

COVID-19 and Gas-Powered Leaf Blowers: A Lethal Combination

Abstract

This memorandum discusses three specific problems that gas-powered leaf blowers (GLBs) present during the COVID-19 crisis, including: (i) an increased risk of complications and death from COVID-19 due to the fine particulate matter generated by GLBs; (ii) the sleep, concentration, and other health problems caused by the noise generated by GLBs, which is interfering with the ability of adults and children who are trying to work, learn, and rest at home; and (iii) the disproportionate risks of COVID-19-related illness that landscape workers face as a result of working with GLBs. The authors review the existing literature on the health and environmental problems associated with GLBs and recommend a moratorium on the use of GLBs (and possibly electric/battery blowers too) during the pandemic, as well as a longer-term plan that includes a phase-out of GLBs and help to transition the landscape industry to cleaner, quieter, and healthier alternatives.

MEMORANDUM

Re: **COVID-19 and Gas-Powered Leaf Blowers:
A Lethal Combination**

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PART I: Issue

Gas-powered leaf blowers (GLBs) present three specific problems during the current COVID-19 crisis:

- 1. Pollution from GLBs Increases Risk of Complications and Death from COVID-19.** It is well established that air pollution from GLBs, including fine particulate matter, is hazardous to lung functioning and our respiratory and overall health [1-4]. In fact, both short-term and long-term exposures to fine particulates are known to be harmful [1-4]. This month, researchers at the Harvard School of Public Health released the results of a study that specifically linked that type of pollution (i.e., fine particulate matter) to a higher risk of complications and death from COVID-19 infection [5, 5a]. They found that a one-microgram increase in concentration of fine particulate matter is associated with an 8% increase¹ in risk of death from COVID-19 infection [5]. This is extremely important because a single commercial GLB emits *tens of millions of micrograms of fine particulate per hour* [6-7] at ground level where it is easily inhaled. And these particles may stay suspended in the air for a week or longer [8].
- 2. Noise from GLBs creates other health problems.** The penetrating noise from two-stroke GLBs not only poses threats to hearing but also causes stress-mediated disorders such as heart disease, psychological disturbances, and metabolic abnormalities, some of which raise the risk of complications from COVID-19 [9-10]. In addition, GLB noise interrupts concentration and impairs recovery from illness and interferes with children's learning and with people's ability to work at home [11-12]—which is of special concern as we shelter in place during the COVID-19 crisis. **Vitally important is the situation of first responders and other health care workers—especially those working night shifts—who are unable to sleep during the day because of GLB noise** [13-14].
- 3. Landscape Workers Face Disproportionate Risks from COVID-19 Due to GLBs.** Pollution from GLBs is emitted in close proximity to human airways and is thus easily inhaled by landscape workers [6, 15-20]. These emissions include fine particulates, volatile organic compounds, and carbon monoxide, all of which are known to be associated with higher risks of diseases, including cancer, heart and lung disease, developmental disorders infection, and death (including from COVID-19) [1-6, 21-25]. In fact, a number of medical societies [26] and agencies including NIOSH [27] and the California Air Resources Board [16, 21] have acknowledged/raised concerns about the problem. The risk to workers is compounded by the fact that landscape crews are often asked to simultaneously operate multiple GLBs (in violation of industry guidelines) [28-29]). In addition, landscape workers are often asked to ride together in trucks and are unable to maintain safe physical distance. As a result of these conditions, workers are exposed to extraordinary levels of pollution, putting them at higher risk of complications and death from COVID-19 and increasing the chance they will spread the virus to their families and co-workers. It is important to note that many landscape workers are minorities who, statistically speaking, are already at higher risk of COVID infection and mortality [30].

¹ Their preliminary results from a smaller dataset indicated a 15% increase in risk, as reported in *The NY Times* [5a].

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PART II: Action Required

In light of the COVID-19 crisis, policymakers must act *immediately* to protect the public from the health hazards posed by GLBs. Specifically, policymakers must:

- Impose an **emergency moratorium** on the use of GLBs (and ideally on the use of electric/battery blowers too).
- Educate the public (including landscape workers) about the risks associated with GLBs, including those associated with the COVID-19 pandemic
- Remind landscapers that their workers must wear masks and follow social distancing rules.
- Adopt a longer-term plan to promote the use of cleaner, healthier alternatives, such as raking and electric/battery equipment.

Such a moratorium will not affect the ability of landscapers to continue working during the pandemic. They are and should remain “essential workers.” A moratorium requires only that landscapers: (i) stop using GLBs to blow grass clippings and dust during weekly maintenance, and (ii) shift to manual tools (or possibly electric/battery powered tools) for larger jobs (i.e., fall/spring cleanups). For a more detailed discussion of the mechanics and feasibility of such a transition, see **Part V**.

Several towns in the U.S. have already imposed emergency moratoriums due to the pandemic. (See [Exhibit A](#) for a Sample Emergency Order). As one mayor noted,

“COVID-19 is fundamentally an insidious respiratory condition . . . having particulates of dust and dung blown into the air with the force that a leaf blower brings creates a HAZMAT situation. We breathe those particulates; they are getting into and irritating our lungs. Particulates hang in the air for hours after a leaf-blower has been shut off... our neighborhood streets are far more active, especially during the daylight hours when our children would be -- under normal conditions -- in school” [31].

In addition to the above emergency measures, policymakers should also take steps over the longer term to promote the permanent conversion to cleaner, quieter, and healthier alternatives (see **Part V**).

PART III: The Problems with GLBs

The negative effects of noise and pollution from GLBs have been known for a long time. Indeed, they cause or contribute to the following serious health [1-4, 8-10, 21-25] and environmental [32-33] problems:

- Heart disease, hypertension, heart attacks, heart failure, and strokes
- Lung disease, including asthma, COPD, and acute respiratory infection
- Cancer
- Hearing damage, including hearing loss, tinnitus, and hyperacusis
- Neurological disorders, including dementia, autism, and Reynaud’s syndrome
- Developmental, reproductive, and metabolic disorders, as well as psychological problems
- Learning and concentration issues, especially in children
- Contamination of air, soil, and water
- Loss of vegetation, insects, and biodiversity

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Why are GLBs so problematic?

1. **GLBs have especially “dirty” engines.** Most GLBs have two-stroke engines that run on a combination of gasoline and oil. Two-stroke engines feed more of the fuel/oil mixture than is necessary into the combustion chamber, which means that as much as 30% of the fuel/oil mixture escapes *unburned* into the atmosphere [21]. Thus, exhaust emissions from GLBs consist of *both* unburned fuel and products of combustion. Research shows that GLBs produce large amounts of carbon monoxide (which is toxic), hydrocarbons (which are toxic, carcinogenic, and ozone-forming), and fine particulates (which are toxic, carcinogenic and now known to raise the risk for COVID-19 death) [6, 15-21]. In fact, the main hydrocarbons produced by GLBs (benzene, butadiene, and formaldehyde) are listed among the four top-ranking cancer-causing compounds [34]. One independent vehicle emissions testing lab found that, when it comes to producing hydrocarbons, running a GLB for 30 minutes was the same as driving a Ford F-150 truck from Texas to Alaska [35]. More recently, the California Air Resources Board equated the pollution from an hour of GLB use to driving 1,100 miles in a 2017 Toyota Camry [36]. California air quality officials state that in 2020, leaf blowers and other small gas engines used in lawn maintenance and gardening will create more [hydrocarbon-based] ozone pollution than all of the passenger cars in the state [20]. The fine particulates produced by GLBs are also concerning. Short-term and long-term exposure have both been linked to serious health effects and higher risk of death [1-4]. In 2013, the World Health Organization concluded that fine particulate matter is associated with increased cancer incidence, specifically lung and bladder cancers [37]. And GLBs produce copious amounts of fine particulates. Indeed, a single commercial backpack GLB can produce 30 million micrograms of fine particulates every hour [6-7]. And these particles may stay suspended in the air for a week or longer [8].
2. **GLBs disperse other harmful materials.** In addition to exhaust pollution, the powerful air jet (150-280 mph) of a single GLB can disperse up to five pounds of coarser particulates from the ground into the air *every hour*—particles that may carry pesticides, herbicides, fertilizers, animal droppings, spores, fungi, pollens, brake-lining dust, tire residue, heavy metals—all detrimental to our respiratory and general health [21]. (See video [38]). It is important to note that, while electric/battery-powered blowers eliminate the problem of exhaust pollution, they too may disperse harmful coarser substances from the ground.²
3. **GLBs operate close to humans.** Unlike emissions from power plants and industrial sources, pollution from GLBs is emitted at ground level, where it is easily inhaled. Indeed, for workers, this may be especially hazardous [6, 15-20] (See video [39]). Tests of several commercial GLB models show that concentrations of ultrafine particles (the most hazardous type of fine particulates) were found to be up to 54 times higher within a few feet of use than in a busy highway intersection in Los Angeles [18-19].
4. **GLB noise is harmful, travels long distances, and penetrates walls and windows.** Popular models of commercial GLBs emit noise that exceeds 100 decibels at the source and are 76-83 decibels at 50 feet [40].³ According to the US CDC and NIOSH,⁴ the maximum recommended

² Because the jet velocities of electric/battery blowers are lower (150-170 mph), they typically create smaller plumes of particulates and debris [40]. Moreover, due to concerns about battery life, landscapers tend to use electric/battery blowers more judiciously and at lower power settings, which also reduces the dispersion of ground-sourced particulates and debris.

³ The occupational standard (NIOSH) is 85 decibels averaged over an 8-hour day.

⁴ US Centers for Disease Control and Prevention (CDC) and National Institute of Occupational Safety and Health (NIOSH) [QuietCommunities.org](https://www.quietcommunities.org) is a nonprofit organization whose mission is to transition landscape maintenance to low noise, zero emissions practices with positive solutions to protect the health of workers, children, the public and the environment.

exposure to 100 decibel noise is 15 minutes [41-42]).⁵ Landscapers operate GLBs for hours a day, several days a week, often in groups of 2 or more, thereby exposing themselves and members of the public to chronic levels of harmful noise (see video [43]). The adverse effects of such noise on hearing and our general health is well documented and include heart disease, sleep disturbance, psychological, cognitive and learning problems, and metabolic abnormalities [9-10]. Noise in excess of 60 decibels increases risk of heart disease [10]. In addition, GLB noise has a strong low frequency component, enabling it to travel long distances and penetrate walls and windows [44-46]. Low frequency noise is of special concern to health, as stated in the WHO Guidelines on Community Noise [47]. A single GLB can affect 90-100 homes in a densely populated neighborhood [48] with harmful noise levels (≥ 55 decibels, defined by WHO and EPA [47, 49]). People especially affected by GLB noise include people working from home, children schooling at home, night workers (including first responders and health care workers), those affected with autism and sensory processing disorders, and veterans and others with post-traumatic stress disorder [13, 50-52].

5. **GLBs and spread of COVID-19 and other diseases.** Preliminary studies from Italy have found the presence of the COVID-19 virus on coarse airborne particulates, raising the possibility that airborne particulates contributed to the rapid spread of COVID-19 in hard-hit regions of that country [53-54]. In addition, a study of landscape workers in Martha's Vineyard showed that those operating leaf blowers were at increased risk for tularemia (a contagious, potentially life-threatening bacterial infection), presumably due to the aerosolization of the bacteria and infected materials [55]. A recent study from China suggests that strong airflow from a restaurant air conditioning system helped spread the COVID-19 virus [56]. These studies raise the possibility that air flow from GLBs is a source of transmission for COVID-19.
6. **GLBs harm the environment, wildlife, and ecosystems.** GLBs consume hundreds of millions of gallons of gasoline every year, generate tens of millions of tons of CO₂, spill tens of millions of gallons of fuel into soil and storm drains, and add toxic, non-recyclable waste to landfills [6, 57-59]. The high velocity air jets of GLBs destroy nests and habitats, desiccate pollen, sap, other natural plant substances, and injure or destroy birds, small mammals, and beneficial insects that live in the leaf litter [33, 60-61]. Instead of nurturing our landscapes, GLBs damage plants, remove beneficial topsoil and mulch, and desiccate soil. In fact, experts say that leaving grass clippings and leaves in place is actually beneficial to the environment and healthy for the lawn [62-63].
7. **Non-compliant and excessive use of GLBs compound the threat.** Landscapers routinely violate industry recommendations and local government regulations on the proper use of GLBs [28-29, 64]. As noted above, instead of using just one at a time, it is common to see two, three or more GLBs used simultaneously, even on small properties. Moreover, instead of running these machines at the lowest possible throttle to reduce noise and dust, GLBs are typically run at full throttle, generating tremendous noise and large clouds of ground particulate matter and dust [64]. Landscapers are also using GLBs more frequently and not just for large cleanups or leaf removal. In many parts of the country, landscapers are using GLBs *every week* to blow grass clippings—a practice that, as noted above, is unnecessary and environmentally unsound. Landscapers have also been spotted using these machines for unusual/inappropriate tasks such as sand and snow removal (see videos [65-66]). These practices have even raised the concern of a major industry lobbyist who recommends the use of quieter blowers [64].

⁵ The decibel scale is logarithmic. Small increases in decibel level mean sharp decreases in permissible exposure times. QuietCommunities.org is a nonprofit organization whose mission is to transition landscape maintenance to low noise, zero emissions practices with positive solutions to protect the health of workers, children, the public and the environment.

PART IV: Current State of Leaf Blower Regulation

Two hundred cities/towns across the U.S. have already enacted some form of legislation to restrict or ban the use of GLBs ([Exhibit B](#)). In addition, four counties (one each in Arizona, California, Maryland and Virginia) have done the same. The state of Hawaii has statewide restrictions on use [67] and has considered banning them entirely [68], as have California and Illinois, more recently [69-70]. Ann Arbor, MI has banned all 2-stroke engines in its downtown area [71]. But many other jurisdictions have failed to act—and health professionals are concerned. Major health and environmental organizations, including the US Centers for Disease Control and Prevention [41], the American Lung Association, the National Institutes of Health, physician groups in California, New York ([Exhibit C](#)), and Utah, and various medical societies, have warned against their use and/or the use of gas-powered lawn and garden equipment. The Medical Society of the State of New York and the Massachusetts Medical Society have both passed resolutions discouraging the use of GLBs because of their detrimental effects on workers and public health ([Exhibit D](#)).

PART V: How Can We Permanently Transition to Cleaner, Quieter, Healthier Practices?

Transitioning to cleaner, quieter, healthier equipment is a 3-step process, one that provides immediate benefits to the community while simultaneously giving landscapers time to acquire and adapt to greener technology.

Step 1. Adopt an emergency moratorium on GLBs (and ideally, on the use of electric/battery blowers too) (see **Part II** above).

Step 2: Ban the use of GLBs during “summer” and “winter” months. Policymakers should encourage municipalities to adopt a ban on the use of any GLBs, EXCEPT for two brief periods in the spring and fall to allow for large seasonal cleanups.

As noted above, blowing grass clippings weekly (i.e., the primary purpose of summer use) is not only unnecessary, it negatively affects lawn, soil, and plant health [63]. Similarly, the weekly blowing of dust and debris or the winter blowing of snow, especially with 200+ mph air jets, is unnecessary, hazardous to health, and contrary to industry recommendations [28-29, 64]. Rakes and brooms (possibly supplemented with electric/battery blowers,) represents a practical alternative for routine clean-up work. Street sweepers, not leaf blowers, should be used to safely remove sand from roads in northern states.

We note that such a ban on GLBs should not affect the cost of weekly service. By abandoning weekly blowing with GLBs, landscapers will save time (i.e., lower labor costs) and money (i.e., lower fuel and maintenance costs). In fact, those savings can offset the price of larger clean-ups with greener (zero emissions, low noise) equipment and may allow landscapers to service more customers and/or become more profitable. This could be a triple win: for the public, landscapers, and the environment.

Step 3. Phase Out the Use of GLBs Entirely. In addition to the moratorium and ban described above, policymakers should encourage municipalities to adopt regulations that *phase out the use of GLBs entirely* (i.e., ban GLBs even for large seasonal cleanups). Such a ban should be phased in over a sufficient period (e.g., 18-24 months) to give landscapers time to transition to greener and healthier alternatives.

The American Green Zone Alliance (AGZA) actively assists municipalities, schools, and businesses in transitioning to zero emissions, low noise practices. According to AGZA President, Dan Mabe, the operating costs of battery/electric equipment are a fraction of the costs of gas equipment because of avoided fuel and maintenance costs [58]. And those savings can help defray the cost of new, greener equipment. However, the initial high capital cost of establishing battery banks adequate for commercial workloads and the need for proper training of operators must be taken into consideration.

To help finance that transition, landscapers could charge a small premium for green landscaping (including hand raking)—at least initially. Many clients who use landscaping services can afford this and many people, when surveyed, have indicated they are willing to pay a bit more for quieter/cleaner landscaping [72]. Crowdsourcing is another potential source of funding. In addition, municipalities, donors, and other stakeholders can establish financial incentives and loan programs to help landscapers transition. At the same time, nonprofits and other experts can (i) guide the selection of the “right” equipment, (ii) educate and train workers (e.g., safety, charging infrastructure, operation, care), and (iii) demonstrate how Return on Investment can be achieved and profitability increased. All stakeholders should help raise awareness of the dangers of GLBs and the need for cleaner, quieter, and healthier equipment.

There is no doubt this can be accomplished. Today, around 200 companies operate exclusively with electric- or battery-operated machines and/or manual tools [73] and entire municipalities and school districts are operating with electric and manual tools for all routine maintenance. These cities and schools have been certified as AGZA Green Zones[®] and have substantially reduced toxic and carcinogenic emissions, noise, waste, and carbon dioxide [74].

PART VI: Conclusion

The new and serious threats posed by the COVID-19 pandemic highlight the dangers posed by GLBs and require immediate intervention. The pollution and noise discharged by these machines are hazardous to the health of workers, the public, and the environment. Policy makers need to take immediate action to stop their use during the pandemic and also take steps to transition the industry to cleaner, quieter, healthier equipment and practices through appropriate policies and regulation.

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References

1. American Lung Association. [Particle Pollution](#). Accessed 4/19/20.
2. U.S. Environmental Protection Agency (2019) [Integrated Science Assessment for Particulate Matter-Final Report](#), EPA/600/R-19/188. Accessed 4/19/20.
3. Thurston GD, Kipen H, Annesi-Maesano I, et al (2017) [A joint ERS/ATS policy statement: what constitutes an adverse health effect of air pollution? An analytical framework](#), Eur Resp J
4. Paulin L, Hansel N (2016) [Particulate air pollution and impaired lung function](#), F1000Res, Feb 22.
5. Wu X, Nethery RC, Sabath MB, et al. [Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study](#). Report (as of April 24, 2020), Harvard TH Chan School of Public Health, Dept of Biostatistics; 5a. [Earlier report](#) (as of April 5, 2020) covered in Wilson M (2020) [Meanwhile, in the Suburbs: Leaf Blower Drama](#), *The New York Times*, April 10.
6. Banks JL, McConnell R (2015) [National Emissions from Lawn and Garden Equipment](#), presented at the International Emissions Inventory Conference, San Diego, April 13-16.
7. [Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition](#), US Environmental Protection Agency, July 2010, EPA-420-R-10-019, NR-010-f.
8. U.S. Environmental Protection Agency (2018) [Report on the Environment: Particulate Matter Emissions](#).
9. Basner M, Babisch W, Davis A, et al (2014). [Auditory and non-auditory effects of noise on health](#). Lancet 383: 1325–32.
10. Munzel T, Schmidt FP, Steven S, et al (2018) [Environmental noise and the cardiovascular system](#). J Amer Coll Cardiol 71:88-697. doi: 10.1016/j.jacc.2017.12.015.
11. Propper D (2020). [Some villages banning leaf blowers amid coronavirus work at home orders](#). Journal News, April 17.
12. Wilson M (2020) [Meanwhile, in the Suburbs: Leaf Blower Drama](#), New York Times, April 10.
13. Fink DJ, [Post-Hearing Statement of Daniel Fink, M.D., to the Washington, D.C. City Council's Committee of the Whole Regarding the Leaf Blower Amendment Act of 2017](#) (Bill No. 22-234), July 2, 2018.
14. [Letter from K Jubanyik, MD](#), April 19, 2020.
15. Volckens J, Braddock J, Snow RF, et al. [Emissions profile from new and in-use handheld, 2-stroke engines](#). Atmospheric Environment 2007;41:640-649.
16. California Air Resources Board (2018) [Summary Document: Operator Exposure to Emissions from Lawn and Garden Equipment](#), October 12.
17. Baldauf R, Fortune C, Weinstein J, et al (2006) [Air contaminant exposures during the operation of lawn and garden equipment](#). J Expos Sci Environ Epidemiol 16:362–370
18. Silverstein S, Boiko-Weyrauch A (2017) [Noisy, but that's not all: Leaf blowers flagged as prodigious polluters -- and possible health threat](#), FairWarning, September 19.
19. Dekeyan HC, Steedman-Lyde J. Health Science Associates. [Industrial Hygiene Survey. HSA Project 170335LA](#). September 14, 2017.
20. Gorn, David (2017) [More Pollution Than Cars? Gas-Powered Gardening Equipment Poses the Next Air Quality Threat](#), KQED News, February 13.
21. California Air Resources Board, California Environmental Protection Agency. Mobile Source Control Division (2000) [A Report to the California Legislature on the Potential Health and Environmental Impacts of Leaf Blowers](#). Accessed 4/19/20.
22. American Heart Association. [Facts: Danger in the Air -Air Pollution and Cardiovascular Disease](#). Accessed 4/19/20.
23. American Lung Association, [Ozone](#), Accessed 4/19/20.
24. U.S. Environmental Protection Agency (2013) [Integrated Science Assessment for Ozone and Related Photochemical Oxidants](#). EPA/600/R-10/076F.

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25. Raz R, Roberts AL, Lyall K, et al (2015) [Autism Spectrum Disorder and Particulate Matter Air Pollution before, during, and after Pregnancy: A Nested Case–Control Analysis within the Nurses’ Health Study II Cohort](#). Environ Health Perspect 123(3):264-70.
26. Massachusetts Medical Society (2017) [Policy of the Massachusetts Medical Society Concerning Gas Powered Leaf Blowers](#), April 29.
27. [Study participants wanted: NIOSH to explore hazards in landscaping and groundskeeping](#) (2020) Safety & Health, Feb 25.
28. [Leaf Blower: A Training Manual in the Proper Use of Leaf Blowers](#). Echo, Inc. Accessed 4/19/20 at A Training Manual in the Proper Use of Leaf Blowers
29. [A Guide to Safe and Courteous Use](#). OPEI/Stihl.
30. U.S. Centers for Disease Control and Prevention (2020) [COVID-19 in Racial and Ethnic Minority Groups](#), Page last reviewed April 22.
31. [Order to ban leaf blower use for the during of the COVID-19 pandemic](#) from Ken Wray, Mayor, Village of Sleepy Hollow, NY, April 3, 2020.
32. California Department of Fish and Wildlife (2015). [Gasoline Spills Fact Sheet](#). February 26.
33. [Leaf blowers fatal to declining insects, Germans warned](#). BBC News, November 19, 2019.
34. Loh MM, Levy JI, Spengler JD, et al (2007) [Ranking Cancer Risks of Organic Hazardous Air Pollutants in the United States](#), Environ Health Perspect 115:1160–1168.
35. Edmunds.com, [Emissions Test: Car vs. Truck vs. Leaf Blower](#), 2011. Video at <http://www.youtube.com/watch?v=pDxQIH0Tmxs>
36. California Air Resources Board (2017) [Small Engine Fact Sheet](#).
37. International Agency for Research in Cancer, World Health Organization (2013) [Air Pollution and Cancer](#). K Straif, A Cohen, J Samet (Eds), Scientific Publication 161, Lyon Cedex FR:IARC, 2013.
38. Quiet Communities, Inc., [Good morning commuters, please detour](#) (video), October 22, 2013, http://youtu.be/FFzBKmxzq_U
39. Quiet Communities, Inc., [Blower hygiene](#) (video), April 21, 2014, <http://youtu.be/5hRC37Q7b8E>
40. Johnson, T (2019) [Best backpack blower shootout](#), opereviews.com, December 26.
41. US Centers for Disease Control and Prevention (2017) [Too Loud, Too Long. CDC Vital Signs](#).
42. U.S. Centers for Disease Control and Prevention, NIOSH. [Noise and hearing loss prevention: Guidance and regulations](#). Accessed 4/20/20.
43. Quiet Communities, Inc. [Next Door Decibels](#) (video), April 28, 2015, <https://www.youtube.com/watch?v=tCLmE6C9sGk>
44. Walker E, Banks, JL (2017) [Characteristics of Lawn and Garden Equipment Sound: A Community Pilot Study](#). J Environ Toxicol Stu 1(1) doi <http://dx.doi.org/10.16966/jets.106>
45. Pollock C, Sparks G, Banks JL (2018) [Lawn and Garden Equipment Sound: A Comparison of Gas and Battery Electric Equipment](#). J Environ Toxicol Stud 2(2): dx.doi.org/10.16966/2576-6430.118
46. Pasanen T, Ryttonen E, Sorainen E (2004). [Leaf Blower Noise](#). Joint Baltic-Nordic Acoustics Meeting 2004, June 8-10, Mariehamn, Åland BNAM2004-2. Accessed 4/19/20.
47. World Health Organization (1999) [Guidelines for Community Noise](#). Berglund B, Lindvall TM, Schwela DH (Eds). Geneva.
48. Banks JL. [Report in Support of the Leaf Blower Regulation Amendment Act of 2017, Bill 22-234 DC Council of the Whole](#), Washington D.C. City Council, July 2, 2018.
49. [Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety](#). Washington, DC:US Environmental Protection Agency, March 1974, Publication 550/9-74-004.
50. Van Kamp I, Davies H (2013) [Noise and health in vulnerable groups](#). Noise and Health 15:153-159.
51. Fagelson MA (2007) [The association between tinnitus and posttraumatic stress disorder](#). Am J Audiol 16:107-117.

52. Center for Hearing and Communication. [The impact of noise on childhood cognitive development: Poor classroom acoustics: The invisible reason Johnny can't read](#). Accessed 4/19/20.
53. Setti L, Passarini F, De Gennaro G, et al (2020) [Evaluation of the potential relationship between Particulate Matter \(PM\) pollution and COVID-19 infection spread in Italy](#). A report from the Italian Society of Environmental Medicine, University of Bologna, and University of Bari.
54. Setti L, Passarini F, De Gennaro G, et al (2020) [SARS-Cov-2 RNA Found on Particulate Matter of Bergamo in Northern Italy: First Preliminary Evidence](#) (not yet peer reviewed), medRxiv
55. Feldman KA, Stiles-Enos D, Julian K, et al (2003) [Tularemia on Martha's Vineyard: Seroprevalence and occupational risk](#). Emerging Infectious Diseases 9:350-354.
56. Lu J, Gu J, Li K, et al (2020) [COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China](#), 2020, Emerg Infect Dis. <https://doi.org/10.3201/eid2607.200764>
57. US Department of Energy (2010) [Fact #635. Fuel Consumption from Lawn and Garden Equipment](#), August 9.
58. Dan Mabe, American Green Zone Alliance, Studio City, CA, personal communication.
59. Steinberg, T. (2006). American Green, The Obsessive Quest for the Perfect Lawn. W.W. Norton & Co. ISBN 0-393-06084-5.
60. Green Jay Landscaping (2019) [Blog: Why leaf blowers & lawn care practices are hazardous to our health](#), April 1.
61. Knoedler M, Baranow M, Dix K (2017) [Pollinator Protection in Williamstown, MA](#). Williams College.
62. Mizejewski D (2014). [What to do with fallen leaves](#). A blog of the National Wildlife Federation, November 12.
63. University of Minnesota Extension, [What to do with lawn clippings?](#) Accessed 4/20/20
64. Will L (2018) [Industry specialist warns leaf blower bans are coming if changes are not made](#), Total Landscape Care, Jan 18.
65. Quiet Communities, Inc., [Spring clean-up](#) (video), April 21, 2014, <http://youtu.be/maskgTda07HI>
66. Quiet Communities, Inc. [Blowing deep snow on a roof](#) (video), January 30, 2015, <https://youtu.be/iXLEycUrvjs>
67. Quiet Communities, Inc., Ordinance database, last update March 2020.
68. David M-E (2010) [Hawaii lawmakers seek tough restrictions on leaf blowers](#). Hawaii News Now, March 10.
69. Benoit C (2020) [California looking to ban gas-powered lawnmowers, leaf blowers](#). Electtrek.com, January 9.
70. [Proposal Filed to Ban Gas-Powered Leaf Blowers in Illinois](#) (2020) WCSJ, February 17.
71. Stanton R (2019) [Ann Arbor bans 2-cycle leaf blowers, other equipment downtown](#). Michigan Live, July 29.
72. Marea Hatziolos, personal communication, from discussions with residents in Chevy Chase, MD, 2019.
73. Quiet Communities, Inc. Database of eco-friendly landscapers.
74. AGZA Green Zones[®] at agza.net