classrooms, as well as assess whether children are provided with sufficient fresh air under the ongoing pandemic.

## 2 METHODS

Between October 2020 and June 2021, a field study was conducted among 37 classrooms of 11 secondary schools in the Netherlands. For each school, three to four classrooms equipped with different ventilation regimes were selected. All the classrooms were visited twice, before and after a national lockdown (from December 2020 to February 2021). The school survey included 1) CO<sub>2</sub> and temperature measurements: CO<sub>2</sub> concentrations and air temperature were continuously measured in the selected classrooms during school hours using HOB0® CO<sub>2</sub> loggers (model: MX1102A), which were placed on the front and back walls; outdoor CO<sub>2</sub> concentrations and air temperature were also measured at the entrance of schools. 2) building and classroom inspections: a technical questionnaire and a classroom checklist were adopted to record the characteristics of building construction, HVAC system, and indoor environment.

3) interviews: detailed information on COVID-19 measures implemented in the schools, both before and after the lockdown, was collected through an interview with the facility managers.

4) occupancy observation: the time of lessons, the number of present students, and the behaviours related to ventilation (e.g., opening/closing windows/doors) were recorded through observation. Statistical analyses were conducted using IBM SPSS Statistics 26.0 (SPSS Inc. Chicago, IL, USA).

### **3 RESULTS AND DISCUSSION**

Results show that before the lockdown, most of the classrooms were used under full occupancy (usual number of children). The CO<sub>2</sub> concentrations were relatively high compared to the Dutch national guidelines of indoor environment in schools (Programme requirements – Fresh Schools 2021) (RVO, 2021), and some exceeded the maximum threshold level, indicating insufficient ventilation. After the lockdown, the CO<sub>2</sub> concentrations in most classrooms largely decreased, which was mainly due to the halved occupancy. Other changes in COVID-19 measures, such as longer/shorter duration of lessons, did not have a significant impact. Moreover, under the pandemic, in order to increase the fresh air supply, the schools tended to keep the windows and doors open during each lesson, which on the one hand helped to enhance natural ventilation, while on the other hand hindered the proper use of mechanical ventilation. Consequently, although the classrooms were equipped with various types of ventilation, comparisons could hardly be made based on the actual operation strategy (that is open windows and doors during each lesson). Besides, the air temperature in the classrooms were found to be lower than the minimum level required by the Fresh School 2021 guidelines during the heating season, which could result in thermal discomfort for the school children.

### **4 CONCLUSIONS**

With the existing settings, the ventilation at the studied Dutch secondary schools failed to meet the current requirements. Temporary pandemic control and prevention measures can be effective, yet cannot be taken as long-term solutions. Opening windows and doors as much as possible is not always helpful, in particular for the classrooms equipped with mechanical ventilation systems. New ways of ventilation are needed in school classrooms to improve the overall health and comfort of school children.

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