

Table 2. Building characteristics and the effect of having windows/doors closed on indoor air pollution concentrations during smoke episodes. All abbreviations are defined in a footnote below the table.

Reference	Setting	Building characteristics	Window status	Effect (I/O ratio or F_{inf})
Studies where windows closed for study period				
Willis et al. 2023 ⁴⁰	Wildfire; Butte, Montana, USA	- Area (sq. ft.): Homeless shelter: 992; senior assisted living: 3680; school building: 14,880	Windows closed	- $PM_{2.5}$ I/O reduced from 0.75–0.87 to 0.49–0.72 during wildfire smoke events comparing rooms with or without a PAC
Montrose et al. 2022 ³³	Wildfire; Idaho, USA	- Skilled nursing facilities (n=4, 15,000 to 30,000 sq. ft.) - Building age (approximate years): 10, 45, 50, and 50	Windows closed	- $PM_{2.5}$ I/O ratio increased from 0.27 to 0.56 comparing non-wildfire to wildfire days - $PM_{2.5}$ F_{inf} increased from 0.29 to 0.59 comparing non-wildfire to wildfire days
Dev et al. 2021 ³⁴	Wildfire; Fairbanks, AK, USA	- 1 university building and 2 residential detached houses - Construction year: University building: 1964, renovated 2002	Windows closed	- $PM_{2.5}$ I/O ratios were 0.37, 0.14, and 0.44 for the university building, House A (no ventilation), and House B (HVAC) respectively
May et al. 2021 ⁴¹	Wildfire; Seattle, Washington, USA	- 2 rooms in a residential detached home (Room A 200 m ³ , and B 50 m ³)	Windows closed	- $PM_{2.5}$ I/O ratio reduced from 0.31–0.50 to 0.003–0.22 for PAC on vs. off during a wildfire
Wheeler et al. 2021 ⁴²	Wildfire; Port Macquarie, NSW, Australia	- Port Macquarie Library, Media Room 22 m ²	Windows closed	- $PM_{2.5}$ F_{inf} reduced from 0.32 to 0.17 with PAC use during wildfire periods
Xiang et al. 2021 ⁴³	Wildfire; Seattle, Washington, USA	- 7 residential detached homes (n=5 PAC, n=2 no filtration) - Construction year: ≤ 1940=1, 1941 to 1960=2, 1961 to 1980=0, 1981 to 2000=2, ≥ 2001=2	Windows closed	- $PM_{2.5}$ F_{inf} reduced from 0.56 to 0.19 comparing PAC on vs. off
Stauffer et al. 2020 ⁴⁴	Wildfire; Butte, Montana, USA	- 2 Montana Technological University offices (12.2 m ²)	Windows closed	- $PM_{2.5}$ I/O ratio was 0.60 for PM _{2.5} when the PAC was turned off

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Henderson et al. 2005 ⁴⁴	Wildfire; Colorado, USA	<ul style="list-style-type: none"> - 4 residential home pairs (1 with PACs, 1 without per wildfire event, n=4) - Area (m³), windows (#), age (years) Polhemus burn: House 1 (PAC): 407, 17, 5; House 2: 815, 27, 7 Snaking wildfire: House 1 (PAC): 453, 7, 3; House 2: 424, 13, 30 Schnoover wildfire: House 1 (PAC): 1415, 37, 6; House 2: 1130, 28, 5 Hayman wildfire: House 1 (PAC): 510, 10, 39; House 2: 396, 21, 39 	Windows closed	- PM _{2.5} F_{inf} reduced from 0.58–0.93 to 0.06–0.34 comparing PACs vs. no PAC
Tham et al. 2021 ⁴⁵	Haze; Singapore	- School building, two classrooms (313 m ³), same location one floor apart	Windows closed	<ul style="list-style-type: none"> - PM I/O ratios reduced from 0.47–0.50 to 0.05–0.07 comparing FFU to control - PM F_{inf} reduced from 0.2–0.3 to 0.06–0.11
Cao et al. 2016 ⁴⁶	Haze; Singapore	- 5 neighboring classrooms (60 m ²), Nanyang Technological University	Rooms have no windows	- PM I/O ratios for all sizes reduced from 0.2–0.62 to 0.06–0.24 comparing MERV 13 or 14 filters with control
Chen et al. 2016 ⁴⁷	Haze; Singapore	- Staff office (300 m ²), Nanyang Technological University	Windows closed	- PM _{0.3} particle concentration I/O ratio reduced from 0.64 to 0.059 comparing AC on vs. off
Studies with window conditions or analysis				
Holder et al. 2025 ³⁸	Wildfire; Missoula, Montana, USA	<ul style="list-style-type: none"> - Church (n = 2), university (n = 2), office (n = 6), hotel (n = 1), fire station (n = 1), museum (n = 2), fitness centre (n = 7), childcare centre (n = 4), community centre (n = 3) - Area range: 6600 to 180,000 sq. ft. - Year range: 1892–2020 	Window type	- PM _{2.5} I/O ratios were significantly increased in buildings with inoperable or sliding windows compared with hinged windows

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Ghetu et al. 2022¹⁵	Wildfire; Washington, Oregon, California, and Idaho, USA	<ul style="list-style-type: none"> - Residential detached homes (n=15) - Age range: 1972–2015 	Windows open average (days): Before wildfires: 10 (range 0–44); During wildfires: 2 (range 0–6)	<ul style="list-style-type: none"> - Vapor-phase LMW and HMW PAH were three and six times higher indoors during wildfires (not significant)
He et al. 2022³⁷	Wildfire; Seattle, Washington, USA	<ul style="list-style-type: none"> - Residential detached homes (n = 4; 1,500 to 3,500 000 sq. ft.), apartment (n = 1, 800 000 sq. ft.), office (n = 2, 135 to 144 sq. ft.) 	Window opening (#) Never: 2 homes, 2 offices; Sometimes: 2 homes; Always: 1 apartment	<ul style="list-style-type: none"> - $PM_{2.5}$ I/O ratio reduced from 0.82 to 0.43 comparing homes with filtration technologies vs. homes without
Reisen et al. 2019⁴⁸	Wildfire and RWC; Yarra Valley and Gippsland, Victoria, Australia	<ul style="list-style-type: none"> - Residential detached homes: prescribed burns (n = 4), and RWC (n = 3) - Building age range (years): 8 to 98 	Windows open: 4 homes Windows closed: 3 homes	<ul style="list-style-type: none"> - $PM_{2.5}$ I/O ranged from 0.13 to 2.9 - $PM_{2.5}$ F_{inf} was 0.58 and 0.3 for prescribed burns and RWC impacted houses, respectively
Shrestha et al. 2019²⁶	Wildfire; Denver, Colorado, USA	<ul style="list-style-type: none"> - Residential detached homes (n = 28) - Building type (homes): Built green: 5; EER: 13; Non-EER 10 	Windows open hours (homes): 0=3, 1–6=4, 7–12=5, >12=16	<ul style="list-style-type: none"> - $PN_{0.5-2.5}$ and BC F_{inf} were 0.4 and 0.52 during smoke plume periods (PM density $\leq 27 \mu g/m^3$) - $PN_{0.5-2.5}$ and BC F_{inf} were significantly higher by 45% (0.46 vs. 0.84) and 67% (0.28 vs. 0.84), respectively, when windows were open for ≥ 12 hours
Barn et al. 2008³⁶	Wildfire and RWC; British Columbia, Canada	<ul style="list-style-type: none"> - RWS: 21 residential detached homes - Wildfire smoke: 17 residential detached homes - Area (square feet): 640–4330 - Windows range (#): 4–21 - Building age (years): 5–60 	Windows open: Never: RWS 12, Wildfire 0 Sometimes: RWS 2, Wildfire 9 Always: RWS 2, Wildfire 4	<ul style="list-style-type: none"> - $PM_{2.5}$ F_{inf} reduced from 0.61 to 0.19 (wildfire) and 0.28 to 0.10 (RWC) comparing PAC on vs. off - Increasing window number associated with increased infiltration ($p < 0.0001$)

Reference	Setting	Building characteristics	Window status	Effect (I/O ratio or F_{inf})
Tran et al. 2021 ¹⁹	Haze; Singapore	- Bedroom in a residential apartment (10.5 m ²), 13th of 25 stories, natural ventilation	Condition: NV = Windows kept open, AC = Windows closed AC on, PAC = Windows closed PAC on	- I/O ratios reduced for PM _{2.5} (0.98 to 0.72 to 0.25), BC (0.97 to 0.60 to 0.15), Ions (1.00 to 0.71 to 0.21), and WSTE (0.79 to 0.42 to 0.07) for NV, AC, and PAC conditions, respectively
Sharma et al. 2017 ²²	Haze; Singapore	- Living room in a residential apartment, 20th floor, natural ventilation	Windows open and closed conditions	- PM _{2.5} I/O ratio reduced from 0.76 to 0.62 to 0.32 comparing windows open to windows closed to PAC on with windows closed
Kajbafzadeh et al. 2015 ³⁵	RWC; Vancouver, British Columbia, Canada	- Residential detached homes (n=20)	Time open windows mean ± SD (%): 15.2 ± 31.3	- PM _{2.5} I/O ratio reduced from 1.3 to 0.87 comparing PAC use with placebo
Artinano et al. 2017 ¹⁸	Landfill fire; Seseña, Toledo, Spain	- School building	Windows closed, windows open for 30 minutes (test condition)	- BC maximum with windows open vs. closed (1.2 vs. 1.8 µg/m ³)

*Abbreviations: **AC**: air-conditioning, **ACMV**: air-conditioning and mechanical ventilation, **AQI**: air quality index, **BC**: black carbon, **FFU**: fan filter unit, **HMW**: high molecular weight, **LMW**: low molecular weight, **NR**: not reported, **NV**: naturally ventilated, **OP**: oxidative potential, **PM_{x-y}**: particulate matter x-y µm in diameter, **PN**: particle number, **RWC**: residential wood combustion, **WSTE**: water soluble trace elements.