기후변화와 호흡기 질환

2025.03.22

환경성폐질환 연구회 심포지엄

Whanhee Lee

School of Biomedical Convergence Engineering

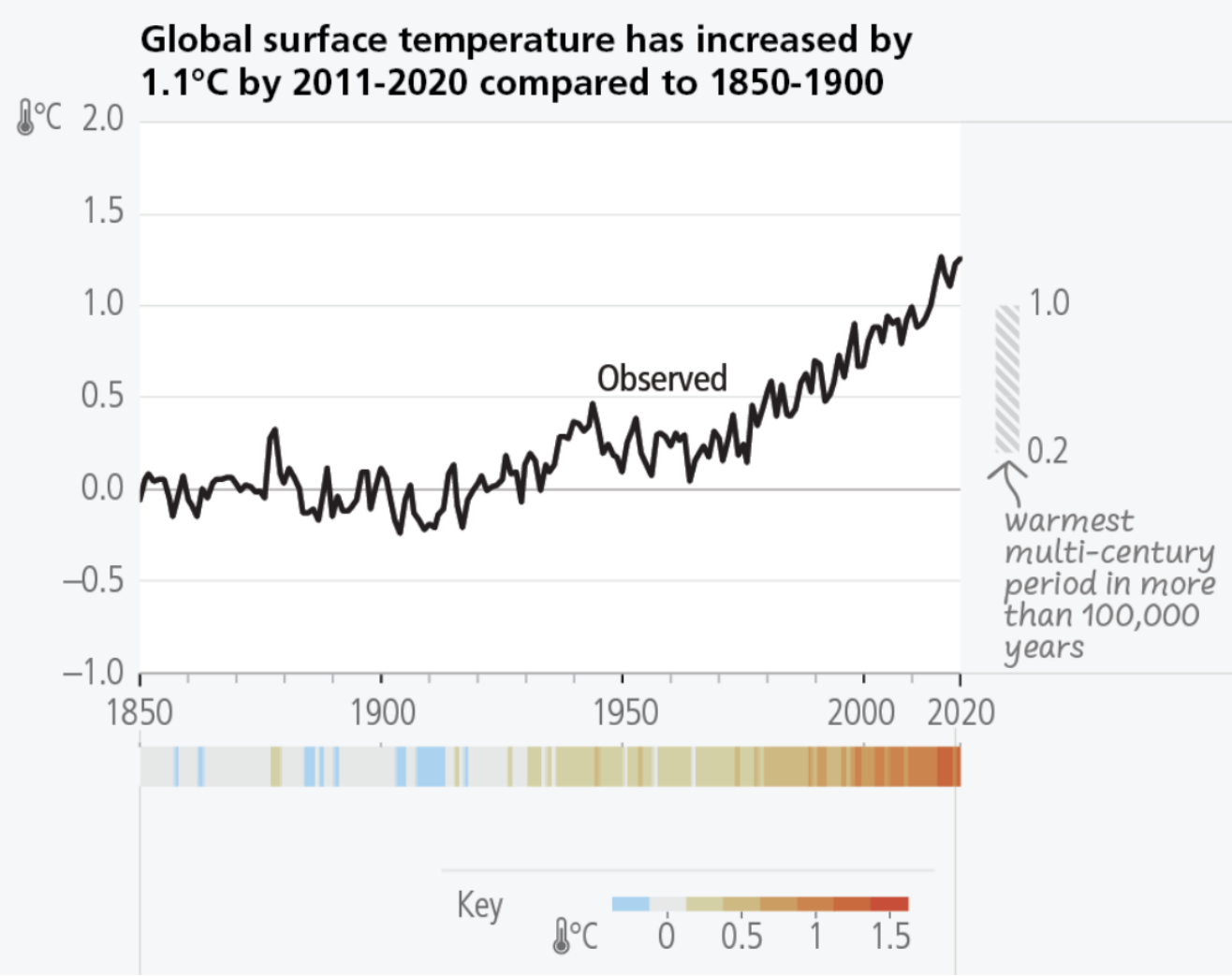
Pusan National University

1. Climate and Environmental crisis

1. Env, Climate Crisis

The Climate Clock is on display in Manhattan's Union Square as part of the city's Climate Week. Photograph by Ben Wolf

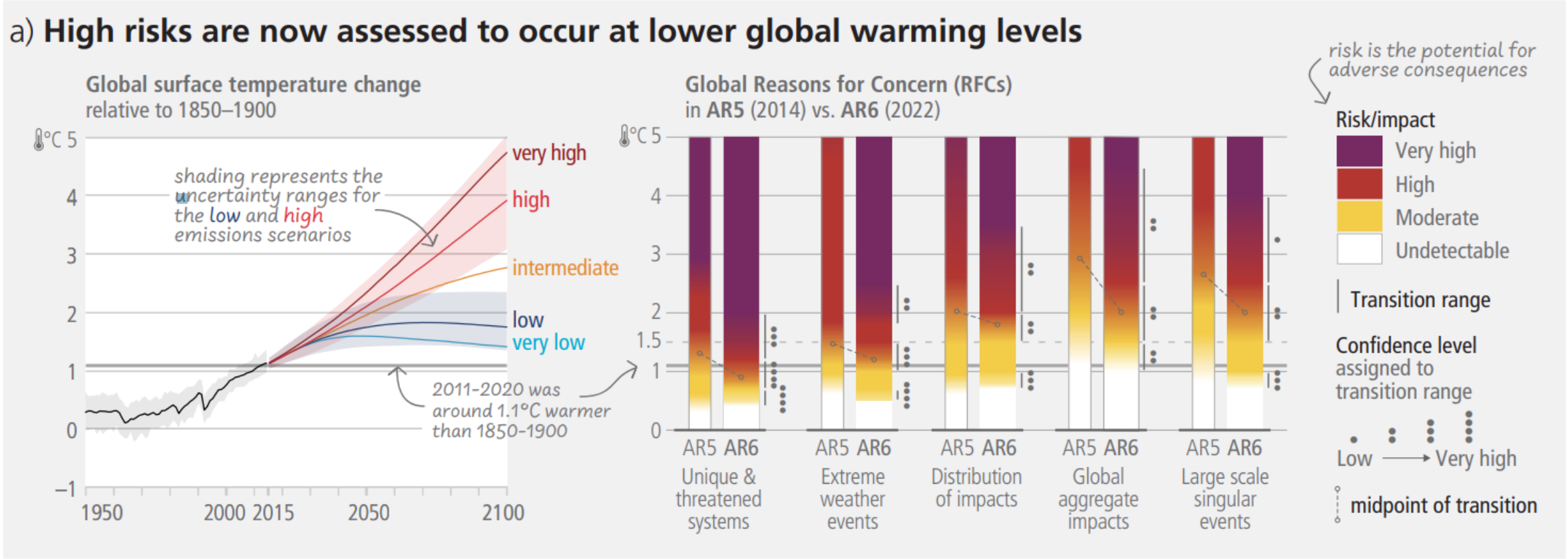
1. Env, Climate Crisis



IPCC 6th Report

1. Env, Climate Crisis

Risks are increasing with every increment of warming



IPCC 6th Report

1. Env, Climate Crisis

Worldwide ambient air pollution accounts for

43 % of deaths

and disease from chronic obstructive pulmonary disease

Worldwide ambient air pollution accounts for

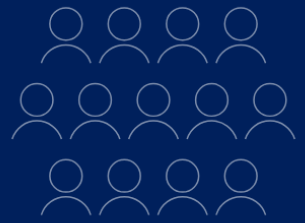
25 % of deaths

and disease from ischaemic heart disease

Worldwide ambient air pollution accounts for

24 % of deaths

from stroke



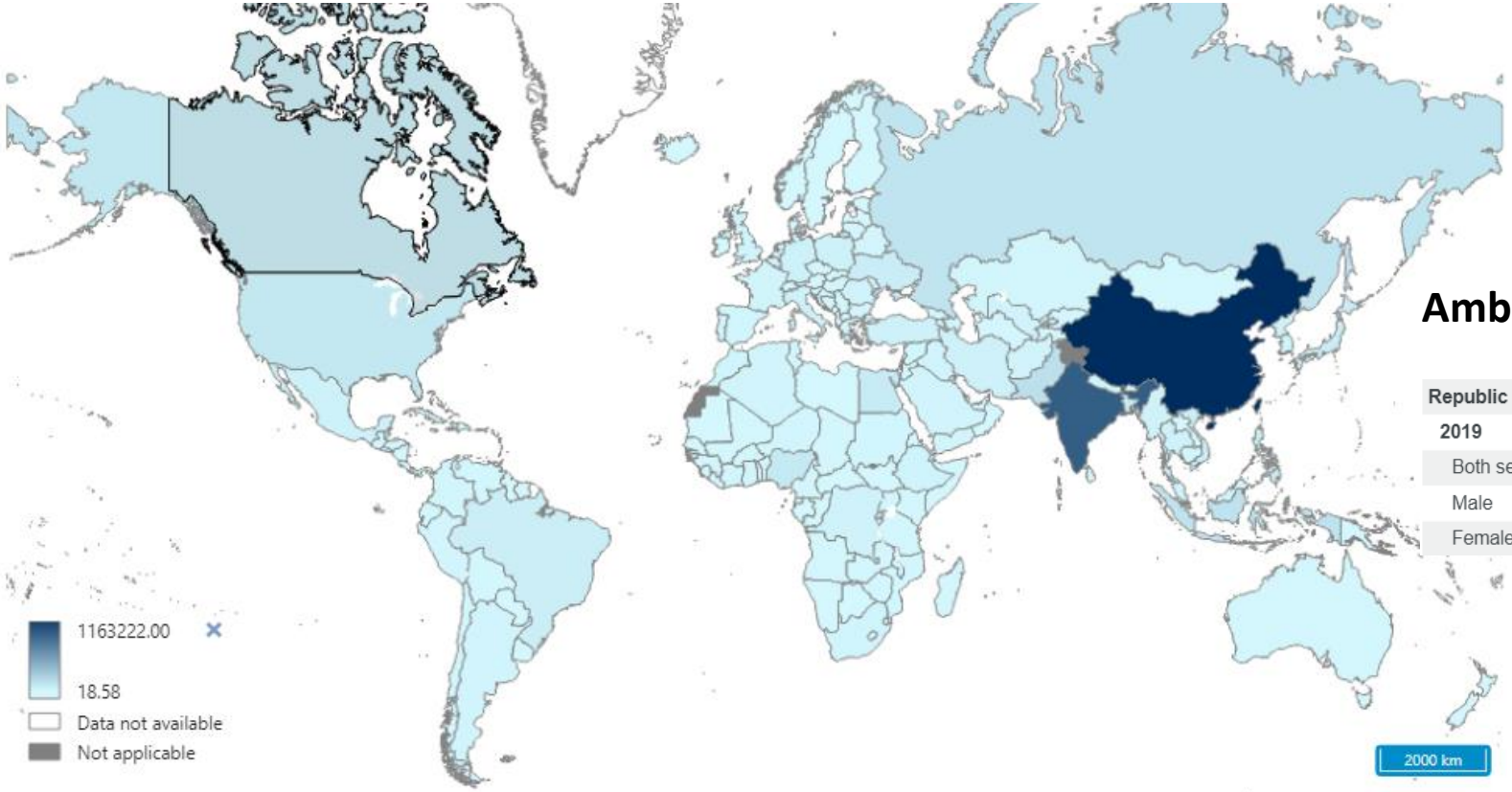
Worldwide ambient air pollution accounts for

17% of deaths

and disease from acute lower respiratory infection

WHO GHO Home

1. Env, Climate Crisis



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

World Health Organization

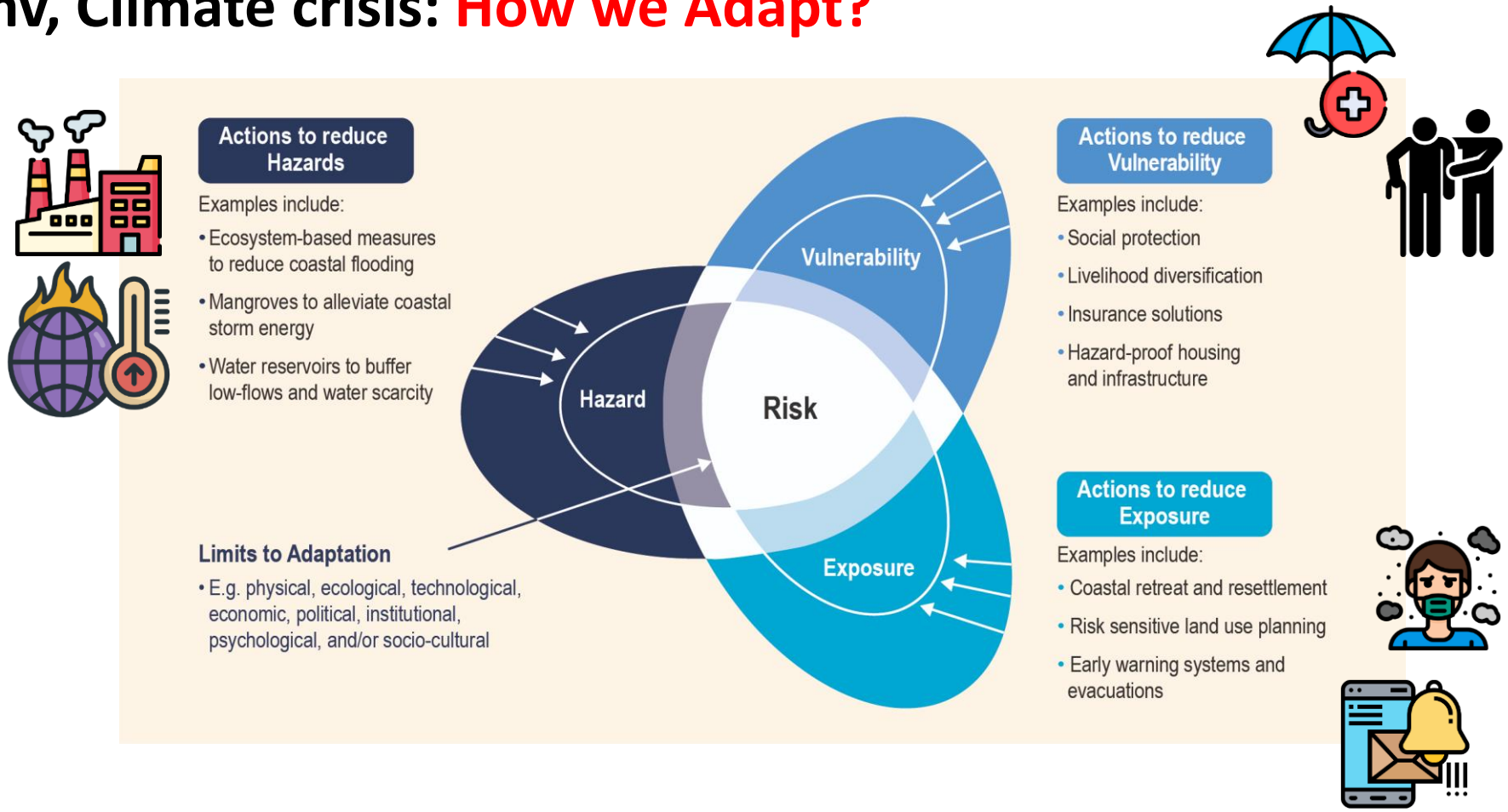
Ambient air pollution attributable deaths

Republic of Korea	
2019	
Both sexes	19 283 [15 394 – 23 344]
Male	10 176 [8243 – 12 327]
Female	9107 [7273 – 11 045]

WHO GHO Home

1. Env, Climate Crisis

- **Env, Climate crisis: How we Adapt?**

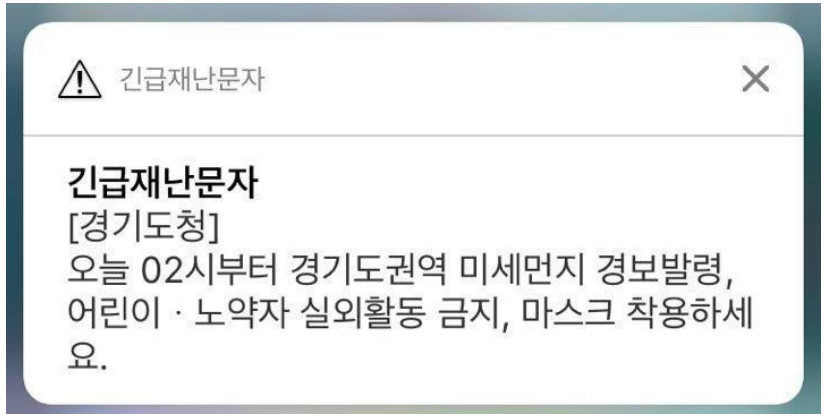


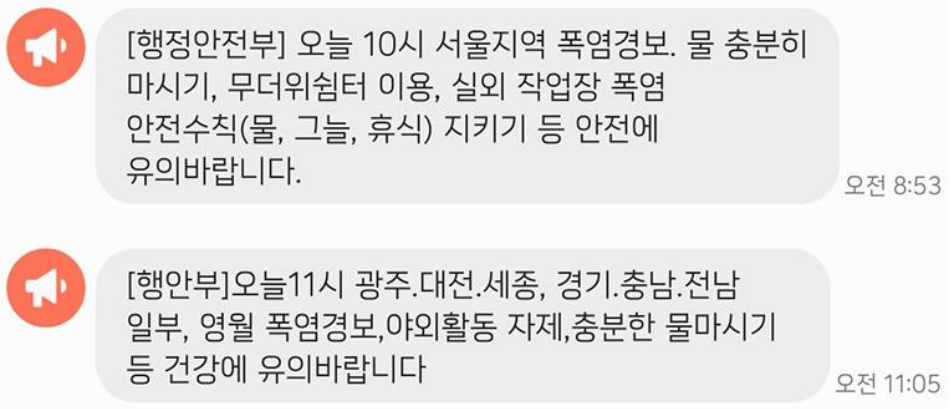
1. Env, Climate Crisis

- Alarming system (top->down)
- Climate shelter (accessibility?)

- Action plans for adaptation? – Our footprints (in Korea)

Alarm texts





Heatwave shelter

KBS 뉴스
https://news.kbs.co.kr › news › view

폭염인데 어디서 쉬나?...무더위쉼터 부실 운영 [취재후]

2023. 8. 8. — **무더위쉼터**를 운영하고 있는 민간시설을 알리는 데 적극적으로 노력할 방침입니다. 또, 지역자율방재단과 **무더위쉼터**의 1:1 담당제를 활용해 문제점을 ...

경향신문
https://m.khan.co.kr › article

[기후적응③]폭염에도 텅 빈 무더위쉼터…"에어컨 틀 줄 몰라" ...

2023. 7. 9. — 폭염이 전국을 덮친 지난 6일과 7일 경향신문이 방문한 서울·경남·경북의 **무더위쉼터** 30여 곳 가운데 제대로 기능을 하는 곳은 3분의 1에도 미치지 못했다 ...

1. Env, Climate Crisis

- **Action plans for adaptation? – Our footprints (Top-down policy-based)**

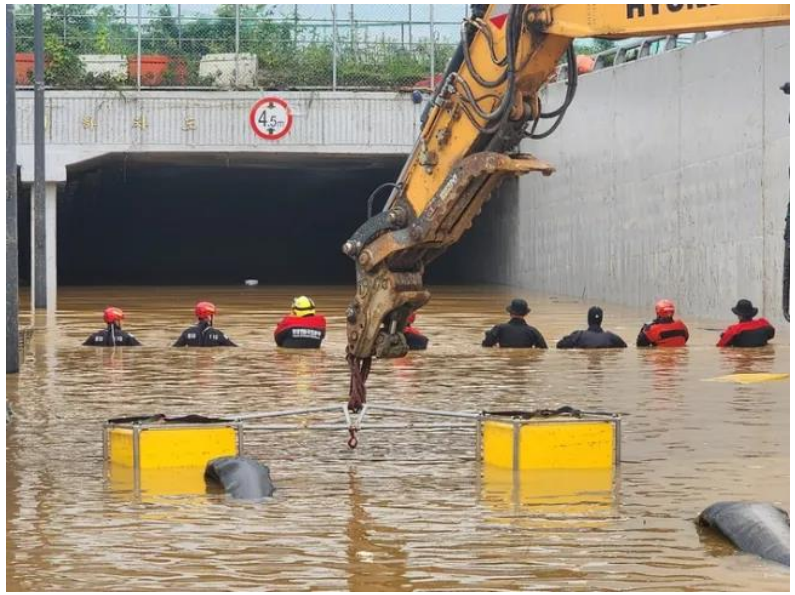
Central Gov.	
Ministry of the Interior and Safety	재난도우미를 활용한 폭염 취약계층 건강·안전 확인 무더위쉼터 적극 개방·운영 각종 홍보 매체를 통한 국민행동요령 집중 홍보 폭염 대비 국민행동요령 재난문자방송 및 재난방송시스템 송출
Ministry of Land, Infrastructure and Transport	매주 지방국토관리청 산하 600여개소 대형 건설현장에 대한 폭염 대책 이행 여부 점검 및 행동요령 홍보
Ministry of Employment and Labor	6만여개 중소 건설현장 등에 열사병 예방 3대 수칙(물, 그늘, 휴식) 및 무더위 시간 작업중지 등 집중 지도·점검
Ministry of Health and Welfare	노인맞춤 돌봄서비스 수행기관(645개)에서 생활지원사가 취약노인 대상 안전확인(전화 또는 방문) 실시
Local Gov.	
재난도우미 취약계층 방문 및 전화, 부채·선풍기 등 예방물품 제공, 노숙인 밀집지역 점검 및 무더위 쉼터 운영 등	

Shelter & Alarm Inspection

Shelter & Regular check

1. Env, Climate Crisis

- **New Challenge: Climate risk is comprehensive**



2023

2022

2022

In Korea…

1. Env, Climate Crisis

- **New Challenge: Climate risk is comprehensive**

A kangaroo rushes past a burning house in Lake Conjola, Australia, Dec. 31 2019.
Matthew Abbott/The New York Times via Redux

Australia

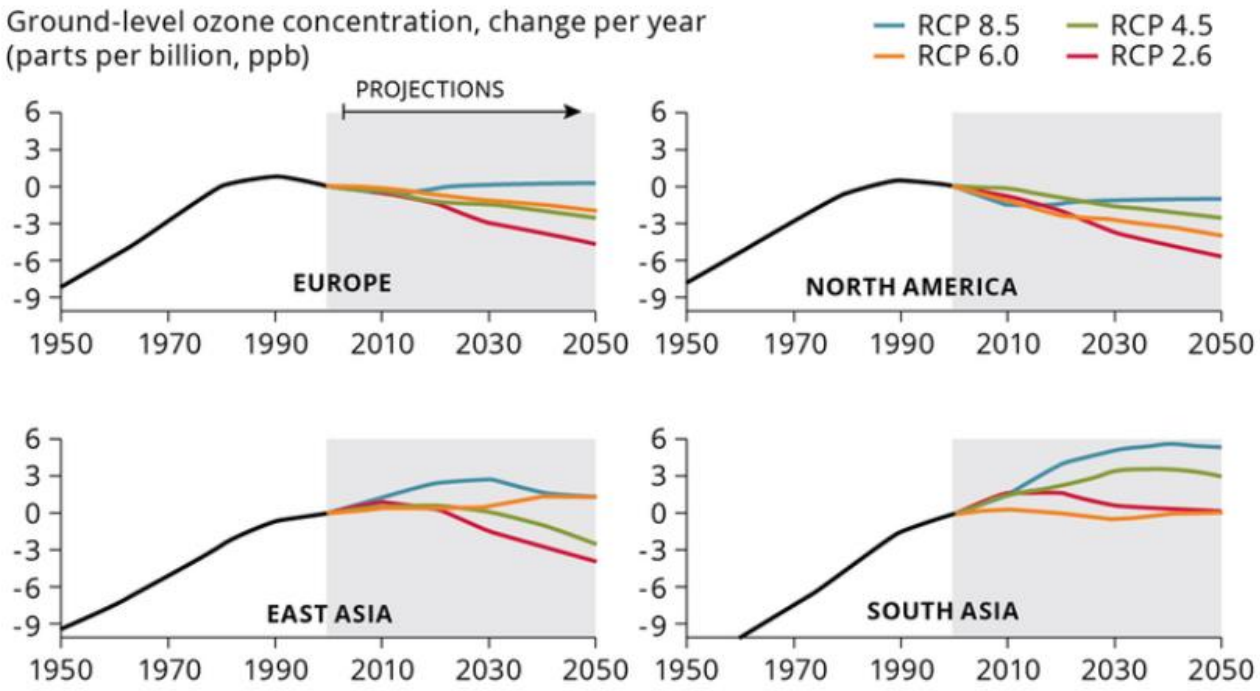
Canada and States

[1/7] Residents look at buildings being burnt down by wildfire in Gangneung, South Korea, April 11, 2023. Yonhap/via REUTERS *Acquire Licensing Rights*

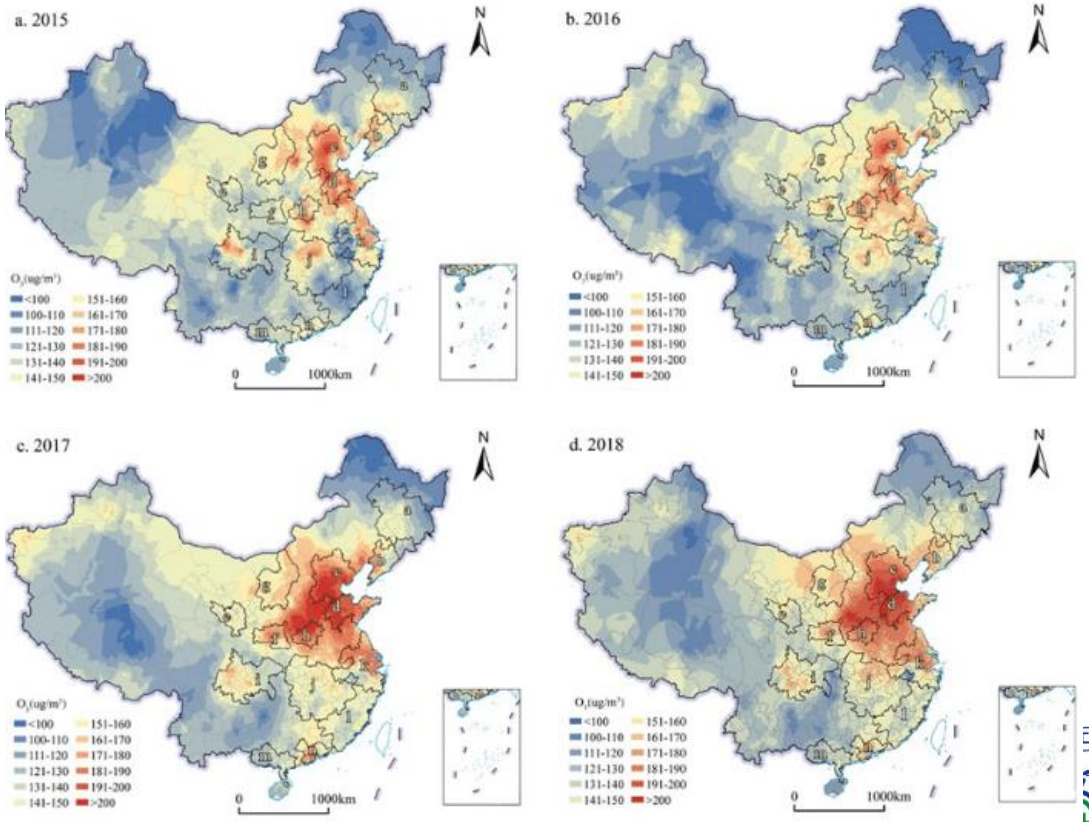
Korea

1. Env, Climate Crisis

- **New Challenge: O_3 – the future hazard**



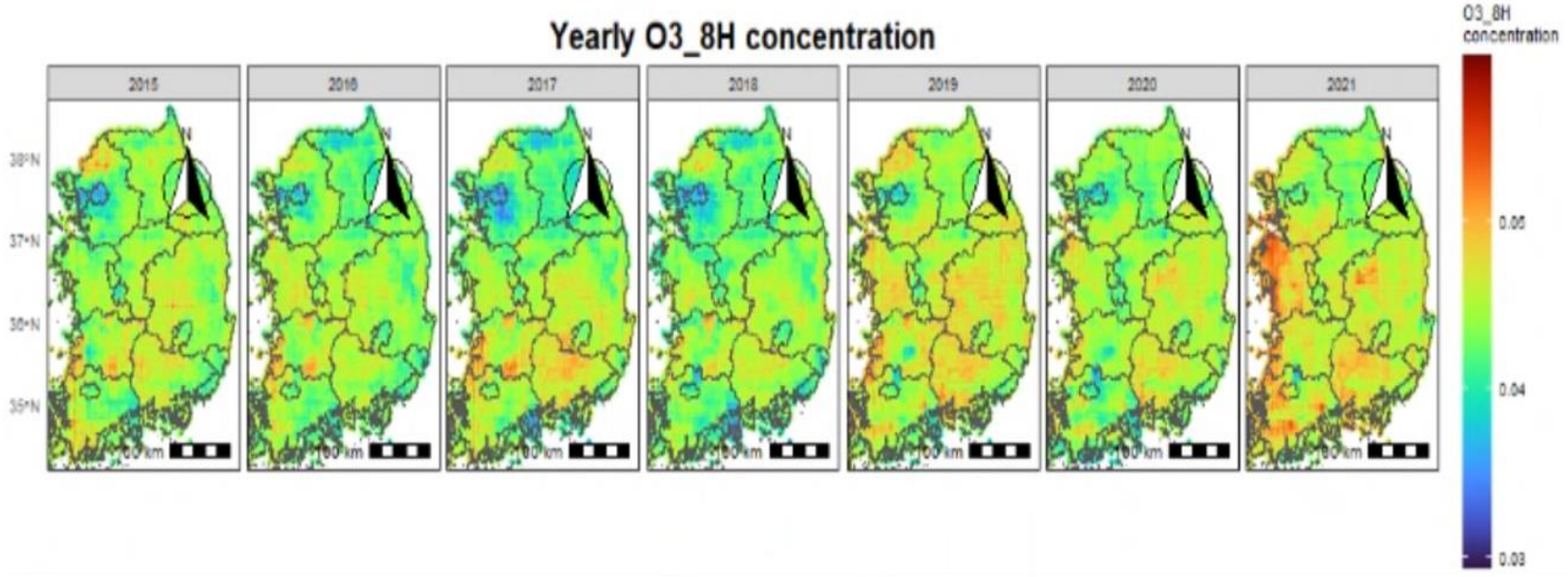
Copyright holder: European Environment Agency (EEA)

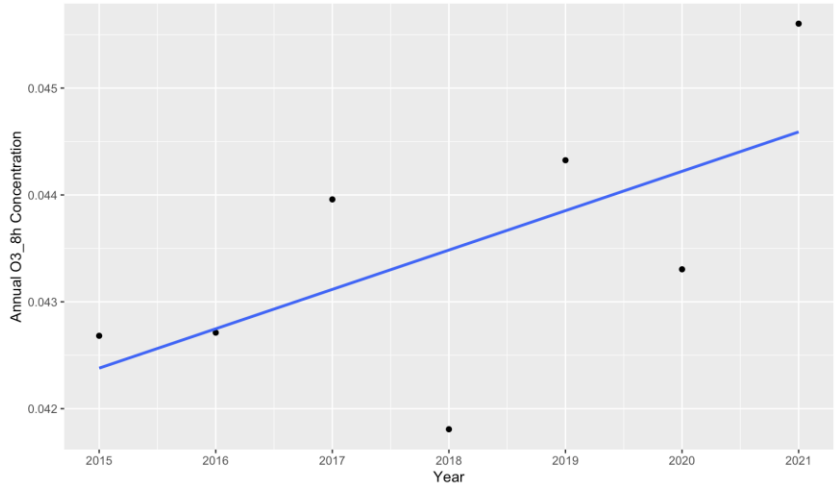


Zheng et al. ESPR (2022)

1. Env, Climate Crisis

- New Challenge: O_3 – the future hazard
- In Korea: O_3 has increased





2. Climate change and respiratory health

2. Climate change and respiratory health

please find evidence on climate change and respiratory health

Climate change has significant implications for respiratory health through various interconnected pathways:

1. Air Quality Degradation

- **Ozone Levels**: Rising temperatures can enhance the formation of ground-level ozone, a key component of smog. Elevated ozone concentrations are associated with diminished lung function and heightened respiratory issues, including asthma exacerbations. EN.WIKIPEDIA.ORG
- **Particulate Matter (PM)**: Increased frequency and intensity of wildfires, driven by climate change, release fine particulate matter (PM2.5) into the atmosphere. These particles can penetrate deep into the lungs, leading to respiratory diseases such as bronchitis and asthma. Recent studies estimate that wildfire smoke may contribute to an additional 12,000 deaths annually due to PM2.5 exposure. THEGUARDIAN.COM

2. Climate change and respiratory health

2. Allergen Proliferation

Longer growing seasons and higher atmospheric CO_2 levels can boost pollen production, intensifying allergic respiratory conditions like hay fever and asthma. EN.WIKIPEDIA.ORG

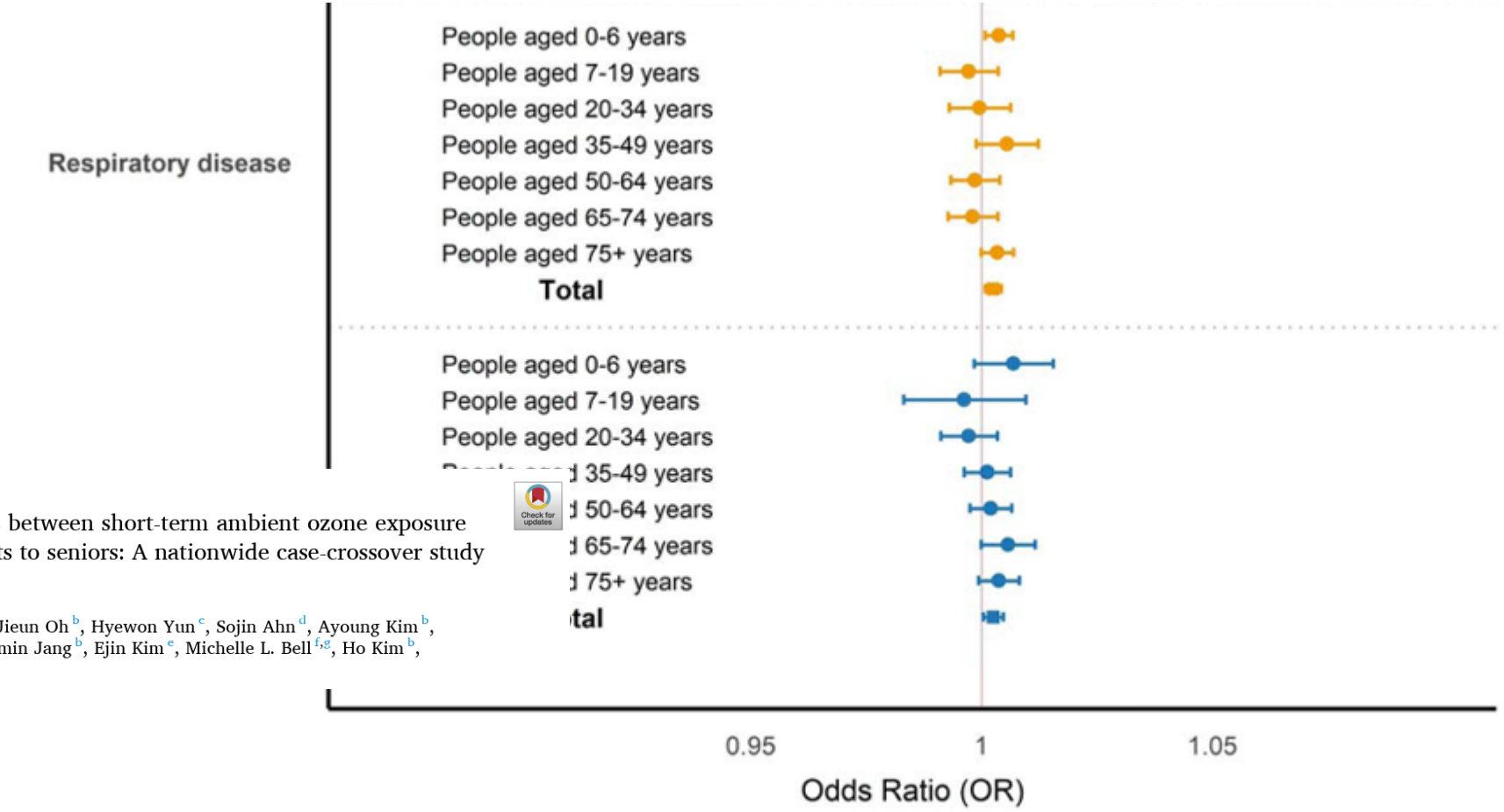
3. Mold Growth

Climate-induced extreme weather events, such as hurricanes and floods, create moist environments conducive to mold proliferation. Exposure to mold spores can trigger respiratory issues, particularly in individuals with asthma or compromised immune systems. WIRED.COM

4. Spread of Fungal Diseases

Changing climate patterns are expanding the habitats of certain fungi, leading to increased cases of respiratory infections. For instance, Valley fever, caused by inhaling fungal spores, has seen a rise in cases, with climate conditions like droughts followed by intense rain fostering the growth and spread of the fungus. VOX.COM

2. Climate change and respiratory health



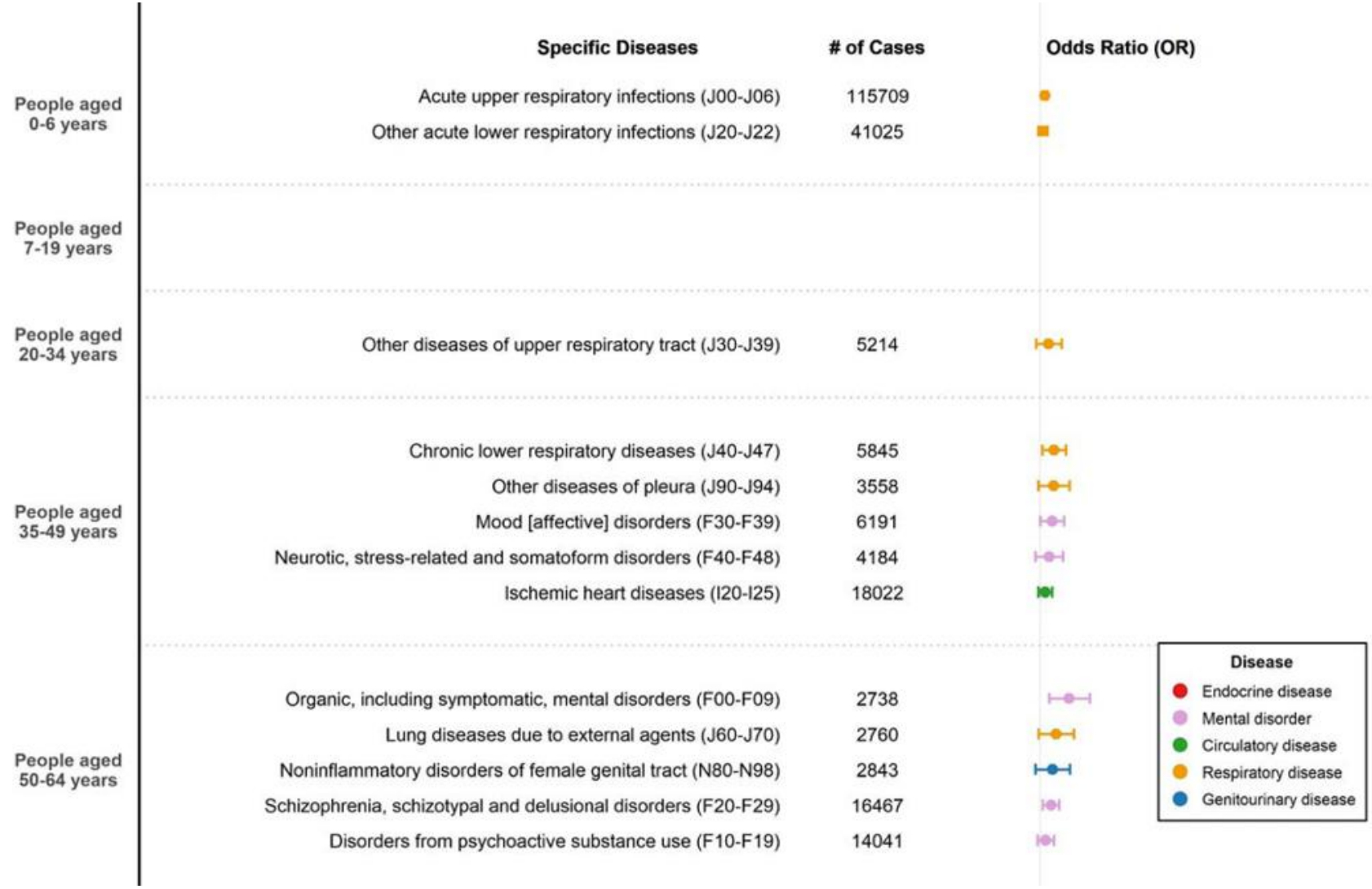
안서영, Seoyeong Ahn
Pusan National University,
부산대학교 의생명융합공학부

Heterogeneous associations between short-term ambient ozone exposure and morbidities from infants to seniors: A nationwide case-crossover study in South Korea

Seoyeong Ahn [a,1], Cinoo Kang [b,1], Jieun Oh [b], Hyewon Yun [c], Sojin Ahn [d], Ayoung Kim [b], Dohoon Kwon [b], Jinah Park [b], Hyemin Jang [b], Ejin Kim [e], Michelle L. Bell [f,g], Ho Kim [b], Whanhee Lee [c,h,*]

Fig. 2. Association between short-term exposure to ambient ozone and ED admissions by reasons for ED admissions and age group. The association of ozone concentration with ED admissions is explained by odds ratios (ORs) for an increase in 10 μg/m^3 of ozone concentration.

2. Climate change and respiratory health



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2. Climate change and respiratory health

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2. Climate change and respiratory health

Research

Rainfall events and daily mortality across 645 global locations: two stage time series analysis

BMJ 2024 ; 387 doi: https://doi.org/10.1136/bmj-2024-080944 (Published 09 October 2024)
Cite this as: *BMJ* 2024;387:e080944

Return period by region	All cause Cumulative relative risk (95% CI)	All cause Cumulative relative risk (95% CI)	Cardiovascular Cumulative relative risk (95% CI)	Cardiovascular Cumulative relative risk (95% CI)	Respiratory Cumulative relative risk (95% CI)	Respiratory Cumulative relative risk (95% CI)
Global (n=645)						
5 years	1.08 (1.05 to 1.11)		1.05 (1.02 to 1.08)		1.29 (1.19 to 1.39)	
2 years	1.03 (0.98 to 1.08)		1.01 (0.98 to 1.04)		1.14 (1.05 to 1.23)	
1 year	0.98 (0.95 to 1.01)		0.98 (0.96 to 1.00)		0.95 (0.89 to 1.02)	
Northern Europe (n=71)						
5 years	0.98 (0.86 to 1.12)		0.94 (0.75 to 1.18)		1.15 (0.96 to 1.34)	
2 years	0.94 (0.85 to 1.04)		1.01 (0.85 to 1.20)		0.95 (0.72 to 1.24)	
1 year	0.98 (0.92 to 1.04)		0.97 (0.89 to 1.05)		1.05 (0.70 to 1.45)	
Central Europe (n=45)						
5 years	1.04 (0.90 to 1.20)		0.84 (0.39 to 1.79)		1.15 (0.56 to 2.35)	
2 years	1.03 (0.94 to 1.13)		0.79 (0.51 to 1.22)		0.93 (0.55 to 1.31)	
1 year	0.96 (0.92 to 1.02)		0.93 (0.81 to 1.07)		0.97 (0.66 to 1.43)	
Southern Europe (n=63)						
5 years	1.07 (0.95 to 1.12)		1.37 (1.07 to 1.77)		1.13 (0.95 to 1.31)	
2 years	1.01 (0.94 to 1.09)		1.15 (0.99 to 1.33)		0.93 (0.66 to 1.31)	
1 year	1.01 (0.98 to 1.05)		1.07 (0.99 to 1.14)		1.07 (0.88 to 1.31)	
East Asia (n=87)						
5 years	1.09 (1.02 to 1.15)		1.03 (0.90 to 1.17)		1.26 (1.06 to 1.46)	
2 years	1.00 (0.97 to 1.02)		1.02 (0.95 to 1.09)		1.24 (1.03 to 1.46)	
1 year	0.98 (0.97 to 0.99)		0.98 (0.96 to 1.00)		0.95 (0.87 to 1.03)	

2. Climate change and respiratory health

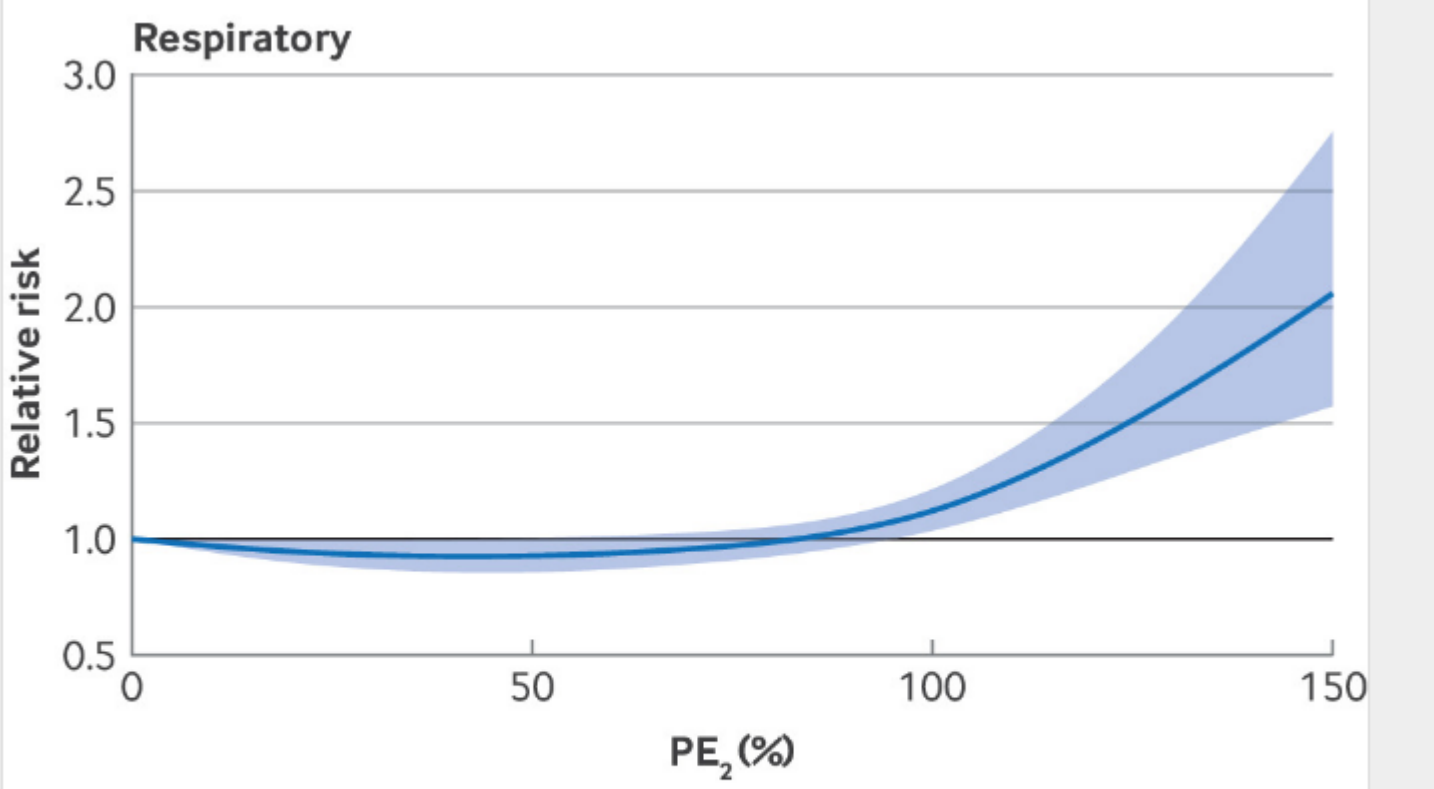


Fig 4

Exposure-response function of the relative risks of all cause, cardiovascular, and respiratory mortality associated with daily accumulated rainfall exceeding the two year return period threshold (PE_2). The return period is the expected average time between occurrences of an extreme event of a certain magnitude

2. Climate change and respiratory health

Critical resource disruptions—Intense rainfall can cause major disruptions to healthcare access. It might damage infrastructure, leading to power outages and hindering essential medical services, both of which can particularly affect older people and those with chronic illnesses, who often require consistent access to drugs and healthcare.[60] Intense rainfall can compromise water and food quality by allowing pathogenic microorganisms to reproduce and spread,[61] leading to diarrhoeal diseases, infections, and associated mortality.[62 63]

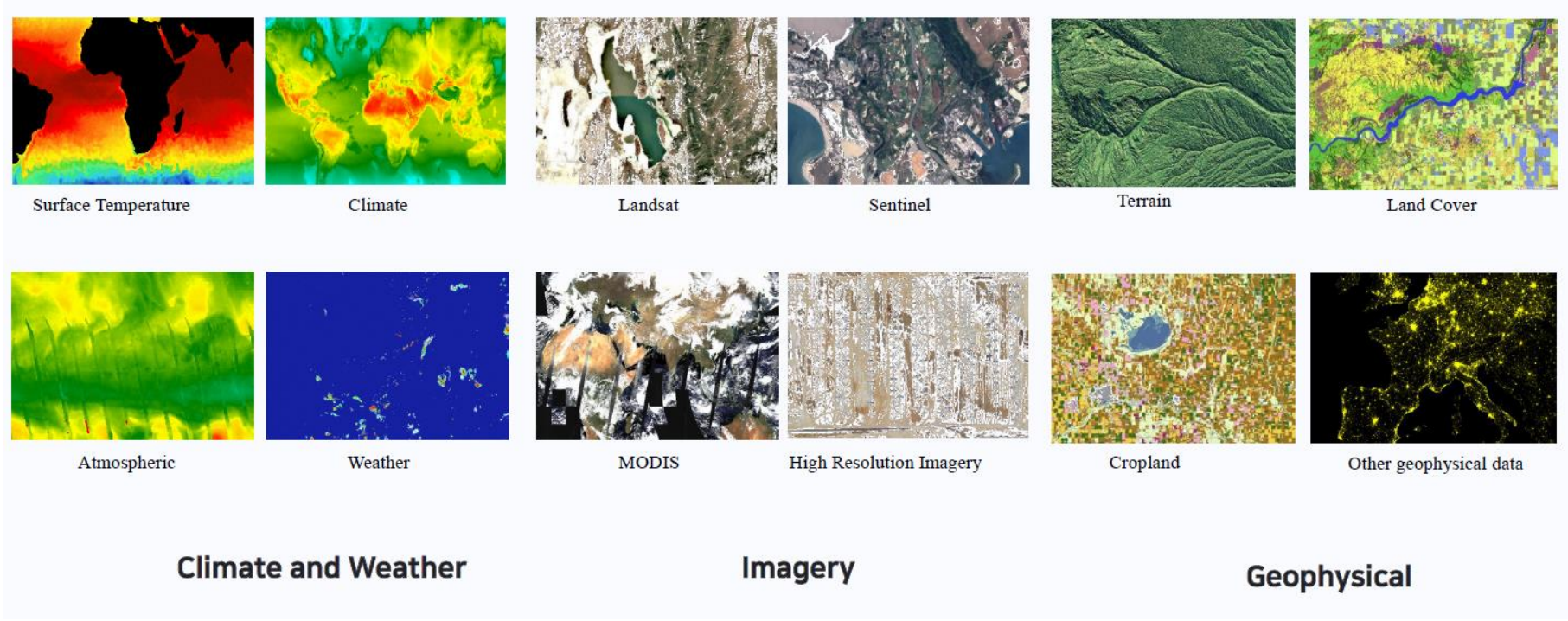
Physiological effects—Increased humidity levels facilitate the growth of airborne pathogens,[64] potentially triggering allergic reactions and respiratory problems, particularly in vulnerable individuals.[65] Rapid shifts in atmospheric pressure can reduce the partial pressure of oxygen in the body,[66 67] leading to cardiovascular and respiratory complications.[60] Furthermore, major temperature fluctuations often accompanying rainfall days can affect both respiratory and cardiovascular systems.[68]

Indirect effects—Extreme rainfall can have profound effects on mental health, inducing stress and anxiety that may exacerbate pre-existing mental health conditions[69] and indirectly contributing to increased total mortality from non-external causes. Overall, these pathways elucidate the complex associations between rainfall intensity and health outcomes observed in our study. Moderate rainfall (PE_2 <100%) shows protective effects, whereas intense rainfall (PE_2 >100%) leads to important harmful effects as negative factors accumulate. Supplementary analysis of the five year return period threshold also corroborated these findings, showing a weaker protective effect and a rapid transition to harmful impacts beyond 50% of the threshold rather than 100% as seen with PE_2 (see supplementary figure S7). Moreover, the rapid onset of these negative factors during extreme rainfall days explained the observed lag pattern (see supplementary figure S2), with health effects most pronounced on the first day and then gradually diminishing.

3. Exposure data

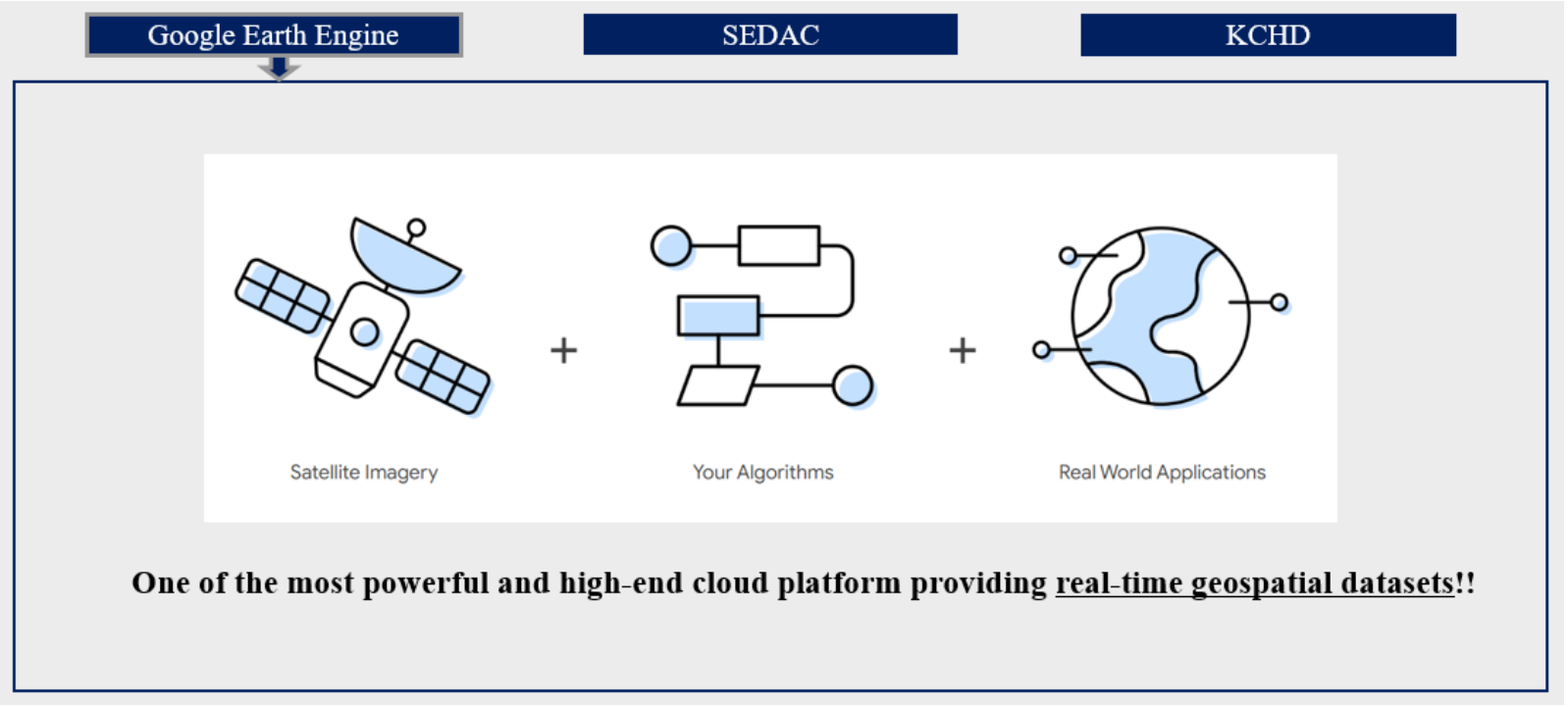
3. Exposure data

- **Large Environments Data**
- **Google Earth Engine**



3. Exposure data

- Large Environments Data
- Google Earth Engine



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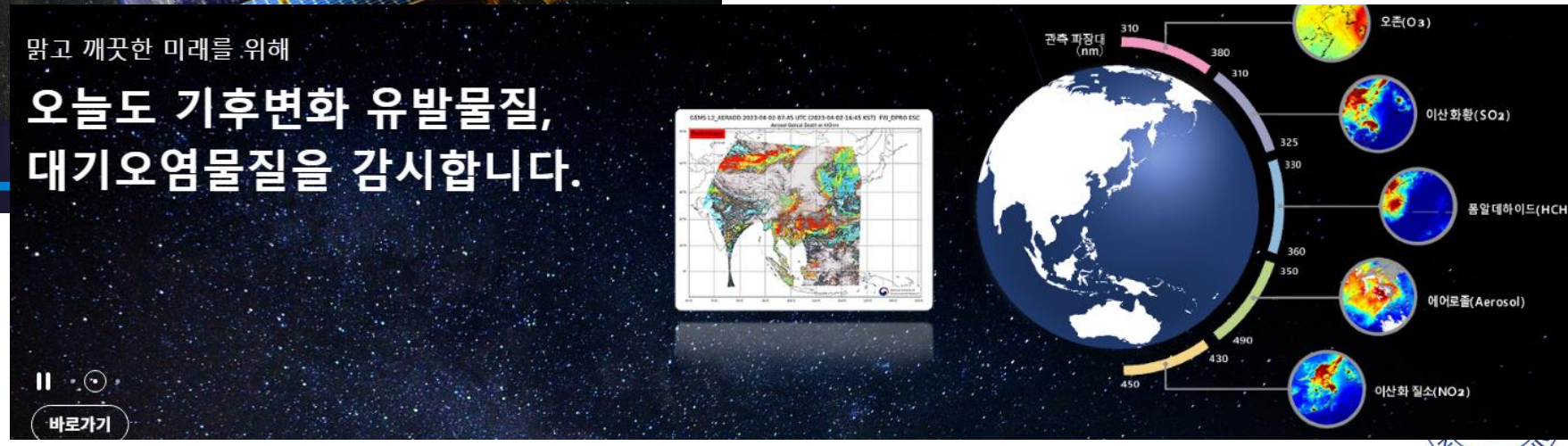
- **Large Environments Data**



3. Exposure data

- Large Environments Data: Real-time Data Base
- API 기반 자동화된 Large 환경 DB 구축

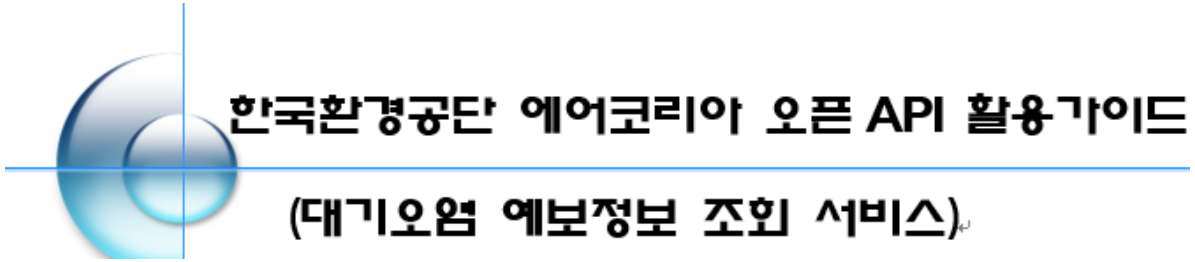
환경위성 Open-API

1. 환경위성 Open-API

환경위성 Open-API는 환경위성(GEMS) Data, Image 자료를 이용하여 공공 및 민간 등에서 자료를 편리하게 활용할 수 있도록 공개한 인터페이스입니다. 사용자는 이를 활용하여 웹 구축, 모바일 어플리케이션 개발 등에 활용할 수 있습니다.

2. Open-API 사용대상

환경위성 자료 활용을 원하는 모든 사용자



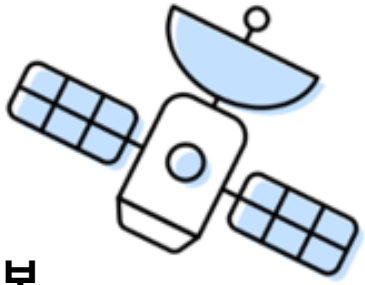
3. Exposure data

- **Large Environments Data**

- **불충분한/부정확한 노출값**
  -> 모델링을 통한 보완
  -> 높은 정확도의 모델링

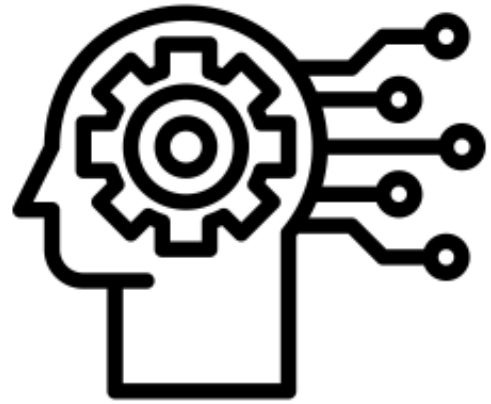
대상물질(1km2)
- 대기오염($PM_{2.5}$, O_3, NO_2)
- 온도
- 강수

측정소 정보



위성 정보

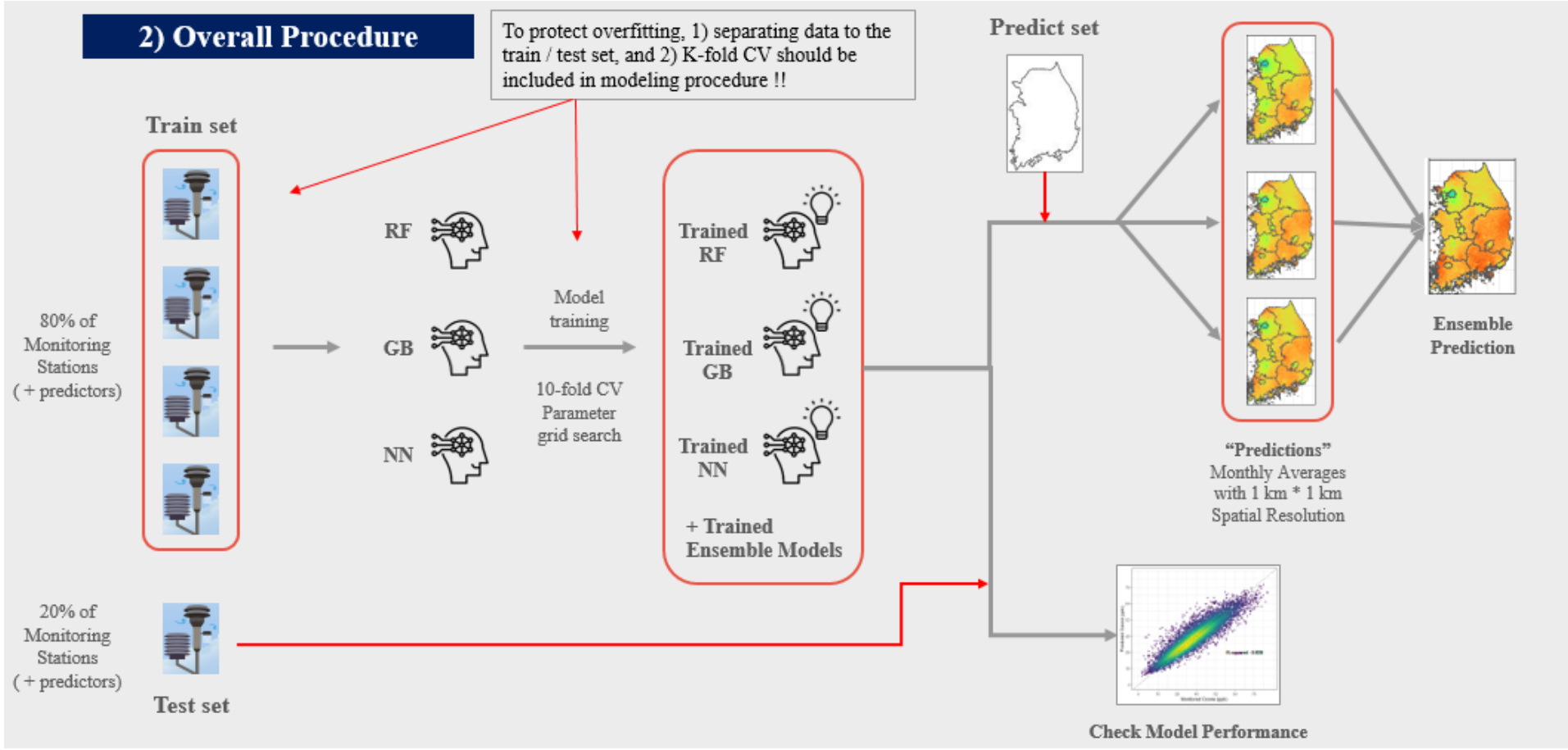
Satellite Imagery



인공지능

3. Exposure data

- **Large Environments Data**



3. Exposure data

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- **Large Environments Data**

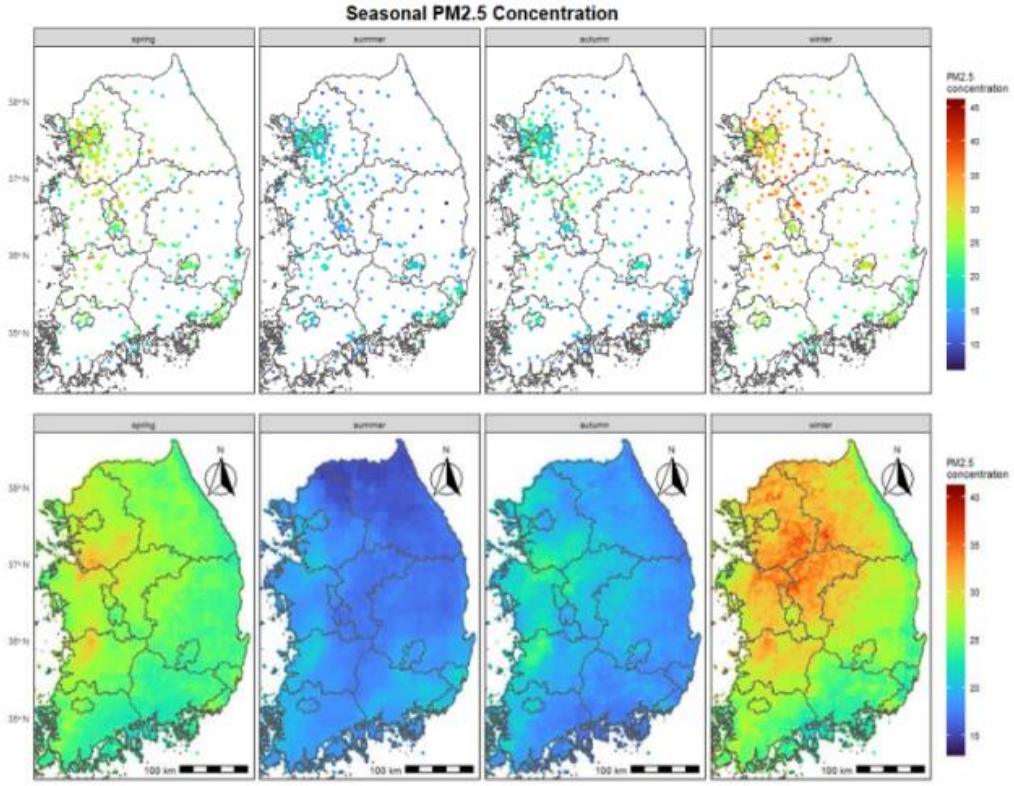


Figure3. Seasonal average $PM_{2.5}$ concentrations with monitoring stations(upper) and estimates of seasonal average $PM_{2.5}$ concentrations(lower)

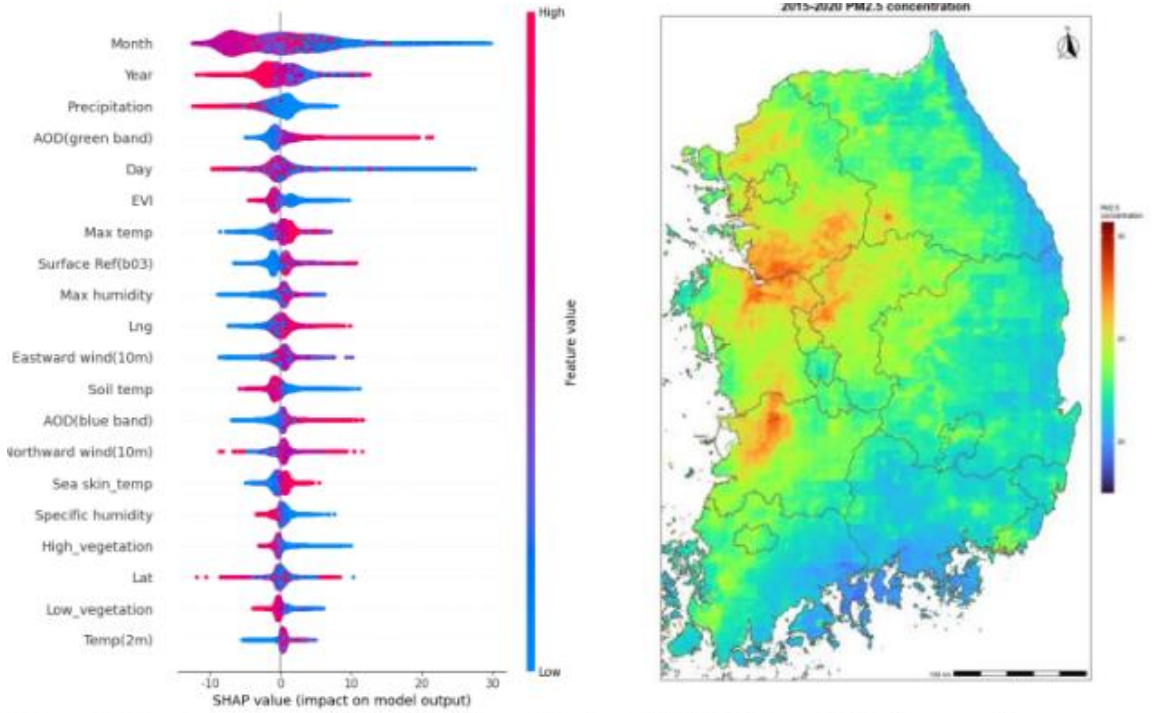
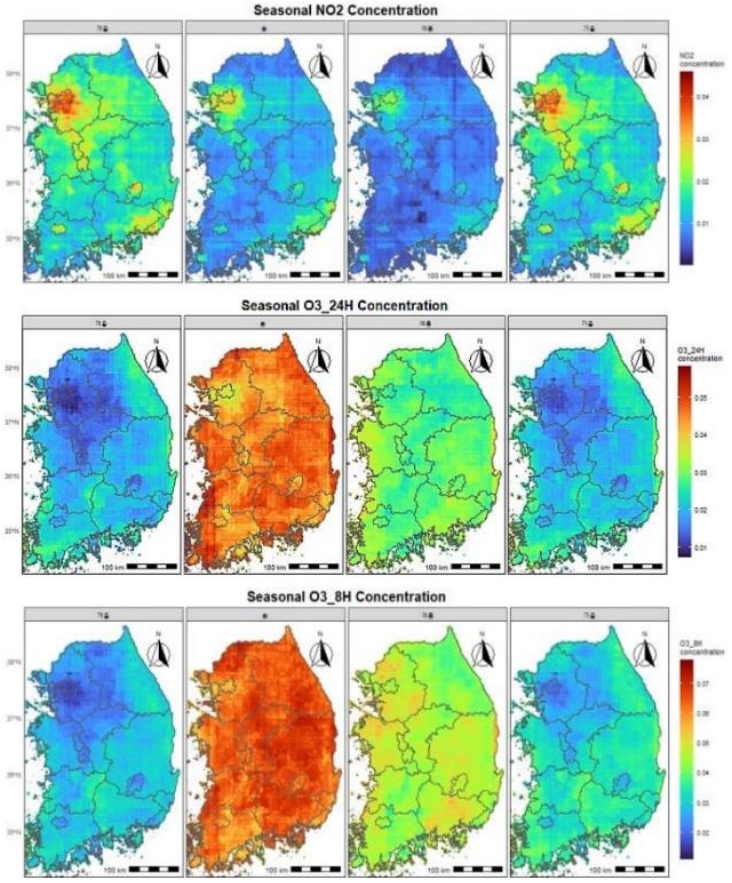


Figure1. Feature contribution of XGB model using SHAP / **Figure2.** Estimates of 6-year average $PM_{2.5}$ concentrations

Daily 2015-2022 (R2>0.95)

3. Exposure data

- **Large Environments Data**



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Pusan National University,
부산대학교 의생명융합공학부

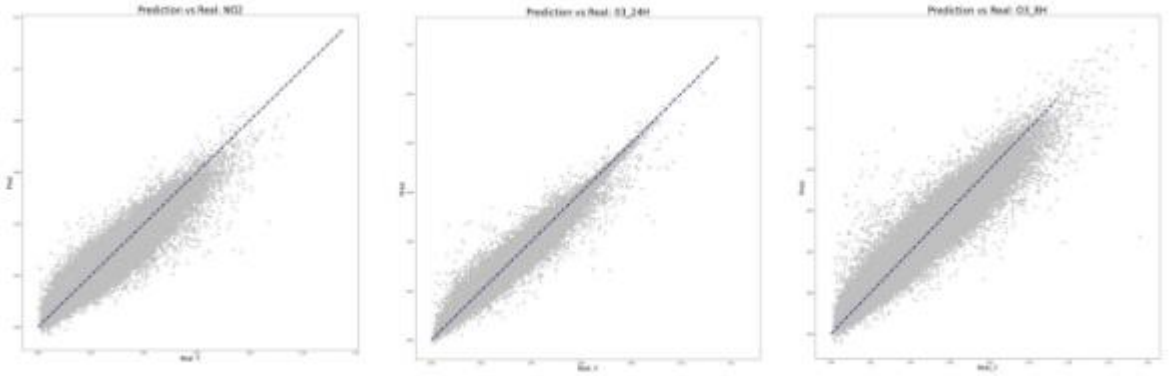
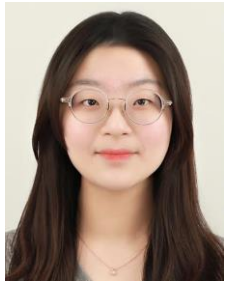


그림2. 본 모형의 예측값(Y축)-실제 관측값(X) plot (NO2, O3_24H, O3_8H 순)

Daily O3 and NO2 2015-2022 (R2>0.95)

3. Exposure data

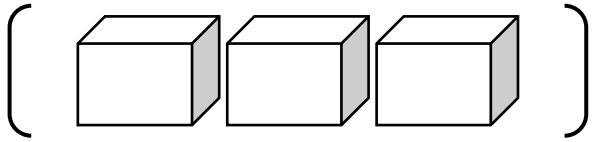


부산대학교 민하린

- **Large Environments Data**

Rainfall Forecasting model using Multivariate LSTM

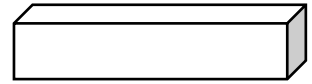
- Period: 2015~2023
- Data source: ERA5(Google Earth Engine), ASOS(KMA)



Input Tensor

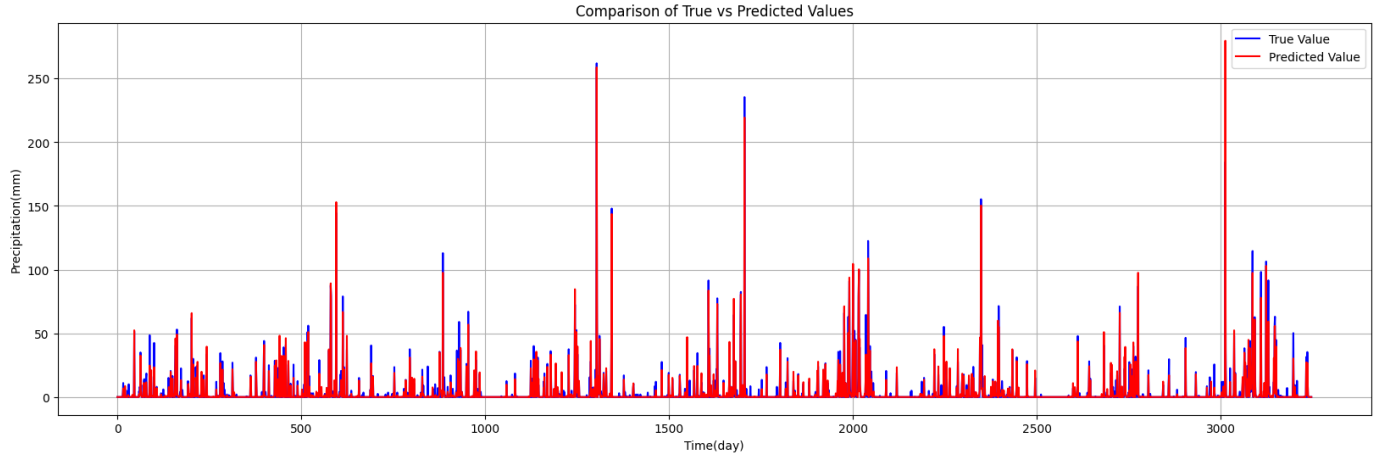
(length, 30 days, 51 features) with 93 grid

multivariate LSTM



Output Tensor

(7 days, 1 prediction)



- **Test R-square: 0.8**

4. NHIS cohort

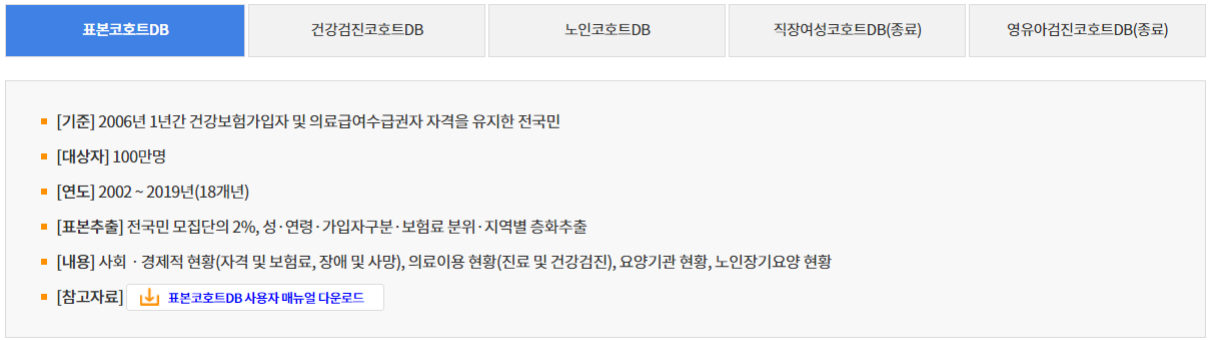
2. Big-data study

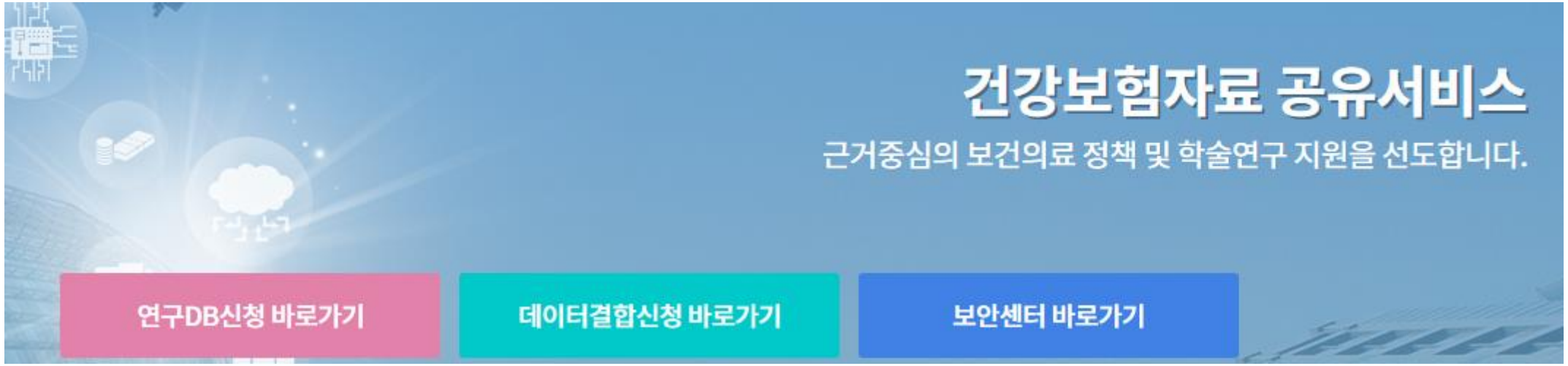
- **Big-health Data: 건강보험자료**

h·well 국민건강보험 National Health Insurance Service

NHISS National Health Insurance Sharing Service

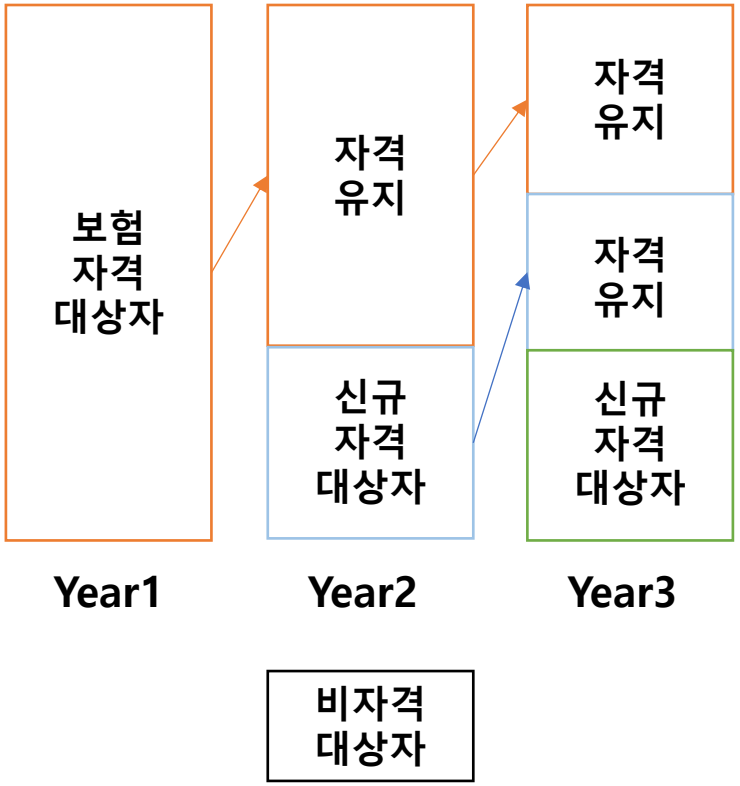
+ 맞춤형 자료





4. NHIS cohort

- **Big-health Data: 건강보험자료**



- **초기 보험 자격 대상자(Initial Beneficiary)**
  - 코호트 시작 시점 건강보험 가입자
  - 국민건강보험의 경우 (거의) 전국민 가입
  - 미가입 대상자: 해외출국 중 내국인, 단기 체류 외국인 등

- **자격 유지 대상자**
  - 코호트 시작 후 해당 연도에 보험가입이 되어있는 대상자

- **신규 자격 대상자**
  - 코호트 시작 후 신규 가입자(i.e. 출생자)
  - 신규 등록 이민자, 외국인
  + 장기 출국 후 입국 내국인

- **비 자격 대상자:** 사망자, 장기 출국 내국인 등 보험자격 상실

4. NHIS cohort

- **Big-health Data: 건강보험자료**

1. **자격DB**
2. **진료DB**
3. 건강검진DB
4. 요양기관DB

자격 및 보험료 테이블

대상	건강보험가입자 및 의료급여수급권자(외국인 제외)
내용	성, 연령대, 거주지역, 가입자 구분, 소득분위 등 대상자의 사회경제적 변수 및 장애, 검진대상자 여부 등
변수	10개 변수로 구성

-> 환자 주소지 기반 환경자료 연계!

진료 테이블

내용	대상자가 요양기관에 방문하여 진료 등을 받은 내역에 대해 요양기관으로부터 요양급여가 청구된 자료
구성	의과_보건기관(M), 치과(D), 한방(K), 약국(P) 자료에 대한 명세서 일반내역(T20), 진료내역(T30), 상병내역(T40), 처방전교부상세내역(T60)의 10개 세부DB로 구성

구분	의과_보건기관	치과	한방	약국
일반내역 (T20)	○	○	○	○
진료내역 (T30)	○	○	○	○
상병내역 (T40)	○	○	○	-
처방전 교부상세내역 (T60)	○	○	-	-

4. NHIS cohort

- **Big-health Data: 건강보험자료**

1. 자격DB
2. 진료DB
3. **건강검진DB**
4. **요양기관DB**

건강검진 테이블

내용	1차 일반건강검진 주요 결과 및 문진에 의한 생활습관 및 행태관련 자료
구성	2002~2008년, 2009~2015년 건강검진DB 별도 구성 ※ 검진제도 개편(2009년)으로 주요 검진 및 문진항목 변경
변수	(2002~2008) 51개 변수, (2009~2013) 54개 변수로 구성

요양기관 테이블

내용	요양기관의 종별, 요양기관 주소, 인력, 병상 수 등
변수	10개 변수로 구성

4. NHIS cohort

- **Nationwide Environmental Epidemiology Studies**

Research

A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP10729.

Air Pollution and Acute Kidney Injury in the U.S. Medicare Population: A Longitudinal Cohort Study

Whanhee Lee,[1] Xiao Wu,[2] Seulkee Heo,[3] Joyce Mary Kim,[4] Kelvin C. Fong,[3] Ji-Young Son,[3] Matthew Benjamin Sabath,[5] Ana Trisovic,[6,7] Danielle Braun,[6,7] Jae Yoon Park,[8,9] Yong Chul Kim,[10] Jung Pyo Lee,[10,11] Joel Schwartz,[12] Ho Kim,[13,14] Francesca Dominici,[6,7] Ziyad Al-Aly,[15,16,17,18] and Michelle L. Bell[3]

[1]School of Biomedical Convergence Engineering, Pusan National University, Yangsan, Republic of Korea
[2]Department of Biostatistics, Mailman School of Public Health, Columbia University, New York, New York, USA
[3]Yale School of the Environment, Yale University, New Haven, Connecticut, USA
[4]Department of Environmental Medicine, College of Medicine, Ewha Womans University, Seoul, Republic of Korea
[5]Faculty of Arts and Sciences Research Computing Department, Harvard University, Boston, Massachusetts, USA
[6]Department of Data Science, Dana-Farber Cancer Institute, Boston, Massachusetts, USA
[7]Department of Biostatistics, Harvard TH Chan School of Public Health, Boston, Massachusetts, USA
[8]Department of Internal Medicine, Dongguk University Ilsan Hospital, Republic of Korea
[9]Department of Internal Medicine, Dongguk University College of Medicine, Republic of Korea
[10]Department of Internal Medicine, Seoul National University Hospital, Seoul, Republic of Korea
[11]Department of Internal Medicine, Seoul National University Boramae Medical Center, Republic of Korea
[12]Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA
[13]Department of Public Health Science, Graduate School of Public Health, Seoul National University, Seoul, Republic of Korea
[14]Institute for Sustainable Development, Graduate School of Public Health, Seoul National University, Republic of Korea
[15]Nephrology Section, Medicine Service, Veterans Affairs Saint Louis Health Care System, Saint Louis, Missouri, USA
[16]Department of Medicine, Washington University School of Medicine, Saint Louis, Missouri, USA
[17]Division of Public Health Sciences, Department of Surgery, Washington University School of Medicine, Saint Louis, Missouri, USA
[18]Institute for Public Health, Washington University School of Medicine, Saint Louis, Missouri, USA

4. NHIS cohort

- **Nationwide Environmental Epidemiology Studies**

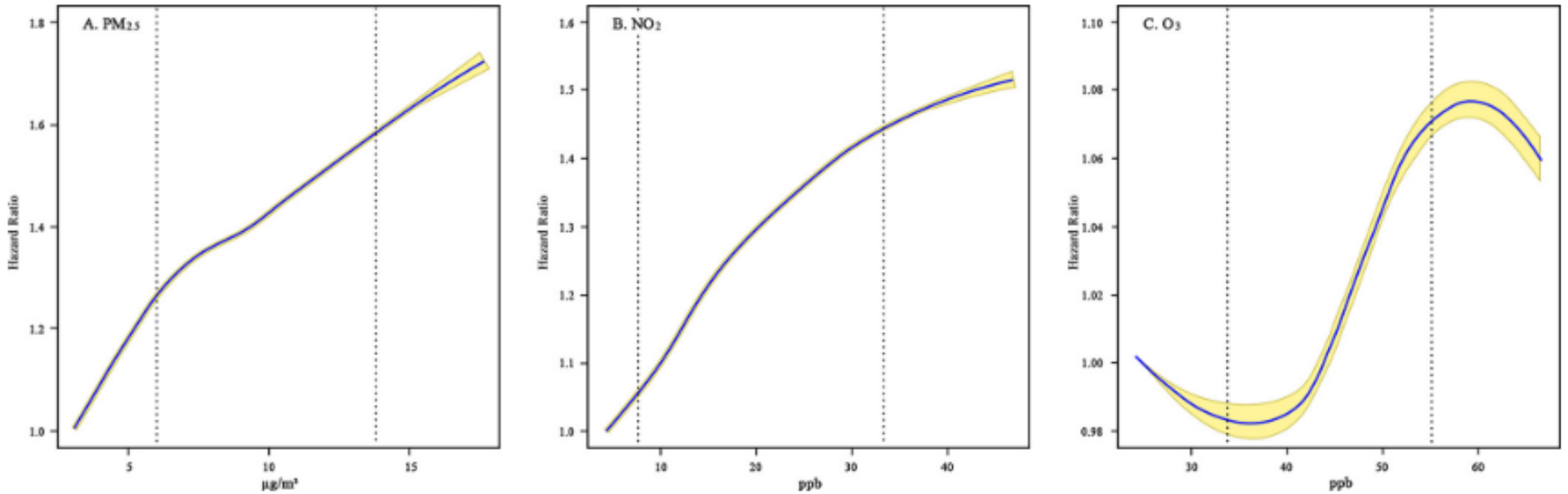


Figure 2. Concentration–response curves for the association between long-term air pollution exposure and kidney diseases: (A) $PM_{2.5}$, (B) NO_2, and (C) O_3. Dotted vertical lines: 10th and 90th percentiles of each air pollution concentration. Shaded areas: 95% CIs. Reference exposure points: 0 $\mu g/m^3$ for $PM_{2.5}$ and 0 ppb for NO_2 and O_3. Individual-level confounders (age, sex, race, Medicaid eligibility) and neighborhood-level socioeconomic status indicators were adjusted in the results. Study population: Medicare Part A fee-for-service beneficiaries (≥65 years of age) from 2000 to 2016. See Table S1 for corresponding numeric data. A Cox-equivalent reparameterized Poisson model was used to estimate the hazard ratios. Note: CI: confidence interval; NO_2, nitrogen dioxide; O_3, ozone; $PM_{2.5}$, fine particulate matter.

4. NHIS cohort

박진아, Jinah Park
Seoul National University,
서울대학교 보건대학원

- **Nationwide Environmental Epidemiology Studies**

Association between heat and hospital admissions in people with disabilities in South Korea: a nationwide, case-crossover study

Jinah Park, Ayoung Kim, Yoonhee Kim, Minhyeok Choi, Tae Ho Yoon, Cinoo Kang, Hee Jung Kang, Jieun Oh, Michelle L Bell, Ho Kim, Whanhee Lee

Summary

Background Despite extensive findings on the hazardous impacts of environmental heat exposure, little is known about the effect on people with disabilities. This study aimed to estimate the association between environmental heat exposure and emergency department admissions for people with disabilities compared with people without disabilities.

Lancet Planet Health 2024; 8: e217–24

Department of Public Health Sciences, Graduate School of

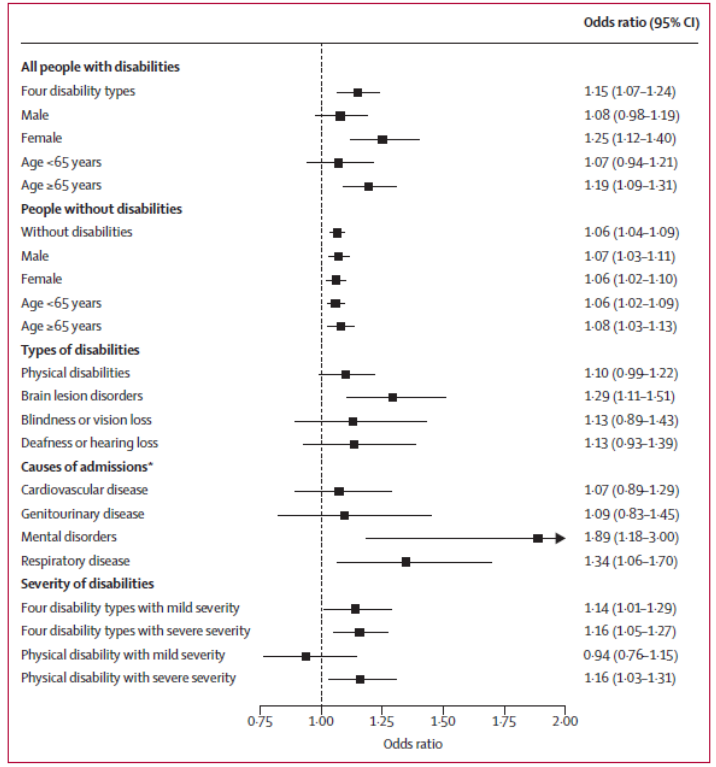


Figure 2: **Risk of emergency department admissions attributable to heat**
Odds ratio with calculated odds at the 99th percentile compared with the 75th percentile (district-specific 99th percentile *vs* 75th percentile) using a time-stratified case-crossover design with a conditional logistic regression. Error bars are 95% CIs for estimates of risk. The four disability types are physical disability, brain lesion disorders, blindness or vision loss, and deafness or hearing loss. *In people with disabilities.

4. NHIS cohort

박진아, Jinah Park
Seoul National University,
서울대학교 보건대학원

- **Nationwide Environmental Epidemiology Studies**

Articles

Heat and hospital admission via the emergency department for people with intellectual disability, autism, and mental disorders in South Korea: a nationwide, time-stratified, case-crossover study

Jinah Park, Ayoung Kim, Michelle L Bell, Ho Kim, Whanhee Lee**

Lancet Psychiatry 2024; 11: 359–67

Summary

Background Given the anticipated increase in ambient temperature due to climate change, the hazardous effects of heat on health have been extensively studied; however, its impact on people with intellectual disability, autism, and

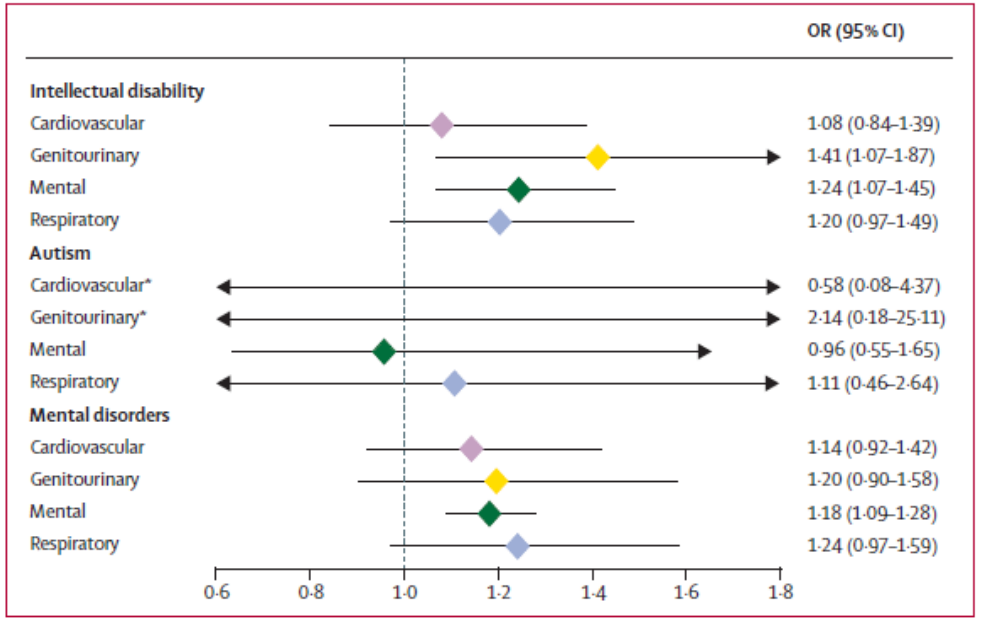


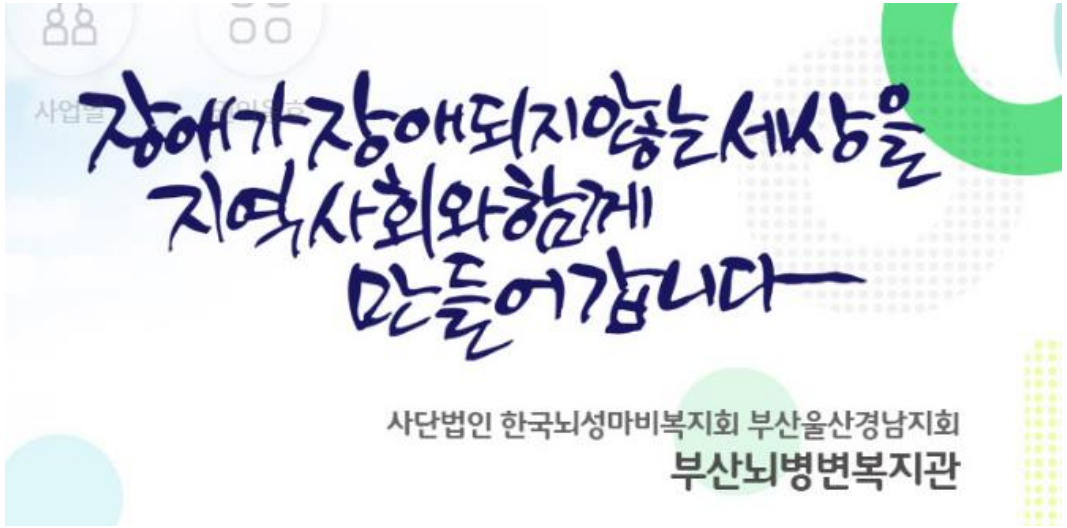
Figure 2: **Risk of ED admission attributable to heat among people with intellectual disability, autism, and mental disorders depending on cause of admission**

Error bars show a 95% CI for estimates of risk. ED admission=admissions through the emergency department. OR=odds ratio. *ORs for cardiovascular disease and genitourinary disease in autism exceed x axis.

5. Digital healthcare

5. Digital healthcare

- **Small-area Digital healthcare study**
- “Counter strategies against climate and environmental risk for people with brain lesion disabilities”



with

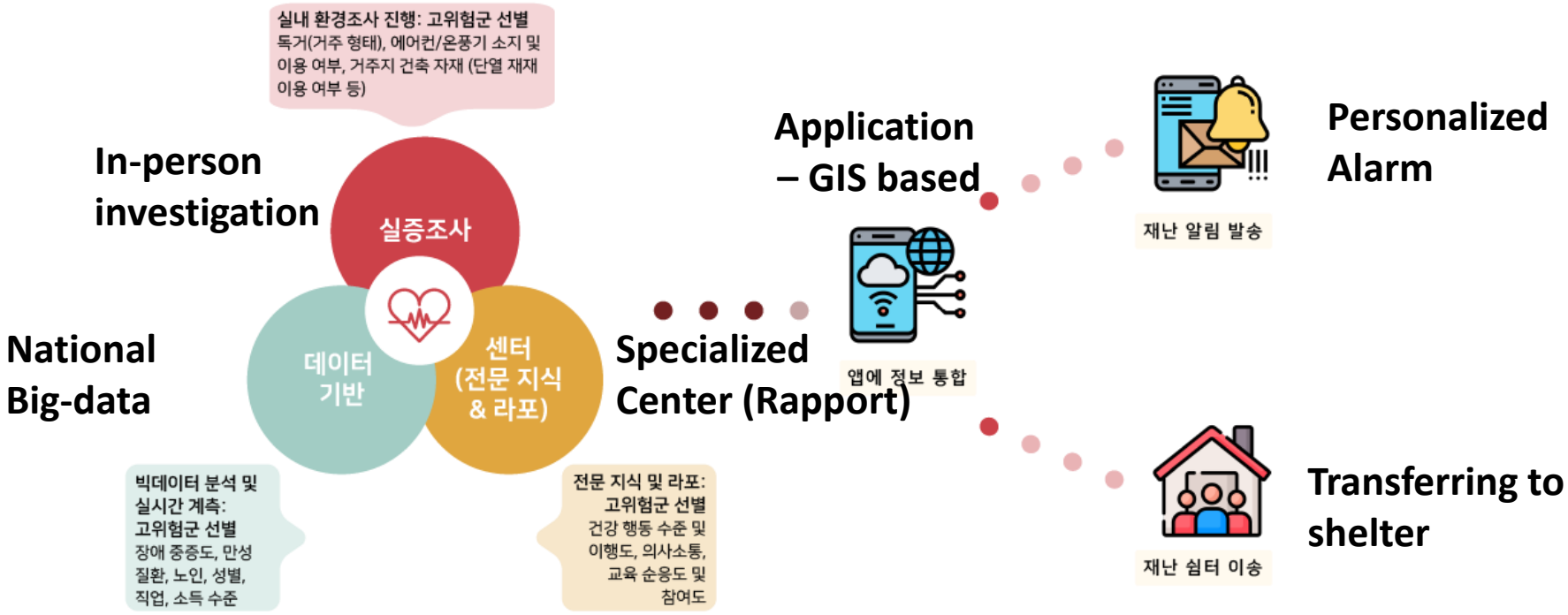
A Center for persons with brain lesion disabilities in Busan

Why here?

- The center already have **very strong Rapport** with participants & also have shelter rooms

5. Digital healthcare

- **Small-area Digital healthcare study**
- **Basic plan:** Online to Offline (O2O) Digital healthcare

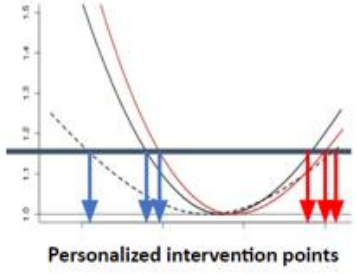


5. Digital healthcare

Data Science

Big Data Analysis

Community Health



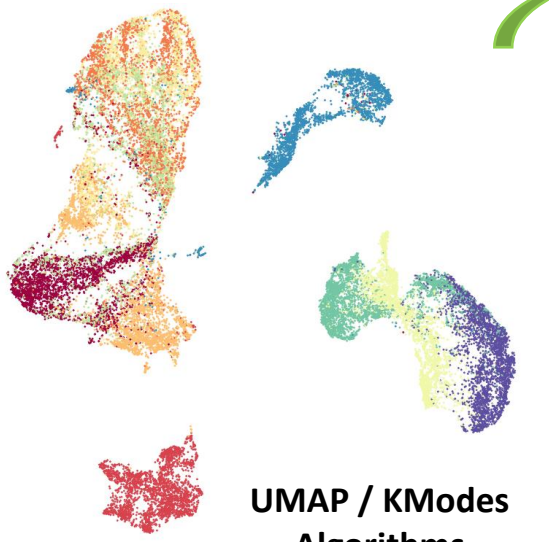
사단법인 한국뇌성마비복지회 부산울산경남지회가 운영하는

부산뇌병변복지관

5. Digital healthcare

h·well 국민건강보험 National Health Insurance Service

Variables						
Address (GU)	Age	Sex	Year	...	DM	HYP
10001	67	F	2002		0	0
10001	68	F	2003		1	0
...			...		...	
45010	78	M	2018		0	1
45010	79	M	2019		0	1



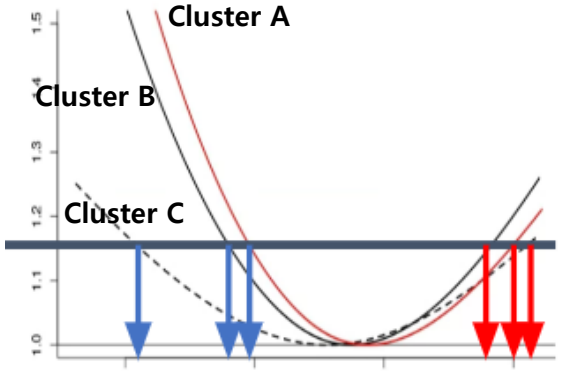
Clustering (Dimension Reduction)
- A.I. / Unsupervised Learning

UMAP / KModes Algorithms

Statistical Analysis
- Cluster evaluation
- Risk estimation

Case time-series /Conditional logistic regression

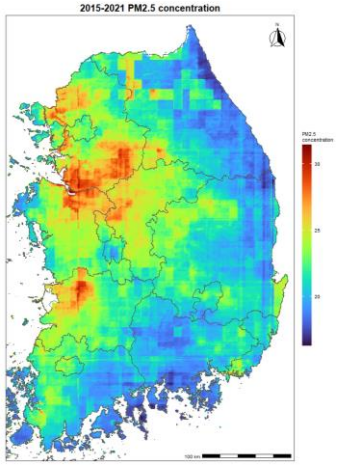
Personalized Risk & Personalized Intervention

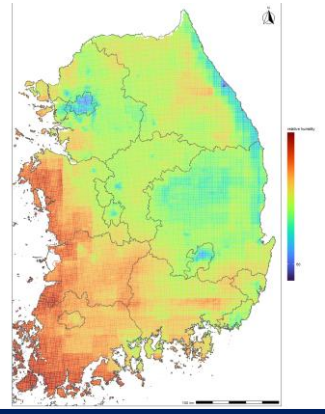


Personalized intervention points

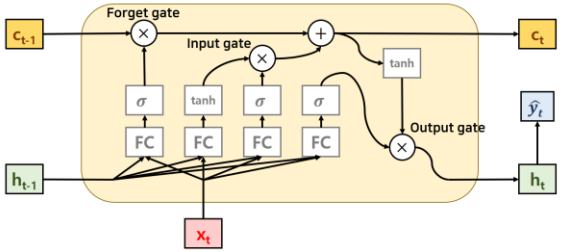
5. Digital healthcare

Step 3 Exposure assessment (real-time & prediction)

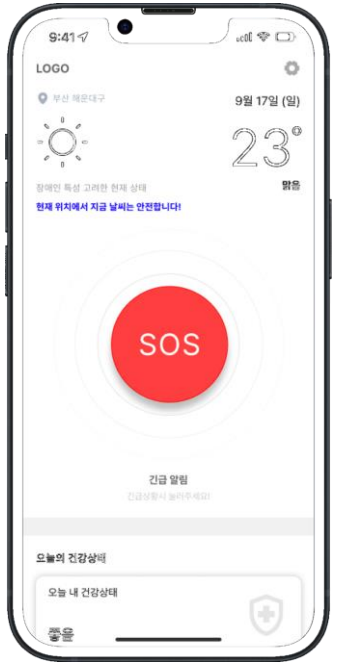




Real-time & Forecasting model data



with Meteorological forecast data (Open API)



App (GIS-based)
Indoor/Outdoor classification

Individual-level exposure assessment (historical & forecast)

&

Individual interventions based on information on App (user written)

5. Digital healthcare

Step 4. Life-log real-time health data

- **Real-time ECG** (with HUINNO)
- Life-log data are collected into DB
- We can operationally **define the "abnormal status" for each individual** (using AI)

- **Daily mood (EMA & Pulse data)**
- We can care daily mental status

- Based on these life-log data, we can determine **"Intervention points" based on AI models**

5. Digital healthcare

Step 5. Real-time Monitoring, Alarm, and Intervention

유저 관리

검색어를 입력해주세요 | 필터

프로필	유저명	연세	실시간 맥박	현재 위치	날씨	실외온도 (°C)	강수량 (mm/시)	강설량 (mm/시)	풍속 (m/s)	비고
	김철수	82	90 bpm	부산광역시 해운...	태풍	16	100	0	33	위험
	홍길동	76	70 bpm	서울특별시 은평구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전
	홍길동	76	70 bpm	서울특별시 강남구...	맑음	23	9.5	0	7	안전

유저 상세

김철수
82세

현재위치
부산광역시 해운대구 ○○동

비고
위험

SOS 요청

유저 정보
연세 **82 세**
실시간 맥박 **90 bpm**
유저 휴대전화 번호 **010 1234 5678**
보호자 휴대전화 번호 **010 4567 1234**

날씨 정보
날씨 **태풍**
실외 온도 **16°C**
강수량 **100 mm/시**
강설량 **0 mm/시**
풍속 **33 m/s**

참여자 특성 고려한 현재 상태
현재 위치에서 지금 날씨는 위험합니다!
태풍을 조심하세요!

현재 상태 메시지 수정

5. Digital healthcare

Step 6 Online and Offline interventions

- **Online care (Online group):** App-based personalized alarm (heatwave, cold spell, heavy rain, and high $PM_{2.5}$) & Real-time emergency transportation
- **Online & Offline care (O2O group)**: Online care + Offline interventions

- **Offline interventions:** Regular consulting with experts (per 3-months), Predictive preventions (based on forecast model) -> *care-call & outreach service (preventive transportation to shelter)*

5. Digital healthcare

지역사회기관
- 코호트 참여자 모집
- 코호트 참여자 교육 및 관리
- 응급 대피 이동 장비 및 쉼터 구축
- 장애인 기후 재난 대응 프로토콜 공동 개발

산학협력기관
- ECG 계측기기 제공
- 부정맥 탐지 알고리즘 협력 개발
- 심전도 분석보고서 제공
- 실시간 ECG 정보 송출 시스템 제공

사단법인 한국뇌성마비복지회 부산울산경남지회가 운영하는 부산뇌병변복지관

HUINNO
인공지능 기반의 디지털헬스케어 선두기업 휴이노

연구책임기관
- 건강보험 데이터 분석
- 실증 평가 수행 및 DB 구축
- 실증 평가 수집 데이터 분석
- 장애인 기후 재난 대응 프로토콜 개발

SNU Health
서울대학교 보건대학원

내일은 개발

참여연구기관
- 건강보험 데이터 분석
- 건강보험 데이터 장애인 환경 역학연구 수행
- 장애인 기후 재난 대응 프로토콜 공동 개발

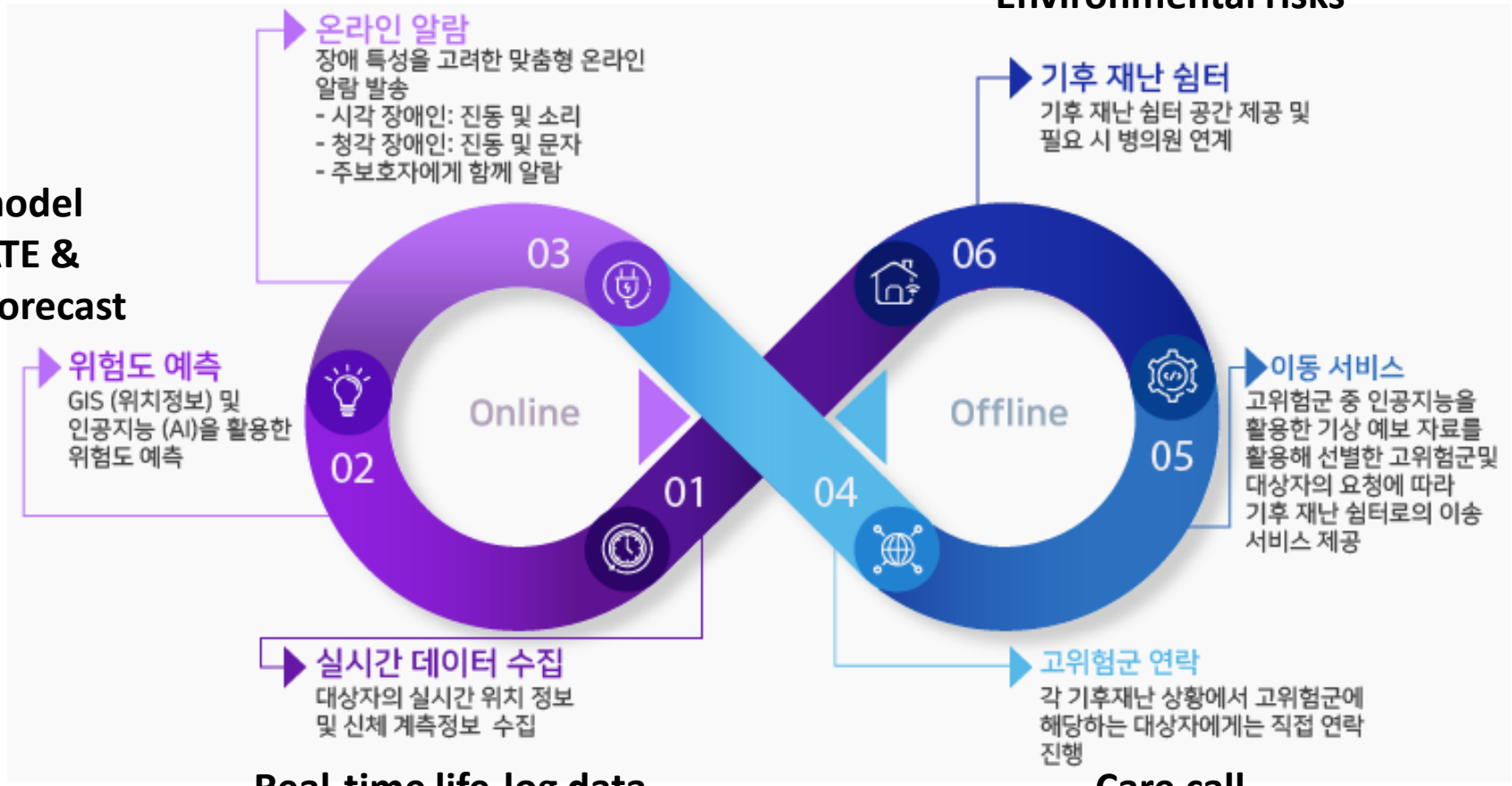
산학협력기관
- 부산대 학생 창업 Start-up
- 실시간 위치 및 실내외 정보 제공 App 개발
- ECG 데이터 및 기상청 API 연계 대시보드 개발

5. Digital healthcare

Online Personalized Alarm

Shelter for Climate and Environmental risks

Prediction model Based on CATE & Weather/PM Forecast models



Emergency / Preventive Transportation service

Real-time life-log data

Care call (Preventive/Real-time)

Thanks a lot

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