Lane, Roger

From: Amanda Hirsch <ahirscha@gmail.com>
Sent: Tuesday, June 12, 2018 12:48 AM
To: Lane, Roger

Subject: Unable to attend June 12th Hearing

Hello Roger,

Please submit this as my testimony against the cement plant since I will be unable to attend the meeting.

Dear Dane County Committee Members,

According to the EPA website cement companies are the third largest industrial air pollutant. A cement batch plant is not beneficial to the town of Burke.

The EPA states that cement companies emit more than 500,000 tons per year of sulfur dioxide, nitrogen oxide, and carbon monoxide. This is directly from the EPA website at https://www.epa.gov/enforcement/cement-manufacturing-enforcement-initiative

> Health and Environmental Effects of Cement Plant Emissions
>
> Cement plants are a significant source of sulfur dioxide, nitrogen oxide and carbon monoxide, which are associated with the following health and environmental impacts:
>
> Nitrogen oxide (NOx) can cause or contribute to a variety of health problems and adverse environmental impacts, such as ground-level ozone, acid rain, global warming, water quality deterioration, and visual impairment. Affected populations include children, people with lung diseases such as asthma, and exposure to these conditions can cause damage to lung tissue for people who work or exercise outside.
>
> Sulfur dioxide (SO2) in high concentrations can affect breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. SO2 is also a primary contributor to acid deposition, or acid rain.
>
> Carbon monoxide (CO) can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues, as well as adverse effects on the cardiovascular and central nervous systems. CO also contributes to the formation of smog (ground-level ozone), which can cause respiratory problems.

Another EPA website talks specifically about Portland cement which is an ingredient in concrete. It talks about how the EPA is putting regulations on cement companies to reduce emissions and the specific health risks that each toxin leads to. At most, removing 36% of one specific toxin. That still leaves a large percentage of pollutants out in the air. Especially for being so close to a residential area. More information is on their site at https://www.epa.gov/sites/production/files/2016-04/documents/1999_neshap_factsheet.pdf

There are numerous studies indicating the health issues from having a cement plant close to residential areas. Here are a few.

> https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4338829/pdf/40557_2014_Article_48.pdf
>
> file:///home/chronos/u-efd60bd4f19c5a46caa532bd506ca9246d26a509/Downloads/paper166523_0.pdf

https://link.springer.com/article/10.1007/s00420-017-1244-9

Many school and residential areas that have a cement plant try to come in have been fighting to prevent the plant for these same health risks.

For Zinego Ready Mix this does seem like prime real-estate being right across the street from an active landfill and asphalt company. However, the town of Burke still has room to grow. The land could be used for other commercial use that will not have such a negative impact on the environment or current residents and still generate revenue for the town. This land is also prime real-estate for other companies as well with its proximity to Madison and the growing outskirts for Sun Prairie. I implore you to pursue other options for this land.

Sincerely,

Amanda Hirsch

Lane, Roger

From:	Sonja Lund <sonja.lund@aol.com>
Sent:	Monday, June 11, 2018 11:18 PM
To:	Lane, Roger
Subject:	JUNE 12th DANE COUNTY Public hearing for Conditional Use Permit #2416

Mr. Lane,

I am writing this you so that hopefully you will reconsider the decision to allow the cement trucking company to move in to the Nelson Road and Feland Road area. My husband and I have lived at 5831 Lupine Lane (near the intersection of Feland Road and Nelson Road) for almost 10 years. We chose this area at the time for its location for the country-like feeling. We are able to watch the wild life (deer, turkeys, crane, Canadian geese and the occasional fox). This is much nicer than watching cement trucks.

Just recently we received our new assessment for our condo - a $10,000 increase! Since we purchased our condo in the fall of 2008 just before the market fell, an increase like this was great news. Then only to find out that a cement trucking company wants to move into the neighborhood. We are concerned that this will bring property values down. With all of the other development moving in, its going to make our condo community seem like its in the middle of an industrial park.

Moving a cement company into the neighborhood gives us concerns about environmental issues, more dirt and allergens in the air, more truck noise, more traffic and stress on the already worn out Nelson Road and water pressure issues (its been said that the company will use approximately 40,000 gallons of water per day).

Please take these concerns into consideration.

Thank you for your time,
Sonja and Jerry Lund
5831 Lupine Lane #107
Madison, WI 53718

Lane, Roger

From: marilyn rastall <rastall3@yahoo.com>
Sent: Wednesday, June 06, 2018 10:34 AM
To: Lane, Roger
Cc: Bob Ness
Subject: CUP concrete batch plant

Dear Mr. Lane,

As a resident of the Ambassador Condominiums, this e-mail is in opposition to the proposed concrete plant by Zignego,Inc.

I was at the the May 22 meeting and want to address some things that Mr. Zignego Sr rebutted about concerns that myself and another resident of Ambassador Condominiums had. Since we were not able to rebut his rebuttal I like to do this now.

Our properties would be devalued. Mr Zignego was asked to evaluate this. Seriously?? Isn't that like letting the "fox watch over the henhouse"?

Their elevators have a very high profile. They are 100 ft. tall according to Mr. Zignego. He also tried to give the impression that where the plant will be built is down in a valley. I don't know what the difference of elevation is from the top of Nelson Rd. to where the road intersects at Felland, but the plant would most certainly be seen for a long ways.
Another thing about their plants they put their name on the very top in the very large letters. I would venture to say their name probably could be read from the space shuttle! Granted, they have every right to be proud of their name, but they certainly do not try to blend into their surroundings!

Mr Zignego also said they would save a lot of the trees and plant more. What is the first thing that is done to a building site? Yes, the land is cleared and graded for levelness and to divert any runoff from rain etc to prevent erosion. Very seldom are trees able to be saved. And if they planted trees how long would it take to cover their elevator? Alot longer than any of us will be alive.
Turn lanes also would need to be put in for their trucks. From seeing different road construction sites in my life a lot of land is used for that also. There again more leveling, removal of trees and erosion control grading would need to be done.

That brings up another point that I was not aware of because I was not able to attend the Town of Burke meeting. That point is water. Yes, Mr Zignego brought a "water expert" in to say how the aquifer was very deep and their would be plenty of water for a deep well for this plant. I can't contradict that statement but when I heard that the amount of water in a day used by this plant could supply 45 homes. One day! I may not be as learned as the water expert but that is a lot of water. Also, please remember he was paid by Zignego.

The Zignego lawyer "Mr. Buck" tried to paint such a rosey picture of the property that they want to purchase and I want to refute a couple of his comments. Yes, there is an industrial park across the street form the proposed building site, however, it is only one story tall and their signage is not in your face. The largest trucks that come in and out of the complex are from the Shred-it company not big cement mixer trucks with air brakes.
"Mr. Buck"also stated that there is a asphalt plant close by. This is true, but the Wolf Co. has been on their Reiner Rd. location since 1977. I'm not originally from here but I can imagine at the time they built their plant they were way out in the country and over the years developments have built out to them. Yes, there are newer homes close by but that is there choice to live where they do close to an asphalt plant. It is not my choice to have a cement plant be built near my home.

In closing, I would like to thank you for taking the time to read my concerns and I truly hope that you and the others on the Zoning Committee will use good discernment in your decision on this proposal.

Sincerely
Marilyn Rastall

Lane, Roger

From: Kathy Messier <kaamess72@gmail.com>
Sent: Tuesday, June 05, 2018 8:16 PM
To: Lane, Roger
Subject: OPPOSITION - CUP 02416, Burke , Section 23

Dear Mr. Roger Lane,

I would like to express my opposition to the Conditional Use Permit application CUP 02416, submitted by Zignego Ready Mix for the property located at 5356 Felland Road Burke, Section 23. This CUP is for a Concrete Batch Plant on this plot of land. I will be unable to attend the public hearing on June 12, 2018 and would like the following to be my voice of opposition.

I own a condo unit in the Ambassador Condominium Association on the corner of Nelson Road and Felland Road. This CUP would put a dirty and unsightly industrial facility **directly across** from my property greatly impacting the current property value of my unit. My unit would look directly at the facility and would be highly impacted by the increase in excessive noise due to heavy truck traffic not to mention the dust and air quality.

Cement production is known to have negative impacts on air and water quality. Cement production produces large volumes of CO2 emissions. An article from Building Green.com estimates that for every ton of cement produced, 1.25 tons of CO2 is released into the
atmosphere. (https://www.wbcsdcement.org/pdf/tf2/cementconc.pdf) Another impact to air quality is dust from production and transportation of cement. The article goes on to mention that the U.S. EPA (cited by UBC researchers) estimates total particulate (dust) emissions of 360 pounds per ton of cement produced, the majority of which is from the cement kiln. Other air pollutants commonly emitted from cement manufacturing plants include sulfur dioxide (SO2) and nitrous oxides (NOx). SO2 emissions (and to a lesser extent SO3, sulfuric acid, and hydrogen sulfide) which result from sulfur content of both the raw materials and the fuel (especially coal). (p8) The water pollution issue is another negative impact from having a cement production facility so close by. Wash-out water contains high volumes of pH. This wash-out water could potentially saturate into our ground water and create a toxic environment for fish and wildlife. The area surrounding Burke, Section 23 has a lot of retaining ponds and drainage ditches which would be full of polluted wash-out water, one of these being out front of the Ambassador Condo 3 story building.

These negative impacts to the air and water quality would certainly inhibit my ability to sell my condo unit now or in the future. Who is going to want to own, much less live NEXT TO a concrete batch plant? Not only would this big dirty facility be an eye sore in our neighborhood, but the amount of dust and pollution in the air would make it impossible to open windows during warm weather. It would also discourage the continued development of good quality residential areas. At this moment, the condo units in our building are some of the nicest and most affordable in Dane County. Every time a unit goes up for sale, it sells quickly and most often with multiple offers. That will no longer be the case with a cement plant ACROSS THE STREET. Currently there are deer, ducks, geese and wild turkey populations that inhabit this property and our nearby property. These populations would also be impacted not only by a loss of habitat but by contaminated water sources. As residents, we would be impacted by the loss of this wildlife and the positive impact they have on our environment.

Traffic concerns are also another negative impact that this concrete batch plant would bring to our neighborhood. The roads surrounding Burke, Section 23 are not built to hold heavy truck traffic. As you may know, Felland Road is still a small narrow 2 lane country road that currently contains residential homes that would be directly impacted by this CUP application. Felland Road is used a lot in the summer by motorcyclists, bicyclists, walkers, and joggers. Burke Road is also still a 2 lane country road. Currently, the only traffic control at the corner of Nelson Road and Felland Road is a stop sign on Felland and there is only a 3 way stop sign at the corner of Felland Road and Burke Road. Nelson Road, Felland Road, and Reiner Road are heavily traveled by commuters and heavy truck traffic. With the addition of the Veridian subdivision on Lien Road, Felland Road between County T and Nelson Road will see an increase in residential traffic without the addition of an industrial facility. The increase in traffic from an industrial production facility would cause potential gridlock, an increase in noise, and an increase in safety concerns as traffic on Nelson Road usually travels around 45-55 mph. Having more heavy trucks stopping and turning on and off roads that currently have speed limits of 25 -35 mph would put drivers, joggers, walkers, motorcyclists, and bicyclists at risk of being hit, injured, and possibly killed. There have already been accidents on the corner of Nelson Road and Felland Road because of the high speeds vehicles on Nelson Road travel.

If this CUP for the Concrete Batch Plant is granted, I will have to consider selling my home. With that being said, I highly oppose this CUP due to the impact on my property value, quality of air, increase in noise, and increase in traffic. I ask that you please consider the negative impact on the residential neighbors that surround this property and on our quality of life. I ask that you keep this area for residential development as it was originally intended. I ask that you keep in mind the values to it citizens that makes Dane County a great place to live. I ask that you say NO TO THIS CUP so that the property value and quality of life of good decent citizens is not negatively impacted.

Thank you for your time,
Katherine Messier

Lane, Roger

From: Ness, Bob <BNESS@amfam.com>
Sent: Monday, June 11, 2018 1:10 PM
To: Kolar, Mary; Lane, Roger
Cc: Schauer, Andrew
Subject: Concrete Batch Plant application hearing JUNE 12th
Attachments: 2nd Public Hearing notice for CUP 2416.pdf

http://www.chicagotribune.com/suburbs/naperville-sun/news/ct-nvs-concrete-plant-st-0726-20150724-story.html

In preparation for the Zoning and Land Regulatory Committee meeting residents of the 66 unit Ambassador Condo Association would like to share this news story, which should serve as a warning of what is to come if the use permit is approved by the county.

Thank you,
Bob Ness
5831 Lupine Ln.
Madison, WI

#302

Dear Dane County Committee Members,

According to the EPA website cement companies are the third largest industrial air pollutant. A cement batch plant is not beneficial to the town of Burke.

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> https://link.springer.com/article/10.1007/s00420-017-1244-9

Many school and residential areas that have a cement plant try to come in have been fighting to prevent the plant for these same health risks.

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Sincerely,

Amanda Hirsch

#302
5831 LUPINE LN.
MADISON, WI.

Fact Sheet

FINAL AIR TOXICS RULE FOR

PORTLAND CEMENT MANUFACTURING PLANTS

TODAY'S ACTION...

- The Environmental Protection Agency (EPA) is today issuing a final regulation to reduce emissions of toxic air pollutants from portland cement manufacturing plants. Portland cement is an ingredient in concrete, which is a widely used construction material. Air toxics, also referred to as hazardous air pollutants (HAPs), are those pollutants that are known or suspected to cause cancer or other serious health effects.

- EPA developed today's rule in close partnership with representatives of the portland cement industry as well as representatives of state and local agencies.

WHAT ARE THE HEALTH AND ENVIRONMENTAL BENEFITS OF THIS ACTION?

EPA's rule will reduce emissions of air toxics from new and existing portland cement manufacturing plants by approximately 90 tons annually, representing a 31 percent reduction from current levels.

These include reductions in emissions of air toxics, such as arsenic, cadmium, chromium, lead, benzene, toluene, dioxins/furans, hexane, and formaldehyde from portland cement plants. Specifically, this rule will reduce annual emissions of dioxins/furans by 36 percent. Exposure to these compounds may be associated with a number of adverse health effects, including cancer, respiratory illness, and nervous system, dermal, developmental, and/or reproductive effects.

EPA's rule will also reduce emissions of particulate matter by 5,200 tons annually, a 24 percent reduction from the levels currently emitted by these facilities. Exposure to particulate matter has been linked with adverse health effects, including aggravation of existing respiratory and cardiovascular disease and increased risk of premature death.

The rule will also reduce emissions of hydrocarbons from new portland cement kilns by 220 tons per year, a 38 percent reduction from projected future emissions levels. Some of these hydrocarbons are volatile organic compounds, which can contribute to the formation of ground-level ozone. Ground-level ozone can cause a variety of health problems because it damages lung tissue, reduces lung function, and makes the lungs susceptible to other irritants.

BACKGROUND

Under the Clean Air Act Amendments of 1990, EPA is required to regulate emissions of 188 specific air toxics. (Note that this list originally referenced 189 pollutants, but EPA has subsequently removed the chemical caprolactum from the list.) On July 16, 1992, EPA published a list of industry groups, known as source categories, that emit one or more of these air toxics. For listed categories of "major" sources (those that have the potential to emit 10 tons/year or more of a listed pollutant or 25 tons/year or more of a combination of pollutants), the Clean Air Act requires EPA to develop standards that are based on stringent air pollution controls, known as maximum achievable control technology (MACT).

EPA's published list of industry groups to be regulated includes portland cement manufacturing plants.

HOW DOES THE CEMENT MANUFACTURING PROCESS WORK?

Portland cement manufacturing is an energy intensive process in which cement is made by grinding and heating a mixture of raw materials such as limestone, clay, sand, and iron ore in a rotary kiln. The kiln is a large furnace that is fueled by coal, oil, gas, coke and/or various waste materials. The product (called clinker) from the kiln is cooled, ground, and then mixed with a small amount of gypsum to produce portland cement.

- The main source of air toxics emissions from a portland cement plant is the kiln. Emissions originate from the burning of fuels and heating of feed materials. Air toxics are also emitted from the grinding, cooling, and materials handling steps in the manufacturing process.

- There are about 210 kilns located at 110 portland cement plants in the U.S.

WHAT DOES EPA'S THE RULE REQUIRE?

EPA's rule limits emissions of particulate matter, which contain toxic metals (such as cadmium and chromium), from kilns and clinker coolers. The rule also limits emissions of opacity (a surrogate pollutant for particulate matter and toxic metals) from the kiln, clinker cooler, and materials handling facilities. Finally, the rule places limits on emissions of dioxins/furans and hydrocarbons (a surrogate for toxic organic compounds) from cement kilns.

EPA based the emission limit for hydrocarbons on the emissions levels that can be achieved through the pollution prevention technique of using clean feed materials. However, the rule does not dictate any particular type of air pollution control. Rather, the rule allows industry to use a variety of techniques to achieve the emissions limits.

- EPA's rule also includes new test methods for measuring emissions of air toxics from cement kilns. These new methods can be used by portland cement plant owners/operators to help determine if their plants are major sources of air toxics.

The rule also requires continuous monitoring of emissions and/or operating parameters which indicate the emissions of particular pollutants. EPA outlines the details of the monitoring, recordkeeping, and reporting requirements in the rule.

The rule requires the installation and use of continuous emission monitors to measure particulate matter emitted from the kiln, although the compliance date for the installation of these instruments is deferred pending further testing of this technology and additional rulemaking.

WHO WILL BE AFFECTED BY EPA'S RULE?

All portland cement manufacturing plants in the nation will be affected by EPA's final rule. Under the Clean Air Act, MACT standards typically only apply to major sources in the source category. However, under the authority of Section 112 (c)(6) of the Clean Air Act, and due to the high toxicity of dioxins/furans and polycyclic organic matter, the provisions of the rule regarding dioxin/furan and total hydrocarbon (surrogate for polycyclic organic matter) emissions limitations and associated monitoring, recordkeeping, and reporting also apply to "non-major" (known as area) sources of air toxics. Area sources are stationary sources that emit hazardous air pollutants, but are not classified as a major source. EPA estimates that about 20 percent of the portland cement plants may be area sources.

- About 30 out of the 210 cement kilns in the U.S. burn hazardous waste as fuel. It is important to note that kilns that burn hazardous waste will not be covered by this rule. This is due to their different emissions characteristics, different air pollution controls, and separate classification in the Resource Conservation and Recovery Act (section 3004 (q)) . The cement kilns that burn hazardous waste will be covered under an air toxics standard for hazardous waste combustors that EPA proposed on April 19, 1996 and will be promulgated soon.

- However, today EPA is also proposing to address any sources of hazardous air pollutants at a cement plant which are not part of the combustion phase of the process (i.e., emissions associated with the kiln), regardless of whether or not the cement kiln burns hazardous waste.

HOW MUCH WILL THE FINAL RULE COST?

EPA estimates the total annual cost to portland cement manufacturers to comply with the rule to be about $37 million. EPA estimates the initial capital cost to portland cement manufacturers to comply with the rule to be about $108 million.

FOR MORE INFORMATION...

Interested parties can download the rule from EPA's web site on the Internet under recent actions at the following address: *http://www.epa.gov/ttn/oarpg*. For further information about the rule, contact Joseph Wood, P. E. of EPA's Office of Air Quality Planning and Standards (OAQPS) at (919) 541-5446 or e-mail at wood.joe@epamail.epa.gov. For information about the emission test methods, contact Rima Dishakjian of OAQPS at (919) 541-0443.

EPA's Office of Air and Radiation's homepage on the Internet contains a wide range of information on the air toxics program, as well as many other air pollution programs and issues. The Office of Air and Radiation's home page address is: *http://www.epa.gov/oar/.*

Last updated on Wednesday, August 30th, 2006
URL: http://www.epa.gov/ttn/atw/pcem/portf_fs.html

Kim et al. Annals of Occupational and Environmental Medicine (2015) 27:3
DOI 10.1186/s40557-014-0048-6

ANNALS OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE

RESEARCH ARTICLE

Open Access

Ventilation impairment of residents around a cement plant

Sul Ha Kim[1], Chul Gab Lee[1*], Han Soo Song[1], Hyun Seung Lee[1], Min Soo Jung[1], Jae Yoon Kim[1], Choong Hee Park[2], Seung Chul Ahn[2] and Seung Do Yu[2]

Abstract

Objectives: To identify adverse health effects due to air pollution derived from a cement plant in Korea. The ventilation impairment in residents around a cement plant was compared to another group through a pulmonary function test (PFT).

Methods: From June to August of 2013, both a pre and post-bronchodilator PFT was conducted on a "more exposed group (MEG)" which consisted of 318 people who lived within a 1 km radius of a cement plant and a "less exposed group (LEG)" which consisted of 129 people who lived more than 5 km away from the same plant. The largest forced expiratory volume in a one second (FEV1) reading and a functional residual capacity (FVC) reading were recorded after examining the data from all of the usable curves that were agreed upon as valid by PFT experts of committee of National Institute of Environmental Research. The global initiative for chronic obstructive lung disease (GOLD) criteria for COPD, defined the FEV1/FVC ratio < 0.7 as the obstructive type, and the FEV1/FVC ratio ≧ 0.7 and FVC% predicted < 80% were as the restrictive type. The FVC% predicted value was estimated using Korean equation. We compared the proportion of lung function impairments between the MEG and the LEG by using a chi-square, and estimated the OR of obstructive and restrictive ventilation impairments by logistic regression.

Results: The obstructive type impairment proportion was 9.7% in the MEG, whereas it was 8.5% in the LEG. The restrictive type was 21.6% in the MEG which was more than the 12.4% of the LEG. The odds ratio (OR) of total ventilation impairment in the MEG was 2.63 (95% CI 1.50 ~ 4.61) compared to the LEG. The OR of obstructive type in the MEG was 1.60 (95% CI 0.70 ~ 3.65), the smoking history was 3.10 (CI 1.10 ~ 8.66) whereas OR of restrictive type in the MEG was 2.55 (95% CI 1.37 ~ 4.76), the smoking history was 0.75 (95% CI 0.35 ~ 1.60) after adjusting for sex and age. Level of exposure to particulate played a role in both types. However, it appeared to be a significant variable in restrictive type, while smoking history was also an important variable in obstructive type.

Conclusion: Although this study is a limited cross-section study with a small number of subjects, ventilation impairment rate is higher in the MEG. There might be a possibility that it is due to long-term exposure to particulate dust generated by the cement plant.

Keywords: Cement, Particulate, Pulmonary function test, Restrictive ventilation impairment

* Correspondence: eecg@daum.net
[1]Department of Occupational & Environmental Medicine, School of Medicine, Chosun University, 558 Pilmun-daero, Dong-gu, Gwangju 501-759, Korea
Full list of author information is available at the end of the article

Introduction

Although cement is the most widely used essential construction material, there are many hazardous environmental pollutants such as particulate matter, various oxides, and heavy metals, which are released in its production process. Most of the Portland cement plants in Korea have been in operation since the 1970s by the national policy to accelerate industrialization. The residents who have lived near the cement plants have always been complaining because of the inevitable dust created at plants when they were carrying limestone from the mine to the plant. However, because the protest movements from the residents have continued, epidemiological surveys have been conducted by the Ministry of Environment (National Institute of Environmental Research) since 2007 [1]. This survey was carried out in 2013, as one of a series of epidemiological investigations about the relationship between environmental particulates derived from a cement plant and pulmonary functions of the residents in Jeollanam-do Jangseong-gun.

Portland cement is composed of a mixture of materials. It is mostly made of calcium oxide (CaO, 62-67%) and silica glass (SiO_2,17-25%) with a lesser amount of aluminum trioxide(Al_2O_3 3-8%), iron oxide(Fe_2O_3 0-5%), magnesium oxide (MgO, 1-2%), and other heavy metals such as hexavalent chromium (Cr^{6+}), nickel, etc. [2,3]. The cement manufacturing is done in three simplified steps. First, the raw material and fuel supply preparation (mining and/or outsourcing, crushing, storage, and preblending), second the pyroprocessing to make clinker, grinding of clinker and gypsum in the finishing mill to make cement, and finally the storage, packaging, and loading for the finished products [2]. Cement is made from the intermediate product of finely ground clinker formed through a high-temperature burning of limestone and other materials in a kiln (pyroprocessing). The emissions created by the combustion such as particulates, carbon dioxide (CO_2), nitrogen oxides, sulfur oxides, and heavy metals are discharged in the process [4]. There is additional dust generated from the mining and transportation. Various types of particulate emissions and dust are continually created by the comminution circuits when crushing and grinding the raw materials and clinker, from the pyroprocessing or kiln line, intermittently and diffusely from quarrying activities as well as through limestone transportation.

In general, fugitive emissions from coarse particulates (particularly of particle diameters >10 μm) are considered to be the reason for repeated protests by the residents near the cement plant. This is believed to be due to the visible accumulation rather than the health hazards. However, fine particulates, <10 μm (PM_{10}) and <2.5 μm ($PM_{2.5}$), can cause health problems, if one experiences prolonged exposure for 30 to 40 years, because of their respirable nature, and because they may contain potentially harmful concentrates of toxic metals and compounds. Cement dust can cause lung function impairment, pneumoconiosis [5], carcinoma of the lungs and larynx [6,7], and may cause inflammatory changes in the skin, and often leads to skin diseases or autoimmune diseases [8-10].

Many studies for cement factory workers on the adverse respiratory effects of cement dust exposure have been focusing on pulmonary function and symptoms, or their relationships [11-17]. But, few have researched the health effects of cement dust and asbestos [18,19], or heavy metals [20,21] derived from cement plants, thus a study on the relevance of dust and lung diseases of residents who live around these plants was rare. It is difficult to explain the relationship between environmental cement dust exposure and occurrence of a pulmonary disease due to the variety of other factors involved such as age, sex and smoking. Therefore, we are going to report about the difference in ventilation impairment between the more exposed group of residents and less exposed group of residents living around the cement plants or limestone mines in the region using the results of a health survey.

Materials and methods

Study subjects

The surveyed cement plant is located in a rural area near a big city, and about 13,000 residents live in this area. The epidemiological survey target population is about 900 over 40-year-olds living near the cement plant. The residents who lived within the 1 km radius of the cement plant were designated as the "more exposed group (MEG)". The "less exposed group (LEG)" lived more than 5 km away from the cement plant in an area that was not typically in the path of incoming wind from the plant but was similar to the MEG in socioeconomic living conditions. The population of the eligible LEG was about 370 residents. The participants in the MEG and LEG were 453 (50.3%) and 153 (41.4%) respectively. Participants were given both pre and post-bronchodilator tests. The exceptions were persons considered to be too old or those having contraindicating reasons such as a recent myocardial infarction or infected lung disease. PFT were carried out within a university hospital and four experts of the committee of National Institute of Environmental Research determined whether the PFT test results were acceptable and reproducible. Therefore, among the participants, 447 cases were determined as valid and the pre and post-bronchodilator test results were used in the analysis; the MEG was 318 (/453 = 70.2%), the LEG was 129 (/153 = 84.3%) (Table 1). The proportions of persons with valid results of the pre and post bronchodilator test decreased with increasing age,

Table 1 Participants (pN) and valid pulmonary function test (vPFT) of subjects

Sex	Age	~59			60 ~ 69			70+			Total		
		pN	vPFT	%	pN	vPFT	%	pN	vPFT	%	pN	vPFT	%
Female	LEG	26	22	84.6	29	23	79.3	45	39	79.3	100	84	84.0
	MEG	67	54	80.6	82	60	73.2	118	75	63.6	267	189	70.8
	Subtotal	93	76	82.6	111	83	76.3	163	114	71.5	367	273	74.4
Male	LEG	11	8	72.7	8	6	75.0	34	31	91.2	53	45	84.9
	MEG	62	55	88.7	60	44	73.3	64	30	46.9	186	129	69.4
	Subtotal	73	63	80.7	68	50	74.2	98	61	69.1	239	174	72.8
Total	LEG	37	30	78.7	37	29	77.2	79	70	85.3	153	129	84.3
	MEG	129	109	84.7	142	104	73.3	182	105	55.3	453	318	70.2
	Subtotal	166	139	81.7	179	133	75.2	261	175	70.3	606	447	73.8

%: Valid PFT number/participant number.
MEG: 'more exposed group' who lived within the 1 km radius of the cement plant.
LEG: 'less exposed group' who lived 5 km or more away from the cement plant in not related to usually wind direction.

in particular, the lowest of 46.9% in men over 70 years of the MEG.

Pulmonary function test

The authors first explained the purpose of the epidemiological survey to participants, including the assumed respiratory health effect regarding the cement plant and the PFT method in more detail. We conducted PFT screenings at 9 ~ 11 AM daily by 10 ~ 20 people units from June to August in 2013. PFT was performed in a separate hospital pulmonary function laboratory following the guidelines of KOSHA and ATS/ERS TASK FORCE [22-24]. Before the test, a trained technician explained how the procedure would work and gave them a demonstration. If the elderly had a risk of falling due to syncope during a test, the PFT procedure was performed in a sitting position. The residents who refused or quit during the test were excluded from the participants. The PFT procedure was conducted twice for all participants, before and after the administration of a bronchodilator. After the pre-test was completed, 200 μg the salbutamol was inhaled twice at an interval of 30 seconds, using a total of 400 μg. The PFT procedure was then repeated after waiting for 15 minutes in a comfortable posture. Because the test results could vary due to the use of different spirometry equipment, a single model, the MicroQuark, Cosmed® (Italy), was used. We checked for abnormalities in the spirometry equipment after calibrating it by using a 3 L calibration syringe loaded into it. Each test was carried out after a preliminary examination. In addition, an investigation was conducted to asses for other factors that could affect pulmonary function, for example, past and present respiratory disease history, smoking history, residential and job history, use of firewood, general health status, history of drugs taking, recent major surgery and history of a heart disease.

Data analysis

The FVC measurement is the maximal volume of air exhaled with maximally forced effort from a maximal respiration. The FEV1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full respiration. The FVC and FEV1 are measured through a series of at least three forced expiratory curves that have an acceptable beginning to the test and are free from artefacts, such as a cough [25]. We took the largest FVC and FEV1 results recorded (agreed to be valid by four PFT expert committees of National Institute of Environmental Research) after examining the data from all the usable curves of post-bronchodilator test. The valid tests were analyzed using a modification of the global initiative for chronic obstructive lung disease (GOLD) criteria for COPD [26], the FEV1/FVC ratio <0.7 was defined as the obstructive type of ventilation impairment, and the FEV1/FVC ratio ≧0.7 and FVC% predicted <80% was the restrictive type. We used a formula of the FVC% predicted based on Korean standard [27] (Male,- $4.8434\text{-}0.00008633{*}age^2$(year) + $0.05292{*}$Height (cm) + $0.01095{*}$Weight (kg); Female, $-3.0006\text{-}0.0001273{*}age^2$ (year) + $0.03951{*}$Height (cm) + $0.006892{*}$Weight (kg).

Then we calculated proportions of ventilation impairment respectively in the MEG and LEG based on sex, age, residency period, current job, smoking or past occupational dust exposure history, and firewood use history. The residency period was divided into less than and more than 25 years living since the dust collection facilities of the cement plant had been incorporated in the mid-1980s. The smoking history was divided into two groups (never, current or ex-smoking) because there was no significant difference in MEG and LEG, especially in women, and the rate of women with a smoking history was as low as 4.4% (ex-smoker 1.5%, current smoker 2.9%). We tested to identify if there was a difference in proportions between ventilation impairment and other variables for two groups using a chi-square test. Variables tested included sex, age, smoking history, residency period, current job, and past occupational dust exposure or firewood use history. We used logistic regression to estimate the OR of total, obstructive and restrictive subtype impairments, using ventilation impairment as a dependent variable and other factors (two groups, sex, age and smoking history) as independent variables. A p-value of less than 0.05 was regarded to be statistically significant. All statistical analyses were performed in SPSS 21.

Results

General characteristic of analyzed subjects

An analysis was performed on 447 residents that showing valid results of a pre and post-bronchodilator test conducted on the 606 participants. Among the 318 in the MEG, 59.4% were male and 40.6% were female. In the LEG a total of 129 participants were included, 65.1% male and 34.9% female. This was not a significant difference (Table 2). Of the LEG 54.3% were over the age of 70, which was significantly higher than the MEG, which was 33.0%. Those with a smoking history were 33.0% and 31.8% respectively; there was no significant difference between the two groups. Similarly, there was no difference in the residence period. In regards to current employment, farmers and laborers made up 56.6% of the LEG, in contrast retired or tradesmen made up 65.7% of the MEG, which was considered to be a significant difference. The rate of using firewood was higher in the MEG. In other words, both groups were similar in sex, residence period, occupational dust exposure history, and smoking rate except for age distribution.

Ventilation impairment rate of MEG and LEG

In both men and women in all age groups, the post-bronchodilator mean FVC value in the MEG was significantly smaller than that of the LEG. But, the FEV1 showed no significant difference except in the ≤59 age group of men (Figure 1).

The obstructive type (FEV1/FVC <0.7) was 9.7% in the MEG, and 8.5% in the LEG. The restrictive type (FEV1/FVC ≥0.7 & FVC% predicted <80%) was 21.6% in the MEG which was higher than 12.4% of the LEG (Table 3). The ventilation impairment proportion, which is the sum of obstructive and restrictive type, was 31.3% in MEG, which was significantly higher than the 20.9% of the LEG. The proportion of ventilation impairment was higher in men than in women and also higher in older age groups and groups with a smoking history (current and ex-smoker). There was no significant difference in the ventilation impairment rate according to residency period, current job, past dust exposure related to occupational history, or firewood use history between the MEG and LEG (Table 3).

The OR value for each variable was adjusted by enter method of logistic regression (Table 4). The OR of the ventilation impairment rate in the MEG was 2.63 (95% CI 1.50 ~ 4.61) compared to the LEG. The OR in male was 3.30 (95% CI 1.68 ~ 6.48), higher than that of female. The OR according to age, in 60–69 and ≥70 years was 2.92 (95% CI 1.53-5.56), 7.03 (95% CI 3.71-13.32) compared with <59 years respectively. OR of ventilation

Table 2 General characteristic of analyzed subjects

Variables		LEG (n = 29)	MEG (n=318)	Total (n = 447)	p-value
Sex	Female	84 (65.1)	189 (59.4)	273 (61.1)	0.264
	Male	45 (34.9)	129 (40.6)	174 (38.9)	
Age (yrs)	≤59	30 (23.3)	109 (34.3)	139 (31.1)	0.000
	60 ~ 69	29 (22.5)	104 (32.7)	133 (29.8)	
	≥70	70 (54.3)	105 (33.0)	175 (39.1)	
Residence	≤25	29 (22.5)	84 (26.4)	113 (25.3)	0.404
	>25	100 (77.5)	234 (73.6)	334 (74.7)	
Current job	None/Merchant	56 (43.4)	209 (65.7)	265 (59.3)	0.000
	Farmer/Labor	73 (56.6)	109 (34.3)	182 (40.7)	
Smoking history	Never	88 (68.2)	213 (67.0)	301 (67.3)	0.801
	Current/ex smoking*	41 (31.8)	105 (33.0)	146 (32.7)	
Dust exposure	No	111 (86.0)	246 (77.4)	357 (79.9)	0.038
	Yes	18 (14.0)	72 (22.6)	90 (20.1)	
Firewood	No	37 (28.7)	176 (55.3)	213 (47.7)	0.000
	Yes	92 (71.3)	142 (44.7)	234 (52.3)	

p-value by Chi-square test, MEG: more exposed group, LEG: less exposed group.
*The rate of ex-smoking history in women was 1.5% (LEG 3.6%, MEG 0.5%) and current smokers were 2.9% (LEG 0.5%, MEG 3.6%).

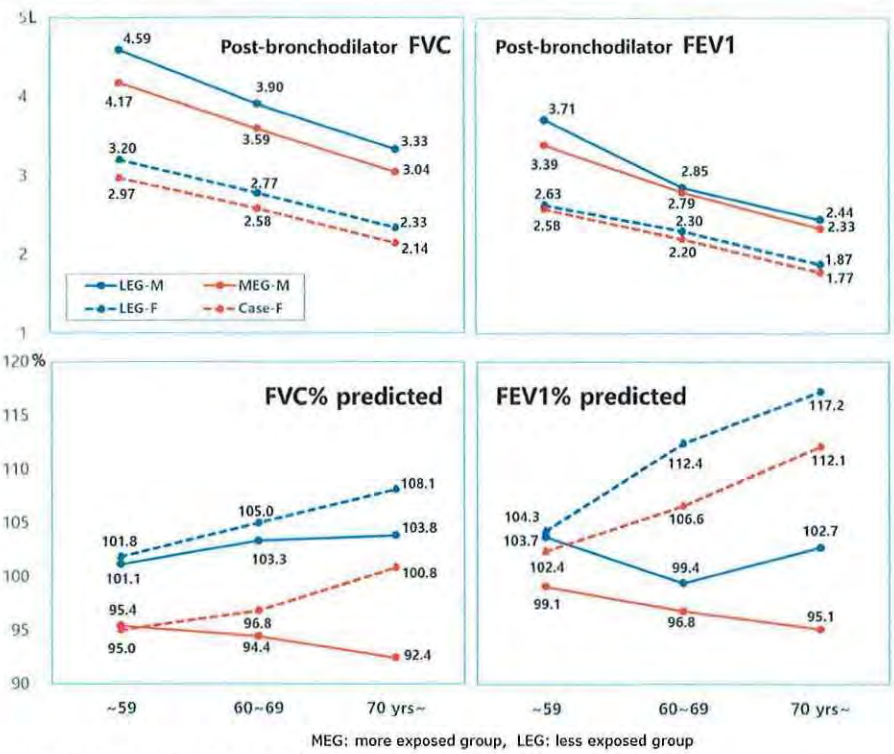


Figure 1 Post-bronchodilator FVC, FEV1 (L) and predicted FVC%, FEV1%.

Table 3 Ventilation impairment of post-bronchodilator PFT

Variable		Number	Ventilation impairment	Type		p-value
				Obstructive	Restrictive	
Group	LEG	129	27 (20.9)	11 (8.5)	16 (12.4)	0.025
	MEG	318	100 (31.3)	31 (9.7)	69 (21.6)	
Sex	Female	273	52 (19.0)	8 (2.9)	44 (16.1)	0.000
	Male	174	75 (43.1)	34 (19.5)	41 (23.6)	
Age (yrs)	≤59	139	20 (14.4)	6 (4.3)	14 (10.1)	0.000
	60 ~ 69	133	37 (27.8)	13.(9.8)	24 (18.0)	
	≥70	175	70 (40.0)	23 (13.1)	47 (26.9)	
Residence period (yrs)	≤25	113	30 (26.5)	12(10.6)	18 (15.9)	0.632
	>25	334	97 (29.1)	30 (9.0)	67 (20.1)	
Occupation	None/Merchant	265	80 (30.2)	17 (6.4)	63 (23.8)	0.338
	Farmer/Labor	182	47 (25.8)	25 (13.7)	22 (12.1)	
Smoking history	Never	301	65 (21.6)	11 (3.7)	54 (17.9)	0.000
	Current/ex smoking	146	62 (42.4)	31 (21.2)	31 (21.2)	
Dust exposure occupational history	No	357	97 (27.2)	31 (8.7)	66 (18.5)	0.295
	Yes	90	30 (33.3)	11 (12.2)	19 (21.1)	
Firewood use history	No	213	60 (28.2)	20 (9.4)	40 (18.8)	0.917
	Yes	234	67 (28.6)	22 (9.4)	45 (19.2)	

p-value on total ventilation impairment by Chi-square test, MEG: more exposed group, LEG: less exposed group.
Ventilation impairment: Obstructive type: FEV1/FVC <0.7, Restrictive type: FEV1/FVC ≥0.7 & FVC% predicted <80%.

Table 4 Adjusted odds ratio and CI of ventilation impairments

		Ventilation impairment		Obstructive type		Restrictive type	
Group	LEG	1					
	MEG	2.63	(1.50-4.61)	1.60	(0.72-3.65)	2.55	(1.37-4.76)
Sex	Female	1					
	Male	3.30	(1.68-6.48)	4.16	(1.35-12.83)	2.26	(1.09-4.66)
Age (yrs)	≤59	1					
	60 ~ 69	2.92	(1.53-5.60)	3.20	(1.13-9.06)	2.09	(1.01-4.29)
	≥70	7.03	(3.71-13.32)	5.74	(2.09-15.76)	4.34	(2.20-8.54)
Smoking history	Never	1					
	Current/ex smoking	1.44	(0.72-2.84)	3.10	(1.10-8.66)	0.75	(0.35-1.60)

Logistic regression with adjusted for all variables, CI: 95% confidence interval, MEG: more exposed group, LEG: less exposed group.
Ventilation impairment, Obstructive type; FEV1/FVC <0.7, Restrictive type; FEV1/FVC ≥0.7 & FVC% predicted <80%.

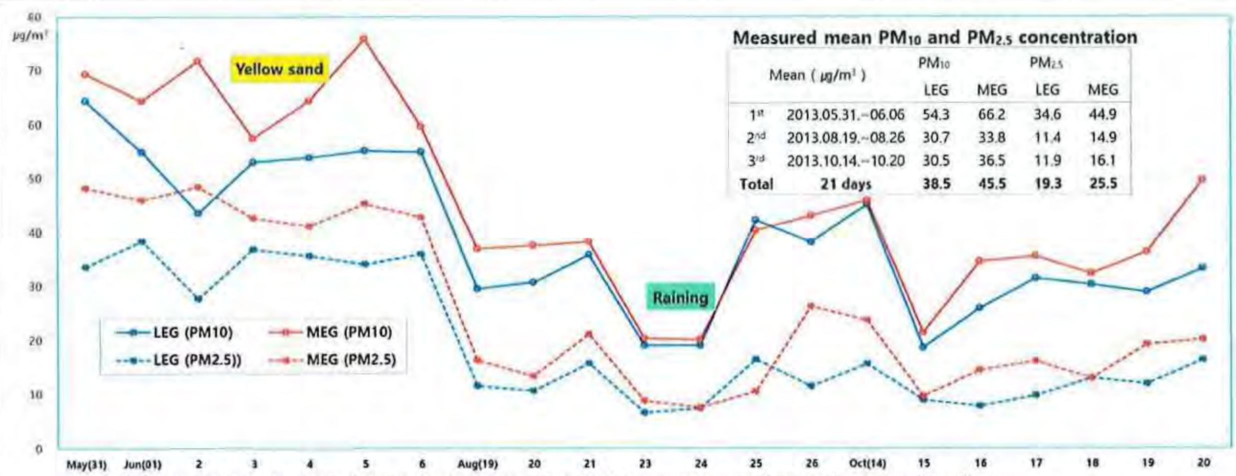
impairment rate in the smoking history was 1.44 (95% CI 0.72 ~ 2.84) compared to the non-smoker. But, OR of obstructive type in the MEG was 1.60 (95% CI 0.70 ~ 3.65), the smoking history was 3.10 (CI 1.10 ~ 8.66) whereas OR of restrictive type in the MEG was 2.55 (95% CI 1.37 ~ 4.76), the smoking history was 0.75 (95% CI 0.35 ~ 1.60). Statistical significance was adjusted depending on the obstructive or restrictive type of ventilation impairment. In restrictive type, level of exposure to particulate was a significant variable while smoking history was also an important variable in obstructive type.

Discussion

The residents who live around the cement plant have always complained about suffering in their daily lives because of dust originating from the plant. These complaints included respiratory symptoms such as chronic cough or phlegm as well as itching sensations from the body surface and prickly feeling eyes. While the residents refer to the irritant as 'cement dust' it should be noted that 'particulate' is the more scientific term. A particulate is anything solid or liquid suspended in the air [28]. It not only includes primary particles coming from limestone powder or directly out of the exhaust from a kiln during preprocessing, but also can include secondary particles, such as sulfates and nitrates, which are formed during the condensation of vaporized materials or from the by-products of the oxidation of gases in the atmosphere. Among these particles, particulates (<10 μm, PM_{10}) and fine particulates (<2.5 μm, $PM_{2.5}$) that were derived intermittently and diffusely from raw materials and other manufactured products appear to be more of a health hazard because of their respirable nature and because they may contain potentially harmful concentrations of toxic metals and compounds [4,29]. Various gases are generated directly from clinker manufacturing, according to a recent study on the health effects of fine particulates and how they affect mortality [30].

In order to determine the health effects of particulates, pulmonary function tests have been used for quite a long time. Ventilation impairments in cement plant workers is already well documented [3,11-15]. According to relatively consistent reports, the FVC and FEV1 of such workers is significantly decreased when compared to their matched control groups. These were also meaningfully decreased based on the length employment [3]. However, the foundation of these studies is different than the situation affecting the health of the residents. These studies reported that the concentration of respirable dust in the workplace for 8 h/day shift ranged from 3.7 mg/m^3 (kilns) to 23 mg/m^3 (ore crushing area) [8]. It was the highest for the crusher at 27.49 mg/m^3, 16.90 mg/m^3 around the packing areas and 1.55 mg/m^3 in administration offices throughout the production process [14,15,17].

However, it seems that there is a significant difference found in health effects between the studies examining ambient pollution and in studies about ventilation impairment among cement plant laborers. This is likely to be due to the concentration of dust within the plant being much higher than the outside of the plant. How is it possible to confirm that the health effects are the result of prolonged exposure to particulate arising from a cement plant? It's a question of whether the respiratory health effects of residents with ventilation impairments found using PFT can be proved to be due to the low concentration long-term exposure to particulates from the cement plant. This study used the data of particulate concentrations collected in a total of 21 days in June, August and October. Data was collected every seven days. The mean PM_{10} concentration in the atmosphere was 45.5 $\mu g/m^3$ (95% CI 37.8 ~ 53.3) beside the cement plant, higher than 38.5 $\mu g/m^3$ (95% CI 32.3 ~ 44.7) in a 5 km away point from the cement plant. Also, the mean $PM_{2.5}$ concentration was 25.5 $\mu g/m^3$ (95% CI 18.7 ~ 32.3), higher than 19.3 $\mu g/m^3$ (95% CI 14.1 ~ 24.6), respectively (Figure 2). Of course, this does not measure



Mean (µg/m³)		PM_{10} LEG	PM_{10} MEG	$PM_{2.5}$ LEG	$PM_{2.5}$ MEG
1st	2013.05.31.~06.06	54.3	66.2	34.6	44.9
2nd	2013.08.19.~08.26	30.7	33.8	11.4	14.9
3rd	2013.10.14.~10.20	30.5	36.5	11.9	16.1
Total	21 days	38.5	45.5	19.3	25.5

At the surveyed point, in order to determine the air pollution status of MEG (more exposed group) and LEG (less exposed group) area, particulate was measured continuously for 24 hours for seven days per season using a low-volume sampler.

Figure 2 Difference of measured PM_{10} and $PM_{2.5}$ concentration in a cement plant area.

the level of exposure of the past and may only reflects the current situation. However, it can be assumed that residents who live close to the cement plant were exposed to higher levels of particulate before dust collection facilities had been implemented in mid-1980s. When the plant location is used as the central location on the map (Figure 3), the LEG lived more than 5 km away in the northwest and the MEG lived within 1 km in the southwest. The wind direction is a northwester during the three seasons in the fall, winter and spring, and is a southwester during summer. The LEG habitats were in an independent wind direction while the MEG was right on the side of the plant, where the northwestern wind blows during three seasons, having the plant in the southwest of the area. It was confirmed that the particulate concentration in cement plant area (MEG region) was higher than that in the control area (LEG region) as well as continuously being exposed to more particulates due to the wind direction. Even so, the concentration around cement plant area would still be lower than the inside of the cement plant.

This study had obvious limitations that included the very small number of surveyed population as well as being a cross-sectional study. Moreover, the pulmonary function test performs a fundamental role in clinical setting, but its result varies with sex, age, height, and ethnicity. Furthermore, ventilation impairment degrees are greatly affected by smoking, occupational exposure (including organic or inorganic dusts), chemical agents and fumes [26], and the use of firewood as cooking or heating fuel in poorly ventilated kitchens. The smoking rates in Korean men were close to 80% in the 1980 ~ 90s [31]. Firewood has been used for a long time including recently as both a cooking and heating fuel source in the rural regions of Korea. Also, the target population in this study was residents who lived near the cement plant, and because many of them are current farmers or had farmed, they were always exposed to dust in the soil and to chemical substances like agriculture chemicals. In spite of these limitations, we were trying to assess pulmonary function status of the MEG who lived near the cement plant compared with the LEG who was living under similar economic living conditions and in sociocultural environments, for example, the use of firewood as cooking or heating fuel, similar types of occupations and smoking rates.

Everyone who was over the age of 40 living in these areas was to receive the pulmonary function test and we also encouraged them to participate actively. As a result, about 50% of the expected target population was examined. In validation checks on pre and post bronchodilator test, 26.2% of the participants were eliminated because the test reproducibility did not meet criteria [25] when matched with three acceptable curves or due to early termination of expiration. Therefore, approximately 40% of the target population was analyzed. The proportion of valid PTF readings in the MEG was 70.2%, but it was 84.2% in the LEG. Despite the PFT tests being carried out under the same conditions in a stable hospital room, there was difference in invalid test proportions between the two groups (Table 1). Unfortunately, the authors also could not find out why there was a significant difference in valid PFT proportions between the two groups. However, if the proportion of valid PFT proportions between the two groups had been similar, then it would mean that there would be a higher obstructive and restrictive ventilation impairment in the MEG while it would be lower in the LEG.

The classification of ventilation impairment is based on a modified GOLD criterion for COPD definition [26,32]. Regardless of the presence of symptoms like chronic coughing or sputum, and dyspnea, the obstructive

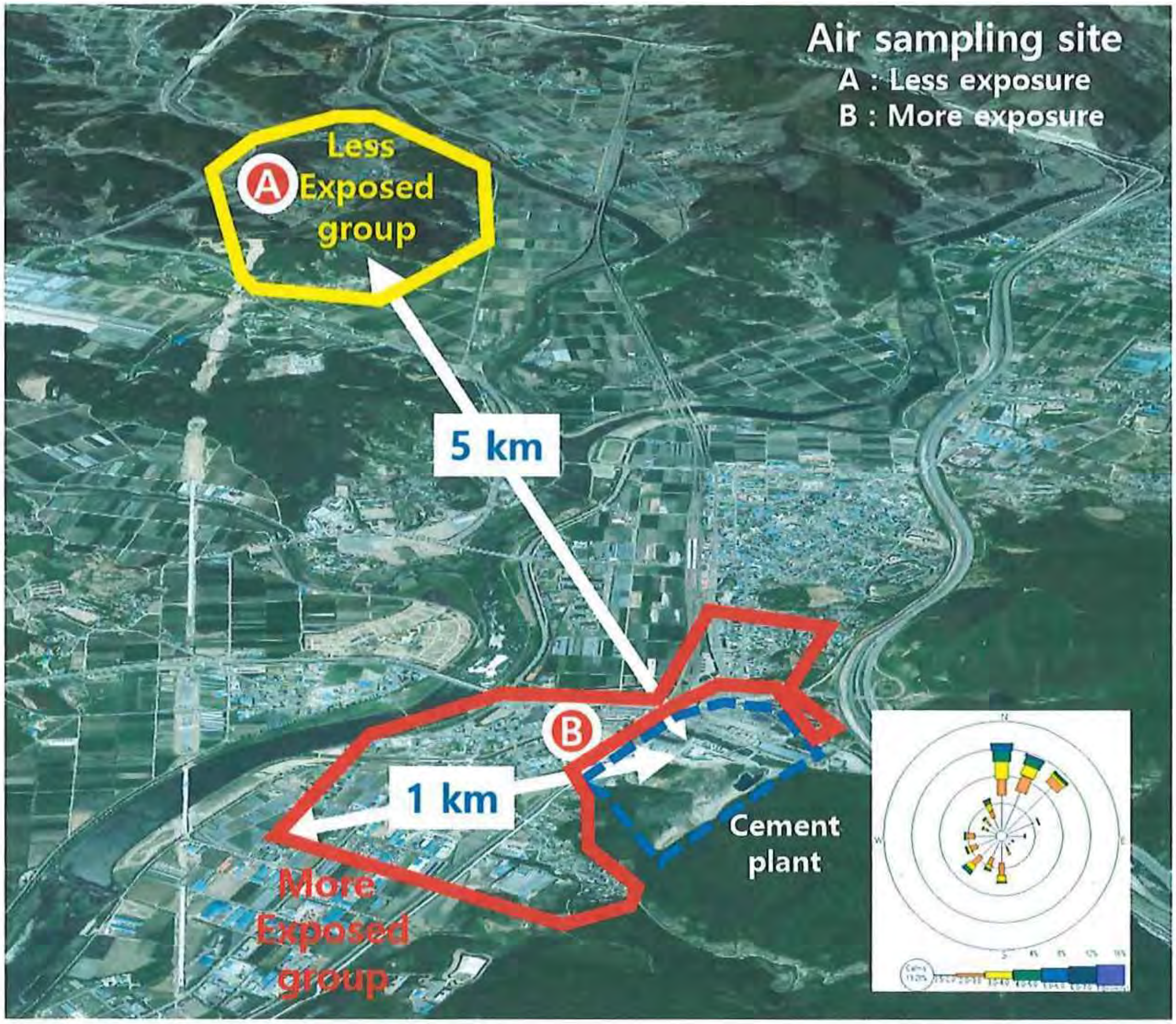


Figure 3 MEG and LEG position.

type was considered to be FEV1/FVC <0.7 in post-bronchodilator readings. If the FVC% predicted was less than 80%, it was considered the restrictive type, even if the FEV1/FVC was above of 0.7. Although the PFT tests showed about 15% difference in invalid test proportions between the two groups, it put us on the spot to compare the two groups for ventilation impairment. Whatever results came from the analysis, the most characteristic finding was a 10% difference in the restrictive type between two groups. There was less visible difference in obstructive type, 9.7% in the MEG and 8.5% in the LEG (Table 3). The relationship between particulates and COPD or increasing mortality rate in respiratory disease is well known [29,33]. The prevalence of COPD was 14.0% in those with the post-bronchodilator test, whereas the prevalence was 20.9% in those with a pre-bronchodilator test during 2007–2010, the National Health and Nutrition Examination Survey of Americans aged 40–79 years [34]. Similarly, the prevalence of COPD in post-bronchodilator tests ranged from 23.4% to 11.6% in 10,360 adults aged 40 years and older in 14 countries in North America, Europe, Africa and Asia who participated in the Burden of Obstructive Lung Disease study [35]. The prevalence rates in China and the Philippines, which belong to Asia like Korea, were the lowest at 11.6% and 12.7%, respectively. When compared with such reports, a prevalence of obstructive type of ventilation impairment in this study was presumed to be similar.

By the way, how can we say that restrictive ventilation impairment in the MEG is much higher than that of LEG? In the regression analysis, the OR of all ventilation impairment was higher in persons of older age and who are men. Smoking is known to be the biggest cause of COPD (chronic obstructive pulmonary disease) [26,36]. We have not separated the number of ex and current smokers in Table 2, because there was no significant difference in both groups. In men in MEG, 37.2% were ex-smokers and 39.5% were current smokers, whereas in men in LEG, 48.9% and 28.9%, respectively. In women, the percentages were very low. In women of MEG, 0.5% were ex-smokers and 2.6% were current smokers, whereas in LEG, 3.6% were ex-smokers and 3.6% were current smokers. Therefore, the reason the obstructive type OR of men against women in Table 4 is as high as 4.16 (95% CI 1.35 ~ 12.83) is because most of the ex and current smokers are men. In fact, the MEG and LEG are similar people living in the same rural area with similar economic and socio-cultural settings. The aim of this study is to determine whether the particles from the cement plant have an effect on ventilation impairment, so we did not need to subdivide the smoking history into more categories.

Restrictive impairment was unrelated to smoking history, while smoking history was a main risk factor of for obstructive impairment. Restrictive impairment may occur because of increased lung recoil caused by pulmonary fibrotic change or weakened respiratory systems due to old age, or both [37]. Particulates were in the lung parenchyma, blood vessel walls, airway, lymphoid follicles and alveolar macrophages [33]. Particulates can be sensed by the airway's epithelial cells, activate macrophages, dendritic cells and innate immune cells. They can then initiate responses in various populations of specific immune cells such as T helper cells, T cytotoxic cells and B cells. Initiation of inflammatory immune responses, activation of immune cells and release of many cytokines, chemokines and other inflammatory molecules, have variable pathologic effects like fibrotic change [38]. There is a limit which is that we could not confirm the total lung capacity (TLC) for restrictive type impairment by body plethysmography or DLco (diffusion capacity of lung for carbon monoxide) [39], in the few residents without a history of occupational dust-related who were diagnosed with pneumoconiosis.

The strength of this study is that at present a particulate (PM 10 and PM 2.5) concentration was measured to evaluate a level of dust exposure related a cement plant; the concentration of the particulate was higher in the area around the cement plant (MEG) than the other area (LEG). And we have compared the health effects by chronic particulate exposure according to GOLD's guideline (post-bronchodilator spirometry) [40]. The PFT was carried out in order to obtain a reliable value by the same examiner in comfortable and stable environment in the hospital. However, we need to take the limitations into account when interpreting the result. This is a cross-sectional study with not enough number of residents to find a significant difference in the ventilation impairment, especially in the obstructive type between the two groups. We have reviewed other data related to this epidemiologic survey such as population change, the lung cancer incidence and mortality due to respiratory diseases, 70% of the residents who were living in the area when the cement plant was first built (1973) have moved to larger cities (as of 2013). And there is also a possibility that the residents whose health had been compromised have already died of lower respiratory tract disorder or lung cancer. The residents who were too old to go through PFT or have been diagnosed with contraindicated diseases have been excluded from the study. In addition, there were significantly lower valid PFT proportions in MEG (70.2%) compared to those of LEG (84.3%). Therefore, it is possible that the health effects of chronic particulate exposure has are actually underestimated.

Conclusion

Although this study was a limited cross-section study with a small number of subjects, the ventilation impairment rate, particularly in restrictive not obstructive type, is higher in the MEG than the LEG even with a lower valid PFT proportion in MEG. There might be a possibility that it is due to long-term exposure to particulate dust generated from the cement plant.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SHK drafted this manuscript. CGL designed this epidemiological survey and corrected final manuscript as corresponding author. HSS, SHK, HSL, MSJ and JYK conducted the survey and contributed to the data collection. CHP revised this manuscript critically, SCA and SDY contributed to the design this study. All authors read and approved the final manuscript.

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