eISSN 2586-0860

# 주간 건강과 질병

# PHWR

Public Health Weekly Report

Vol. 16, No. 21, June 1, 2023

## Content



KDCA
Korea Disease Control and Prevention Agency

PHWR
Public Health Weekly Report

eISSN 2586-0860
Vol. 16, No. 21, June 1, 2023

## Aims and Scope

주간 건강과 질병(*Public Health Weekly Report*) (약어명: *Public Health Wkly Rep*, PHWR)은 질병관리청의 공식 학술지이다. 주간 건강과 질병은 질병관리청의 조사 · 감시 · 연구 결과에 대한 근거 기반의 과학적 정보를 국민과 국내 · 외 보건의료인 등에게 신속하고 정확하게 제공하는 것을 목적으로 발간된다. 주간 건강과 질병은 감염병과 만성병, 환경기인성 질환, 손상과 중독, 건강증진 등과 관련된 연구 논문, 유행 보고, 조사/감시 보고, 현장 보고, 리뷰와 전망, 정책 보고 등의 원고를 게재한다. 주간 건강과 질병은 전문가 심사를 거쳐 매주 목요일(연 50주) 발행되는 개방형 정보열람(Open Access) 학술지로서 별도의 투고료와 이용료가 부과되지 않는다.

저자는 원고 투고 규정에 따라 원고를 작성하여야 하며, 이 규정에 적시하지 않은 내용은 국제의학학술지편집인협의회(International Committee of Medical Journal Editors, ICMJE)의 Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals (https://www.icmje.org/) 또는 편집위원회의 결정에 따른다.

## About the Journal

주간 건강과 질병(eISSN 2586-0860)은 2008년 4월 4일 창간된 질병관리청의 공식 학술지이며 국문/영문으로 매주 목요일에 발행된다. 질병관리청에서 시행되는 조사사업을 통해 생성된 감시 및 연구 자료를 기반으로 근거중심의 건강 및 질병관련 정보를 제공하고자 최선을 다할 것이며, 제공되는 정보는 질병관리청의 특정 의사와는 무관함을 알린다. 본 학술지의 전문은 주간 건강과 질병 홈페이지(https://www.phwr.org/)에서 추가비용 없이 자유롭게 열람할 수 있다. 학술지가 더 이상 출판되지 않을 경우 국립중앙도서관(http://nl.go.kr)에 보관함으로써 학술지 내용에 대한 전자적 자료 보관 및 접근을 제공한다. 주간 건강과 질병은 오픈 액세스(Open Access) 학술지로, 저작물 이용 약관(Creative Commons Attribution Non-Commercial License; http://creativecommons.org/licenses/by-nc/4.0)에 따라 비상업적 목적으로 사용, 재생산, 유포할 수 있으나 상업적 목적으로 사용할 경우 편집위원회의 허가를 받아야 한다.

## Submission and Subscription Information

주간 건강과 질병의 모든 논문의 접수는 온라인 투고시스템(https://www.phwr.org/submission)을 통해서 가능하며 논문투고 시 필요한 모든 내용은 원고 투고 규정을 참고한다. 주간 건강과 질병은 주간 단위로 홈페이지를 통해 게시되고 있으며, 정기 구독을 원하시는 분은 이메일(phwrcdc@korea.kr)로 성명, 소속, 이메일 주소를 기재하여 신청할 수 있다.

기타 모든 문의는 전화(+82-43-219-2955, 2958, 2959), 팩스(+82-43-219-2969) 또는 이메일(phwrcdc@korea.kr)을 통해 가능하다.

**발행일:** 2023년 6월 1일
**발행인:** 지영미
**발행처:** 질병관리청

**편집사무국:** 질병관리청 건강위해대응관 미래질병대비과
(28159) 충북 청주시 흥덕구 오송읍 오송생명2로 187 오송보건의료행정타운
**전화.** +82-43-219-2955, 2958, 2959, **팩스.** +82-43-219-2969
**이메일.** phwrcdc@korea.kr
**홈페이지.** https://www.kdca.go.kr

**편집제작:** ㈜메드랑
(04521) 서울시 중구 무교로 32, 효령빌딩 2층
**전화.** +82-2-325-2093, **팩스.** +82-2-325-2095
**이메일.** info@medrang.co.kr
**홈페이지.** http://www.medrang.co.kr

# 편집위원회 2021년 7월~2024년 7월

PHWR Public Health Weekly Report
eISSN 2586-0860

연구 논문
eISSN 2586-0860
https://doi.org/10.56786/PHWR.2023.16.21.1

PHWR Public Health Weekly Report

# 2022년 기후보건 대국민 인식 조사

황주연[1], 김종희[1], 권호장[2], 황승식[3], 김효은[1], 박성우[1], 이영주[1], 안윤진[1]*

[1]질병관리청 건강위해대응관 미래질병대비과, [2]단국대학교 의과대학 의예과 예방의학교실, [3]서울대학교 보건대학원 보건학과

## 초 록

본 연구에서는 기후변화가 국민 건강에 미치는 영향에 대한 인식을 파악하고자, 국내 처음으로 기후보건에 대한 대국민 인식조사를 수행하였다. 기후변화의 걱정(87.4%) 등 기후변화에 대한 관심은 높았으나, 기후변화 기인 건강영향 위험 인식(63.2%)과 기후보건영향평가(9.1%)에 대한 인식은 낮았으며, 성별·연령대별 인식의 차이를 확인하였다. 또한 기후보건 관련 일반건강·질환정보에 대한 국민 수요가 있었으나, 관련 정보는 불충분한(30.3%) 것으로 나타났다. 기후보건에 대한 국민 인식 제고 및 정보이해 역량 증진을 위하여 과학적 근거 기반의 맞춤형 콘텐츠를 개발하여 향후 국민소통에 적극 활용해 나갈 것이며, 주기적인 기후변화 관련 대국민 인식 조사를 실시하여 정보의 이해와 정책의 효과 등을 파악할 필요가 있다.

**주요 검색어:** 기후변화; 보건정책; 인식조사; 정보이해력

## 서 론

2022년 미국 캘리포니아 데스밸리에서는 1,300년대 이후 가장 큰 폭염이 발생하였고, 서유럽에서는 100년 만의 폭우가 발생하는 등의 전 지구적 기후변화 가속화로 인해 이상기후 발생 빈도와 강도가 증가하고 있다[1,2]. 기후변화에 관한 정부 간 협의체(Intergovernmental Panel on Climate Change, IPCC)의 제6차 보고서에 따르면, 기후문제의 범위에 신체건강과 정신건강 부문을 포함하고 '기후 변화(climate change)'가 아닌, '기후 위기(climate crisis)'에 따른 건강영향 위험성을 강조하고 있다[3-5]. 국제사회에서 고조되는 기후위기(극한기후) 상황에 따라 기후보건 건강문제에 대한 신속대응 및 공조체계를 확립하고자, 세계보건기구(World health organization, WHO)는 제27차 유엔기후변화협약 당사국총회(Conference of the Parties27, COP27)에서 기후보건 분야의 새로운 기후건강, 기후 및 건강에 대한 변혁적 행동을 위한 동맹(Alliance for Transformative Action on Climate and Health, ATACH)을 포함한 다양한 이니셔티브를 주도하였다[6]. 건강 및 환경에 대한 WHO 및 UN (United Nations) 지침서에 따르면, 취약성 및 적응 평가를 통해 취약(민감)계층 발굴, 건강영향평가(health impact assessments) 수행, 보건 인력의 전문 역량 강화에 대한 필요성을 언급하였다[7].

Received January 25, 2023 Revised April 13, 2023 Accepted April 17, 2023
*Corresponding author: 안윤진, Tel: +82-43-219-2950, E-mail: carotene@korea.kr

**핵심요약**

① 이전에 알려진 내용은?

전 지구적 기후변화 가속화 및 온난화 지속으로 이상기후 발생 빈도와 강도가 증가함에 따라 각 국가에서는 다양한 기후변화 관련 정책을 수립하고 국민 인식도 제고를 위해 다각도의 조사와 평가를 수행하고 있다.

② 새로이 알게 된 내용은?

기후변화의 걱정과 기후변화에 대한 관심은 높았으나, 기후변화에 따른 건강영향위험 및 기후보건영향평가에 대한 국민 인식은 낮은편이었다. 기후보건 관련 일반건강 · 질환정보에 대한 수요가 있었으나, 관련 정보는 불충분한 것으로 나타났다.

③ 시사점은?

기후보건 관련 대국민 인식조사는 국내 처음으로 실시하여 전반적인 국민 인식을 파악하고 정리하였다는 점에서 그 의의가 크다. 앞으로 정책 반영 및 활용을 위한 지속적인 조사와 다각적 분석 접근이 필요하며, 기후보건 분야 국민 인식 제고와 이해관계자별 정보이해 역량 제고가 필요하다.

우리나라도 예외는 아니다. 연평균기온이 지난 109년간(1912–2020년) 꾸준히 상승하였고, 가장 더운 10년 중 6회가 최근 10년 내에 발생하였다[8]. 2018년에는 전국적인 기상관측이 시작된 1973년 이후 가장 높은 여름철 전국 평균기온을 기록하였고, 2020년에는 여름 최장 기간 장마(중부지방 54일)로 집중호우가 발생하였고 2022년에는 역사상 최대 규모의 폭우가 발생하였다. 이렇듯 발생 빈도와 강도가 높아지고, 발생 시 기간이 길어지는 기후변화에 대응하기 위해서는 강력한 정부의 완화 · 적응대책 추진의지와 국민들의 관심이 매우 중요하다. 영국, 미국, 유럽연합 등은 다양한 기후보건 및 건강 분야의 정책 및 실천전략을 수립하고, 자국민의 기후-건강 정보이해력(literacy) 증진과 인식 제고를 위하여 주기적인 인식조사와 평가를 시행하고 있다[9–11]. 이에 기후위기 극복을 위한 국제사회의 노력에 발맞춰 대한민국도 「보건의료기본법」에 따라 2021년 제1차 기후보건영향평가[12]를 실시하였고, 그 결과에 대한 국민의 인식도와 기후보건 관련 정보의 수요를 파악하기 위해 '2022년 기후보건 대국민 인식 조사'를 실시하였다.

본 연구는 기후보건 대국민 설문조사를 바탕으로 기후위기 심각성 및 기후변화 기인 건강영향, 기후보건영향평가 등의 기후보건에 대한 대국민 인식도 및 정보 수요를 파악하였다. 이러한 과학적 근거를 기반으로 기후보건 정보이해와 인식제고를 위한 맞춤형 교육 · 홍보 자료 개발에 적극 활용하고자 한다.

## 방 법

설문대상자는 전국 성인 남녀 1,500명(95% 신뢰수준 표본오차 ±2.49%p)을 대상으로 2022년 8월말 기준 행정안전부 주민등록인구통계 모집단 정보를 활용하여 성별 · 연령대별(만 19세 이상 10세 단위 기준) · 지역별(17개 시 · 도) 층화변수로 인구비례할당추출을 통해 선정하였다. 정확한 추정치를 구하기 위해 사후층화(post-stratification) 가중치를 적용하였다. 설문조사는 연구과제 IRB 승인(DKU 2022-06-034, 2022년 7월 14일) 및 응답자의 사전 동의 절차를 거쳐 총 10일간(2022년 8월 29일–9월 7일) 온라인(인터넷 설문) 방식으로 진행하였고 문맹자나 외국인은 조사 대상에서 제외하였다. 1차 이메일 조사 시 모집이 덜 된 지역 · 나이 · 성별에 대해 2차 조사 url 발송을 통해 설문에 응하도록 진행하였다. 수집된 개인정보는 개인정보처리자에 의해 암호화하여 분석 후 폐기하였다. 설문문항은 응답자 일반사항, 기후변화에 대한 일반사항 인식, 기후변화 기인 건강영향 인식, 기후보건정보 관련 국민 수요 파악, 기후보건영향평가 관련 인지로 구성하였다. 설문문항 개발은 국내외 기후보건영향평가 관련 설문자료를 수집하여 비교 분석한 후 전문가의 의견 수렴과정을 통해 최종 완성하였다. 결과분석은 SPSS 22.0 (SPSS Inc.)을 이용하였고, 전체 응답자에 대해 성별, 연령별, 권역별로 빈도분석을 통하여 빈도와 백분율을 구하였다[13].

## 결 과

### 1. 설문조사 응답 현황

본 설문에 인터넷 접속을 통해 참여한 사례수는 전국 만 19세 이상 성인 남녀 총 1,500명으로 성별 비율은 남자가 49.5% (743명) 여자가 50.5% (757명)였다. 연령별로는 60세 이상이 30% (450명)로 가장 높았으며, 50대가 19.5%, 40대가 18.4%, 만 19세 이상 20대가 17.0%, 그리고 30대가 가장 낮은 15.1%였다. 권역별로는 인천/경기 지역이 31.7%로 가장 높았고, 서울이 18.9%, 부산/울산/경남이 15.2%, 대전/충청/세종이 10.4%, 광주/전라 및 대구/경북이 각 9.7%였고, 강원/제주가 4.4% 비율로 가장 낮았다(표 1).

### 2. 기후보건 위기 인식

기후변화에 대해 얼마나 걱정하고 있는지에 대해 '걱정하고 있다'는 응답률(87.4%)은 높았으며(매우 걱정: 40.0%+ 걱정하는 편 47.4%), 남성(85.5%)에 비해 여성(89.3%)에서 위험인식이 높았다(p=0.001). 그리고 연령별로는 20대(78.8%), 30대(81.9%), 40대(88.7%), 50대(90.4%), 60세 이상(92.3%) 순으로 연령대가 증가할수록 기후변화에 대해 크게 걱정하는 것으로 나타났다(p<0.001) (표 2). 기후변화에 따른 건강영향의 위험 인식은 63.2%로 상대적으로 낮은 편이였으며, 남성(61.6%)에 비해 여성(64.8%)의 위험인식이 높았다(p=0.430). 2030세대에 비해 연령대가 높을 수록 기후변화에 대한 걱정은 증가하였고, 기후변화로 인한 건강영향에 대한 항목에는 60세 이상이 70.5%, 20대가 가장 낮은 42.9%로 세대 간 큰 차이가 있는 것으로 나타났다(p<0.001) (표 3).

**표 1.** 설문조사 응답자 특성

| 구분 | 응답자 수(%) |
|---|---|
| 전체 | 1,500 (100) |
| 성별 | |
| 남자 | 743 (49.5) |
| 여자 | 757 (50.5) |
| 연령별 | |
| 19세-29세 | 255 (17.0) |
| 30세-39세 | 226 (15.1) |
| 40세-49세 | 276 (18.4) |
| 50세-59세 | 293 (19.5) |
| 60세 이상 | 450 (30.0) |
| 권역별 | |
| 서울 | 283 (18.9) |
| 인천/경기 | 476 (31.7) |
| 대전/충청/세종 | 156 (10.4) |
| 광주/전라 | 145 (9.7) |
| 대구/경북 | 146 (9.7) |
| 부산/울산/경남 | 228 (15.2) |
| 강원/제주 | 66 (4.4) |

단위: 명(%).

### 3. 기후보건정보

기후변화가 건강에 미치는 영향에 대한 정보가 충분하다고 생각하는 응답자는 30.3%에 불과한 것으로 나타났다. 반대로 '불충분하다'라고 응답한 사례 중에 연령별로는 30대(32.3%)가 가장 높게 나타났다(p=0.341) (표 4). 기후변화가 건강에 미치는 영향과 관련하여 가장 관심있는 분야로 일반건강/질환정보(32.0%), 기후보건정책(26.2%), 안전 · 행동 및 대응수칙(21.3%) 순으로 나타났다(그림 1).

### 4. 기후보건영향평가

질병관리청에서 수행하고 있는 기후보건영향평가(「보건의료기본법」 제37조의2에 따라 5년마다 실시)에 대해서는 9.1%만 '잘 알고 있다'라고 응답하였다. 모든 연령대에서 '모르거나 알고 있었지만 자세히 몰랐다'고 응답하였고(p=0.033), 남성의 40.6%, 여성의 48.2%가 몰랐던 것으로 나타났다(p<0.001) (표 5).

### 5. 시기별 기후변화 국민건강 위협 인식 비교

시기별 기후변화가 우리나라 국민의 건강에 얼마나 큰 위협이 될 것인지에 대한 조사결과, '현재' 기후변화가 국민건

**표 2.** 기후변화에 대한 걱정

| 구분 | N | 사례 수(%) | | | | p-value |
|---|---|---|---|---|---|---|
| | | 걱정하고 있지 않다 (매우 걱정하지 않음+ 걱정하지 않는 편) | 보통이다 | 걱정하고 있다 (매우 걱정+ 걱정하는 편) | 모르겠다 | |
| 전체 | 1,500 | 53 (3.5) | 120 (8.0) | 1,312 (87.4) | 15 (1.1) | - |
| 성별 | | | | | | |
| 남자 | 744 | 40 (5.4) | 61 (8.1) | 636 (85.5) | 7 (1.0) | 0.001 |
| 여자 | 756 | 13 (1.7) | 60 (7.9) | 675 (89.3) | 8 (1.1) | |
| 연령별 | | | | | | |
| 19세-29세 | 254 | 13 (5.2) | 32 (12.5) | 200 (78.8) | 9 (3.5) | <0.001 |
| 30세-39세 | 223 | 17 (7.5) | 24 (10.6) | 182 (81.9) | 0 (0.0) | |
| 40세-49세 | 275 | 6 (2.2) | 23 (8.4) | 244 (88.7) | 2 (0.7) | |
| 50세-59세 | 295 | 6 (2.1) | 21 (7.2) | 267 (90.4) | 1 (0.3) | |
| 60세 이상 | 453 | 11 (2.4) | 21 (4.6) | 418 (92.3) | 3 (0.7) | |
| 권역별 | | | | | | |
| 서울 | 283 | 14 (4.9) | 25 (8.8) | 243 (85.9) | 1 (0.4) | 0.480 |
| 인천/경기 | 475 | 11 (2.3) | 33 (6.9) | 427 (89.9) | 4 (0.8) | |
| 대전/충청/세종 | 158 | 8 (5.0) | 12 (7.6) | 133 (84.2) | 5 (3.2) | |
| 광주/전라 | 147 | 7 (4.9) | 10 (6.9) | 127 (86.1) | 3 (2.1) | |
| 대구/경북 | 147 | 5 (3.5) | 13 (8.8) | 129 (87.7) | 0 (0.0) | |
| 부산/울산/경남 | 227 | 4 (1.8) | 24 (10.4) | 198 (87.4) | 1 (0.4) | |
| 강원/제주 | 63 | 4 (6.2) | 4 (5.9) | 54 (86.5) | 1 (1.3) | |

단위: 명(%). -=not available.

강에 위협을 미친다는 응답은 84.4% (상당한 위협: 66.7%+엄청난 위협: 17.7%)로 나타났다. '5년 이내' 응답은 88.6% (상당한 위협: 52.0%+엄청난 위협: 36.6%)로 나타났다. '20년 이내'(93.5%, 상당한 위협: 25.4%+엄청난 위협: 68.1%)와 '50년 이내'(90.2%, 상당한 위협: 17.2%+엄청난 위협: 73.0%)에는 '엄청난 위협'이라는 응답이 '상당한 위협'이라는 응답보다 각각 42.7%, 55.8% 이상으로 높게 나타났다. 현재로부터 먼미래로 시기가 멀어질 수록 기후변화 위협에 대한 국민의 우려 인식과 위협 강도가 모두 증가하였다(그림 2).

## 논 의

본 연구는 제1차 기후보건영향평가 실시 결과에 따른 기후보건 관련 대국민 인식 조사결과를 바탕으로 국민의 기후위기에 따른 건강영향과 기후보건정책에 대한 인식을 살펴보았다. '기후변화에 대한 우려'에 비해 '기후변화로 인한 건강영향'에 대한 국민 인식수준은 낮게 나타났다. 각 항목에서 성별 및 지역별 인지도의 차이는 적었으나 여성에 비해 남성이 낮은편으로 나타났다. 연령대가 높을수록 인지도는 증가하였으며, 특히 2030세대는 60세 이상 연령군에 비해 현저히 낮은 인지도를 보였고, 두 세대간 인지도 격차는 기후변화 우려(11.95%)에 비해 국민 건강영향위험(21.45%)에서 9.5%가 크게 나타나 향후 미래세대인 청장년층에 대한 맞춤형 정책과 기후보건 위험 인식 제고가 필요하다고 판단된다. 2022년 한국환경연구원에서 발표한 일반국민 1,600명 대상 기후변화 설문조사 중 세대별 기후위기 심각성 결과에서, 2030세대가 81.5%에 비해 60세 이상 응답자는 90.4%로 연령대가 증가할수록 기후위기에 대한 심각성 인지도가 높았으며 본 조사의 기후변화에 대한 심각성 결과와 유사한 것으로 나타났다[14]. 제1차 기후보건영향평가(2021년 실시, 2022년 공

**표 3.** 기후변화로 인한 건강영향

| 구분 | N | 사례 수(%) | | | p-value |
|---|---|---|---|---|---|
| | | 심각하지 않다 (심각하지 않다+매우 심각하지 않다) | 보통이다 | 심각하다(심각하다 + 매우 심각하다) | |
| 전체 | 1,500 | 82 (5.5) | 470 (31.3) | 948 (63.2) | - |
| 성별 | | | | | |
| 남자 | 744 | 38 (5.1) | 248 (33.3) | 458 (61.6) | 0.430 |
| 여자 | 756 | 44 (5.8) | 222 (29.4) | 490 (64.8) | |
| 연령별 | | | | | |
| 19세-29세 | 254 | 36 (14.1) | 109 (43.0) | 109 (42.9) | <0.001 |
| 30세-39세 | 223 | 14 (6.2) | 86 (38.6) | 123 (55.2) | |
| 40세-49세 | 275 | 7 (2.5) | 71 (25.8) | 197 (71.7) | |
| 50세-59세 | 295 | 11 (3.8) | 85 (28.6) | 199 (67.6) | |
| 60세 이상 | 453 | 14 (3.1) | 119 (26.4) | 319 (70.5) | |
| 권역별 | | | | | |
| 서울 | 283 | 15 (5.3) | 93 (32.9) | 175 (61.8) | 0.592 |
| 인천/경기 | 475 | 26 (5.5) | 133 (28.0) | 316 (66.5) | |
| 대전/충청/세종 | 158 | 14 (8.9) | 40 (25.5) | 104 (65.6) | |
| 광주/전라 | 147 | 9 (6.3) | 48 (32.4) | 90 (61.3) | |
| 대구/경북 | 147 | 9 (6.1) | 55 (37.3) | 83 (56.6) | |
| 부산/울산/경남 | 227 | 7 (3.1) | 82 (35.9) | 138 (61.0) | |
| 강원/제주 | 63 | 2 (2.9) | 20 (31.4) | 41 (65.7) | |

단위: 명(%). -=not available.

**표 4.** 기후변화가 건강에 미치는 영향에 대한 정보 충분성

| 구분 | N | 사례 수(%) | | | p-value |
|---|---|---|---|---|---|
| | | 그렇지 않다(그렇지 않다+전혀 그렇지 않다) | 보통이다 | 그렇다(그렇다 + 매우 그렇다) | |
| 전체 | 1,500 | 381 (25.4) | 665 (44.3) | 454 (30.3) | - |
| 성별 | | | | | |
| 남자 | 744 | 173 (23.3) | 341 (45.8) | 230 (30.9) | 0.152 |
| 여자 | 756 | 208 (27.5) | 324 (42.9) | 224 (29.6) | |
| 연령별 | | | | | |
| 19세-29세 | 254 | 65 (25.7) | 108 (42.3) | 81 (32.0) | 0.341 |
| 30세-39세 | 223 | 72 (32.3) | 89 (39.7) | 62 (27.9) | |
| 40세-49세 | 275 | 59 (21.4) | 136 (49.6) | 80 (29.0) | |
| 50세-59세 | 295 | 68 (23.2) | 134 (45.4) | 93 (31.4) | |
| 60세 이상 | 453 | 116 (25.6) | 199 (43.9) | 138 (30.5) | |
| 권역별 | | | | | |
| 서울 | 283 | 84 (29.7) | 124 (43.8) | 75 (26.5) | 0.368 |
| 인천/경기 | 475 | 116 (24.5) | 214 (45.0) | 145 (30.5) | |
| 대전/충청/세종 | 158 | 42 (26.7) | 72 (45.5) | 44 (27.8) | |
| 광주/전라 | 147 | 39 (26.3) | 62 (42.0) | 47 (31.7) | |
| 대구/경북 | 147 | 31 (21.1) | 65 (44.5) | 51 (34.5) | |
| 부산/울산/경남 | 227 | 53 (23.3) | 103 (45.2) | 71 (31.5) | |
| 강원/제주 | 63 | 15 (24.4) | 26 (41.0) | 22 (34.6) | |

단위: 명(%). -=not available.

표)에서 최근 10년간(2011–2020년) 결과를 살펴보면, 폭염으로 인한 온열질환으로 사망, 입원 및 응급실 방문이 증가했고 65세 이상 연령군과 남성이 대부분을 차지하였다. 또한 대기 중 오존노출로 인한 사망이나, 진드기 매개 감염병인 쯔쯔가무시증 및 중증열성혈소판감소증후군 환자 발생이 가장 높은 연령군이 65세 이상인 것으로 나타난 결과와 상관성이 높은 결과라고 할 수 있다[15]. 그러나, 기후변화에 대한 관심도에 비해 제1차 기후보건영향평가에 대한 국민 인지도는 낮았고(9.1%), 특히 60세 이상 연령군은 기후변화에 대한 관심도에 비해 제1차 기후보건영향평가 결과 인지도는 모든 연령군에서 가장 낮게 나타났다(37.9%).

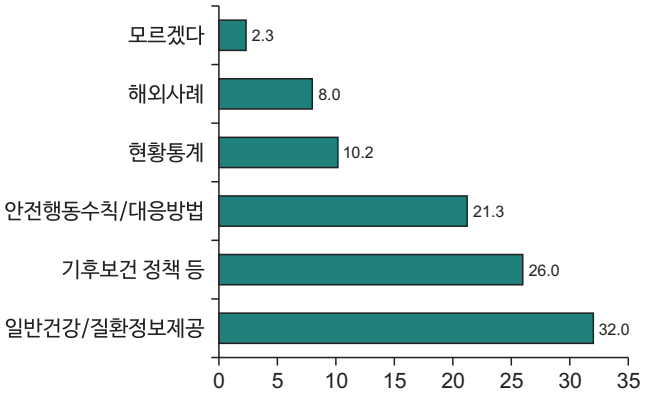


그림 1. 기후변화가 건강에 미치는 영향 관심 분야

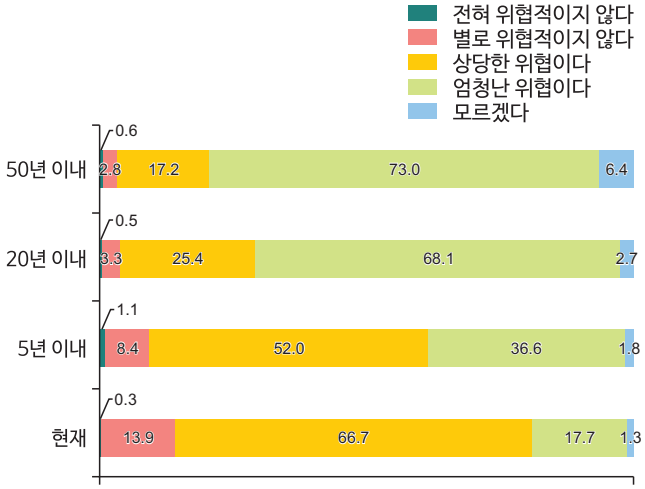


그림 2. 시기별 기후변화 건강위협 인식

표 5. 기후보건영향평가 인지도

| 구분 | N | 사례 수(%) | | | p-value |
|---|---|---|---|---|---|
| | | 몰랐다 | 알고 있었지만 자세히는 몰랐다 | 잘 알고 있었다 | |
| 전체 | 1,500 | 666 (44.4) | 604 (40.3) | 137 (9.1) | - |
| 성별 | | | | | |
| 남자 | 744 | 302 (40.6) | 319 (42.9) | 92 (12.4) | <0.001 |
| 여자 | 756 | 364 (48.1) | 285 (37.7) | 45 (6.0) | |
| 연령별 | | | | | |
| 19세–29세 | 254 | 124 (48.8) | 85 (33.5) | 27 (10.6) | 0.033 |
| 30세–39세 | 223 | 118 (52.9) | 68 (30.5) | 23 (10.3) | |
| 40세–49세 | 275 | 138 (50.2) | 83 (30.2) | 28 (10.2) | |
| 50세–59세 | 295 | 116 (39.3) | 143 (48.5) | 23 (7.8) | |
| 60세 이상 | 453 | 172 (38.0) | 225 (49.7) | 35 (7.7) | |
| 권역별 | | | | | |
| 서울 | 283 | 129 (45.6) | 113 (39.9) | 22 (7.8) | 0.206 |
| 인천/경기 | 475 | 216 (45.5) | 185 (38.9) | 45 (9.5) | |
| 대전/충청/세종 | 158 | 74 (46.8) | 63 (39.9) | 13 (8.2) | |
| 광주/전라 | 147 | 67 (45.6) | 56 (38.1) | 11 (7.5) | |
| 대구/경북 | 147 | 66 (44.9) | 56 (38.1) | 15 (10.2) | |
| 부산/울산/경남 | 227 | 85 (37.4) | 103 (45.4) | 28 (12.3) | |
| 강원/제주 | 63 | 30 (47.6) | 29 (46.0) | 3 (4.8) | |

단위: 명(%). -=not available.

2021년 영국에서 실시한 자국민(만 16세 이상 3,000명) 대상 기후변화와 건강영향에 대한 인식 조사 결과와 서로 일치하는 문항에 대한 항목별 비교 분석 결과, 기후위기에 대한 우려(82%)와 기후변화에 따른 건강영향(73%)에 대한 인식이 우리나라와 유사한 수준임을 확인하였다[16]. 시기별 건강 위협에 대한 조사에서는 거의 절반(48%)이 지금 당장 영향을 미치고, 응답자의 64%가 가까운 미래(5년 이내)에 기후변화가 건강에 영향을 미칠 것으로 예상하고 있으며, 먼 미래(50년 이내)에는 응답자의 약 88%가 기후변화가 건강에 영향을 미칠 것으로 예상하였다[16]. 시기가 증가함에 따라 건강 위협 인식이 높아지는 추세는 우리나라 결과와 유사하였으나, 현재의 시점에서 우리나라 국민이 생각하는 건강 위협 인식은 영국 결과(48%)에 비해 36.4%가 높은 84.4%였으며, 현재와 먼 미래(50년 이내)간 인식의 차이가 영국(40%)에 비해 우리나라는 5.8%에 불과해 전 시기대별로 건강 위협에 대한 인식수준이 전반적으로 높게 나타났다[16]. 기후 변화는 전 지구적인 현상으로 지금과 같은 기후변화 속도라면, 먼 미래에는 대다수가 건강피해가 발생할 것으로 인지하고 있음을 알 수 있었다.

이제 기후보건 문제는 개인의 시급한 건강 문제로 의식 변화가 중요하다. 조사대상자의 대다수(79.3%)가 기후변화와 건강정보에 있어서 예방안전수칙, 기후보건정책, 다양한 일반 건강정보 등에 수요가 있었다. 영국, 미국 등 해외 주요국은 일반 · 보건계열 학생뿐 아니라 보건의료 전문가, 정책입안자 등 다양한 대상자별 인식 제고와 정보이해 역량 증진을 위해 다양한 캠페인(https://breathelife2030.org)과 프로그램(Climate.gov Home, https://climateforhealth.org)을 운영하여 소통을 강화하고 있다. 질병관리청은 기후보건영향평가 결과를 바탕으로 일반국민(소책자, 동영상), 정책실무자(카드뉴스), 전문가(강의 슬라이드) 등 대상자별 시각화 콘텐츠를 개발하여 홍보를 추진하고 있으며, 다양한 이해관계자의 기후보건 정보이해력(literacy) 증진과 지역사회 참여 및 인식 향상을 위해 맞춤형 교육 · 홍보자료를 개발하고 있다. 이번 2022년 기후보건 대국민 인식조사는 제1차 기후보건영향평가 결과를 토대로 다양한 맞춤형 정보 요구도와 기후보건 정책방향을 살표보기 위해 실시하였다. 기후변화 적응 인식조사 결과를 통해 우리나라 국민들의 기후위기와 건강영향 관련 심각성에 대한 인지도를 파악하였고, 다양한 건강정보 제공과 기후보건정책 추진이 필요함을 확인할 수 있었다. 이를 통해 일반국민의 기후변화 적응 이해와 정책적 참여가 얼마나 이뤄지느냐에 따라 국가의 기후변화 적응대책의 효과성 및 성공 여부가 결정된다는 것을 알게 되었다. 향후 질병관리청은 관계부처간 협력을 통해 기후보건 정책 수립에 필요한 근거자료 마련과 보다 적극적인 소통을 통해 국민들의 기후보건 인식 제고를 위해 노력할 것이다.

## Supplementary Materials

Supplementary data are available online.

## Declarations

**Ethics Statement:** Not applicable.

**Funding Source:** None.

**Acknowledgments:** None.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

**Author Contributions:** Conceptualization: JHK, HJK, YA. Data curation: HJK, SSH. Formal analysis: JYH, HK. Investigation: JYH, HJK, SSH. Methodology: All. Project administration: JYH, JHK, HK, YA. Resources: HJK, SSH. Supervision: JHK, SSH, YA. Visualization: JYH. Writing-original draft: JYH, JHK. Writing-review & editing : JHK, YA.

## References


1. Canon G. Record Death Valley flooding 'a once-in-1,000-year event'. The Guardian [Internet]. 2022 Aug 10 [cited 2023 Jan 23]. Available from: https://www.theguardian.com/us-news/2022/aug/10/death-valley-floods-climate-crisis
2. Watts J. Climate scientists shocked by scale of floods in Germany. The Guardian [Internet]. 2021 Jul 16 [cited 2023 Jan 23]. Available from: https://www.theguardian.com/environment/2021/jul/16/climate-scientists-shocked-by-scale-of-floods-in-germany
3. Masson-Delmotte V, Zhai P, Pirani A, et al. Climate change 2021: the physical science basis [Internet]. IPCC; 2021 [cited 2023 Jan 23]. Available from: https://www.ipcc.ch/
4. Climate and Health Alliance. Framework for a national strategy on climate, health and well-being for Australia. Climate and Health Alliance; 2017.
5. Sullivan H. 'Code red for humanity': what the papers say about the IPCC report on the climate crisis. The Guardian [Internet]. 2021 Aug 10 [cited 2023 Jan 23]. Available from: https://www.theguardian.com/environment/2021/aug/10/code-red-for-humanity-what-the-papers-say-about-the-ipcc-report-on-the-climate-crisis
6. The 27th conference of the parties to the United Nations Framework Convention of Clilmate Change (COP27) [Internet]. COP27; 2022 [cited 2023 Jan 23]. Available from: https://cop27.eg/
7. World Health Organization. Compendium of WHO and other UN guidance on health and environment, 2022 update [Internet]. World Health Organization; 2022 [cited 2023 Jan 23]. Available from: https://www.who.int/
8. Korea Meteorological Administration. Korean climate change assessment report. Korea Meteorological Administration; 2020.
9. Moulton AD, Schramm PJ. Climate change and public health surveillance: toward a comprehensive strategy. J Public Health Manag Pract 2017;23:618-26.
10. European Climate and Health Observatory. Climate change and health: the national policy overview in Europe. European Climate and Health Observatory; 2022.
11. Akerlof K, Debono R, Berry P, et al. Public perceptions of climate change as a human health risk: surveys of the United States, Canada and Malta. Int J Environ Res Public Health 2010;7:2559-606.
12. Kim H, Park S, Lee Y, Kim JH, Kim Y, Kwon H. The first national climate health impact assessment in the Republic of Korea: key findings and scientific issues. Public Health Wkly Rep 2022;15:1463-75.
13. Korea Disease Control and Prevention Agency. Development of public communication contents on the first climate change and health impact assessment. Korea Disease Control and Prevention Agency; 2022.
14. Lee SY, Yang YK, Kim SH. 2050 Net-zero awareness survey. Korea Environ Inst Focus 2022;10:1-16.
15. Korea Disease Control and Prevention Agency. The 1st climate health impact assessment report. Korea Disease Control and Prevention Agency; 2022.
16. Ipsos MORI; Health Foundation. Public perceptions of climate change and health. Health Foundation; 2021.

# 2022 National Public Awareness Survey on Health Impacts of Climate Change

Joo-Yeon Hwang[1], JongHee Kim[1], Ho-Jang Kwon[2], Seoung-Sik Hwang[3], Hyoeun Kim[1], Seongwoo Park[1], Youngju Lee[1], Younjhin Ahn[1]*

[1]Division of Climate Change and Health Protection, Director General for Health Hazard Response, Korea Disease Control and Prevention Agency, Cheongju, Korea
[2]Department of Preventive Medicine, Dankook University College of Medicine, Cheonan, Korea
[3]Department of Public Health Sciences, Graduate School of Public Health, Seoul National University, Seoul, Korea

## ABSTRACT

The Korea Disease Control and Prevention Agency operates a Climate Health Impact Assessment every five years and publishes the results to minimize the damage to public health caused by climate change. An online structured survey was administered in the first study which investigated public awareness regarding the impact of climate change on public health. There was a high level of interest concerning about climate change (87.4%). However, awareness of the health risks caused by climate change (63.2%) and the 1st Climate Health Impact Assessment (9.1%) was low, and differences in awareness by sex and age were confirmed. In addition, we confirmed the public demand for climate health information, areas of interest, and preferred media. However, we found that the related information was inadequate (30.3%). Further, we plan to develop more actionable and sustainable evidence-based contents through in-depth comparative research. We must pay more attention to raising public awareness and improving health literacy on climate change.

**Key words:** Climate change; Public health policy; Awareness survey; Health literacy

*Corresponding author: Younjhin Ahn, Tel: +82-43-219-2950, E-mail: carotene@korea.kr

## Introduction

In 2022, the greatest heat wave since the 1,300s occurred in Death Valley, California, and Western Europe experienced the heaviest rainfall in a century. This shows that the frequency and intensity of climate anomalies are increasing worldwide due to the acceleration of climate change [1,2]. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), the physical and mental health sectors were included in the scope of climate problems, and the risk of health impact was emphasized based on the 'climate crisis' rather than 'climate change' [3-5]. To establish a rapid response and coordination system for climate health problems aggravated by climate crisis (extreme climate) in the international society, the World Health Organization (WHO) took the lead on various initiatives including the new climate health platform (Alliance for Action on Climate Change and Health [ATACH]) in the climate health sector at the Conference of the

### Key messages

① What is known previously?

As the frequency and intensity of climate anomalies increase due to continued global warming and accelerated climate change, each nation is establishing policies relevant to various climate change and performing surveys and assessments from various angles to improve the public recognition.

② What new information is presented?

The recognized concern and risk for climate change as well as the interest and support for carbon neutrality policies were high, but the public recognition on public health impact risk and climate health impact assessment according to climate change were low. There was demand on general health and disease information related to climate health, but it was found that information from the climate health sector was insufficient.

③ What are implications?

The public perception survey related to climate health was the first domestically conducted survey. It was meaningful because identified and organized the overall public perception regarding climate health. In the future, continuous investigation is necessary for reflection and utilization in policies as well as multi-angle analysis approaches, and an improvement in the information comprehension capacity for each party of interest, and the public perception in the climate health sector.

Parties 27 (COP27, the 27th United Nations Climate Change Association, November 2022, Egypt) [6]. The WHO and United Nations guideline on health and environment mentions the necessity establish the vulnerable class through vulnerability, adaptation, and health impact and strengthening of the expertise in health workforce [7].

The Republic of Korea (ROK) is not an exception; the annual average temperature steadily increased during the past 109 years (1912–2020), and six of the 10 hottest years have occurred in the last 10 years [8]. In 2018, the highest national average temperature was recorded since 1973 when national meteorological observation began. In 2020, the longest summer rainy season was experienced (54 days in the central part of the ROK) with torrential rain. In 2022, heavy rain occurred in the largest scale on record. Therefore, to respond to the increase in frequency and intensity of climate change strong government commitments to develop mitigation and adaptation measures, and public interest are important. The United Kingdom, United States, and the European Union established various policies, and strategies, and implemented periodic perception surveys and assessments to improve the climate-health information literacy and perception of their citizens [9–11]. The ROK performed the first Climate Health Impact Assessment [12] in 2021 according to the Framework Act on Health and Medical Services in line with the international community's effort to overcome the climate crisis. The '2022 Climate Health Public Perception Survey' was performed to identify the demand for information relevant to climate health and the public perception on the results of the assessment.

This research identifies the demand for information and public perception on climate health, such as, climate health impact assessment, health impacts deriving from climate change, and the severity of the climate crisis based on a climate health public survey. Based on this scientific evidence, we intend to use the results for the development of customized educational and promotional data for improving the perception of and understanding information on climate health.

## Methods

There were 1,500 targets of the survey (±2.49%p sampling

error at 95% confidence level) male and female adults nationwide. They were selected through proportional allocation extraction by sex, age group (10-year age groups equal to or above 19 years old), and region (17 cities and provinces) stratification variables using the resident registration demographic population information of the Ministry of Interior and Safety, in August 2022. To obtain accurate estimation values, the post-stratification weight was applied. The survey occurred over a period of 10 days (August 29th–September 7th, 2022) after undergoing informed consent of respondents and Institutional Review Boards research approval (DKU 2022-06-034). The survey was conducted online, where illiterates and foreigners were excluded. A secondary survey URL was provided for survey participation to region, age, and sex groups that had insufficient participants during the primary E-mail survey. The collected personal information was encrypted by the processor and disposed after the analysis. The questionnaires were composed of queries relevant to the general respondent information, perception on climate change, perception on health impact deriving from climate change, identification of public demand related to climate health information, and perception of the climate health impact assessment. The questionnaires were completed after a comparative analysis of the collected survey data related to domestic and overseas climate change impact assessment, followed by a process of expert input. The results were analyzed using SPSS 22.0 (SPSS Inc.), and the frequency and percentage were acquired through the frequency analysis of the sex, age, and region for the entire respondents [13].

## Results

### 1. State of survey response

There were 1,500 survey participants via the internet comprised of males and females nationwide, age 19 or above. The sex ratio was 49.5% males (743) and 50.5% females (757). The age of the participants was 30% for ≥60 years (450), 19.5% for 50-59 years, 18.4% for 40–49 years, and 17.0% for 19–29 years. The lowest 15.1% was 30–39 years. The region responses comprised of 31.7% from Inchoen/Gyeonggi, 18.9% from Seoul, 15.2%, from Busan/Ulsan/Gyeongnam, 10.4% from Daejon/Chungcheong/Sejong, 9.7% from Gwangju/Jeolla, and 9.7% from Daegu/Gyeongbuk, and 4.4% from Gangwon/Jeju (Table 1).

Table 1. Characteristics of survey respondents

| Classification | Number of respondents (%) |
|---|---|
| Total | 1,500 (100) |
| Sex | |
| Male | 743 (49.5) |
| Female | 757 (50.5) |
| Age (yr) | |
| 19–29 | 255 (17.0) |
| 30–39 | 226 (15.1) |
| 40–49 | 276 (18.4) |
| 50–59 | 293 (19.5) |
| 60 or above | 450 (30.0) |
| Region | |
| Seoul | 283 (18.9) |
| Incheon/Gyeonggi | 476 (31.7) |
| Daejeon/Chungcheong/Sejong | 156 (10.4) |
| Gwangju/Jeolla | 145 (9.7) |
| Daegu/Gyeongbuk | 146 (9.7) |
| Busan/Ulsan/Gyeongnam | 228 (15.2) |
| Gangwon/Jeju | 66 (4.4) |

Values are presented as number (%). Unit: person (%).

## 2. Perception of climate health risk

The response rate for 'concerned' (87.5%) was high for the query on the extent of concern for climate change (very concerned: 40.1% and concerned 47.4%). Females (89.3%) were more concerned than males (85.5%) (p=0.001). In addition, the concern for climate change increased by age, with the 19–29 age group (78.8%) the 30–39 age group (81.9%), the 40–49 age group (88.7%), 50–59 age group (90.4%), and 60s and above (92.3%) (p<0.001) (Table 2). The perception of risk of climate change on health impact was relatively low at 63.2%, and the risk perception of females (64.8%) was higher than males (61.6%) (p=0.43). Compared to the 20–30 generation, the concern for climate change increased with age. In the criteria for the health impact from climate change, a significant generation gap was shown where 70.5% of the ≥60 age group showed concern, while 42.9% of the 19–29 age group showed concern (p<0.001) (Table 3).

## 3. Climate health information

Only 30.3% of participants responded that there was sufficient information on the health impact of climate change. In contrast, the 30–39 age group accounted for the highest number (32.3%) that responded there was 'not sufficient' information (p=0.341) (Table 4). The most interesting sector related to the health impact of climate change was general health/disease information (32.0%), followed by climate health policy (26.2%), and safety, behavior, and response measures (21.3%) (Figure 1).

**Table 2.** Concern for climate change

| Classification | N | Number of cases (%) | | | | p-value |
|---|---|---|---|---|---|---|
| | | Not concerned (not at all concerned+ slightly concerned) | Somewhat concerned | Concerned (extremely concerned+ moderately concerned) | Do not know | |
| Total | 1,500 | 53 (3.5) | 120 (8.0) | 1,312 (87.4) | 15 (1.1) | - |
| Sex | | | | | | |
| Male | 744 | 40 (5.4) | 61 (8.1) | 636 (85.5) | 7 (1.0) | 0.001 |
| Female | 756 | 13 (1.7) | 60 (7.9) | 675 (89.3) | 8 (1.1) | |
| Age (yr) | | | | | | |
| 19–29 | 254 | 13 (5.2) | 32 (12.5) | 200 (78.8) | 9 (3.5) | <0.001 |
| 30–39 | 223 | 17 (7.5) | 24 (10.6) | 182 (81.9) | 0 (0.0) | |
| 40–49 | 275 | 6 (2.2) | 23 (8.4) | 244 (88.7) | 2 (0.7) | |
| 50–59 | 295 | 6 (2.1) | 21 (7.2) | 267 (90.4) | 1 (0.3) | |
| ≥60 | 453 | 11 (2.4) | 21 (4.6) | 418 (92.3) | 3 (0.7) | |
| Region | | | | | | |
| Seoul | 283 | 14 (4.9) | 25 (8.8) | 243 (85.9) | 1 (0.4) | 0.480 |
| Incheon/Gyeonggi | 475 | 11 (2.3) | 33 (6.9) | 427 (89.9) | 4 (0.8) | |
| Daejeon/Chungcheong/ Sejong | 158 | 8 (5.0) | 12 (7.6) | 133 (84.2) | 5 (3.2) | |
| Gwangju/Jeolla | 147 | 7 (4.9) | 10 (6.9) | 127 (86.1) | 3 (2.1) | |
| Daegu/Gyeongbuk | 147 | 5 (3.5) | 13 (8.8) | 129 (87.7) | 0 (0.0) | |
| Busan/Ulsan/Gyeongnam | 227 | 4 (1.8) | 24 (10.4) | 198 (87.4) | 1 (0.4) | |
| Gangwon/Jeju | 63 | 4 (6.2) | 4 (5.9) | 54 (86.5) | 1 (1.3) | |

Values are presented as number (%). -=not available.

Table 3. Health impact according to climate change

| Classification | N | Number of cases (%) | | | p-value |
|---|---|---|---|---|---|
| | | Not severed (not at all severed+ slightly severed) | Moderately severed | Severed (very severed+ extremely severe) | |
| Total | 1,500 | 82 (5.5) | 470 (31.3) | 948 (63.2) | - |
| Sex | | | | | |
| Male | 744 | 38 (5.1) | 248 (33.3) | 458 (61.6) | 0.430 |
| Female | 756 | 44 (5.8) | 222 (29.4) | 490 (64.8) | |
| Age (yr) | | | | | |
| 19–29 | 254 | 36 (14.1) | 109 (43.0) | 109 (42.9) | <0.001 |
| 30–39 | 223 | 14 (6.2) | 86 (38.6) | 123 (55.2) | |
| 40–49 | 275 | 7 (2.5) | 71 (25.8) | 197 (71.7) | |
| 50–59 | 295 | 11 (3.8) | 85 (28.6) | 199 (67.6) | |
| ≥60 | 453 | 14 (3.1) | 119 (26.4) | 319 (70.5) | |
| Region | | | | | |
| Seoul | 283 | 15 (5.3) | 93 (32.9) | 175 (61.8) | 0.592 |
| Incheon/Gyeonggi | 475 | 26 (5.5) | 133 (28.0) | 316 (66.5) | |
| Daejeon/Chungcheong/Sejong | 158 | 14 (8.9) | 40 (25.5) | 104 (65.6) | |
| Gwangju/Jeolla | 147 | 9 (6.3) | 48 (32.4) | 90 (61.3) | |
| Daegu/Gyeongbuk | 147 | 9 (6.1) | 55 (37.3) | 83 (56.6) | |
| Busan/Ulsan/Gyeongnam | 227 | 7 (3.1) | 82 (35.9) | 138 (61.0) | |
| Gangwon/Jeju | 63 | 2 (2.9) | 20 (31.4) | 41 (65.7) | |

Values are presented as number (%). -=not available.

### 4. Climate health impact assessment

The Climate Health Impact Assessment (every five years according to Framework Act on Health and Medical Services Article 37 Paragraph 2), conducted by Korea Disease Control and Prevention Agency (KDCA), resulted in only 9.1% that 'knew it well'. All age groups responded that they 'did not know or know but did not know in detail' (p=0.033), and 40.6% of males and 48.2% of females were shown to not have known (p<0.001) (Table 5).

### 5. Comparing perception of climate change public health threats for each period of climate change

The survey results for the extent of each period of climate change to the public health in The ROK showed that 84.4% responded that the 'current' climate change will threaten public health (very threatening: 66.7%+extremely threatening: 17.7%). A total of 88.6% accounted for the response to 'within five years' (very threatening: 52.0%+extremely threatening: 36.6%). The response to 'within 20 years' (very threatening: 25.4%+extremely threatening: 68.1%) and 'within 50 years' (90.2%, very threatening: 17.2%+extremely threatening: 73.0%) showed that the response to 'very threatening' was 42.7% and 55.8% higher than the response to 'extremely threatening', respectively. The public concern and risk intensity on the threat of climate change both increased as time stretched farther out from the present (Figure 2).

Table 4. Sufficiency of data on the health impact of climate change

| Classification | N | Number of cases (%) | | | p-value |
|---|---|---|---|---|---|
| | | Not sufficient (not at all sufficient+ slightly sufficient) | Moderately sufficient | Sufficient (very sufficient+ extremely sufficient) | |
| Total | 1,500 | 381 (25.4) | 665 (44.3) | 454 (30.3) | - |
| Sex | | | | | |
| Male | 744 | 173 (23.3) | 341 (45.8) | 230 (30.9) | 0.152 |
| Female | 756 | 208 (27.5) | 324 (42.9) | 224 (29.6) | |
| Age (yr) | | | | | |
| 19–29 | 254 | 65 (25.7) | 108 (42.3) | 81 (32.0) | 0.341 |
| 30–39 | 223 | 72 (32.3) | 89 (39.7) | 62 (27.9) | |
| 40–49 | 275 | 59 (21.4) | 136 (49.6) | 80 (29.0) | |
| 50–59 | 295 | 68 (23.2) | 134 (45.4) | 93 (31.4) | |
| ≥60 | 453 | 116 (25.6) | 199 (43.9) | 138 (30.5) | |
| Region | | | | | |
| Seoul | 283 | 84 (29.7) | 124 (43.8) | 75 (26.5) | 0.368 |
| Incheon/Gyeonggi | 475 | 116 (24.5) | 214 (45.0) | 145 (30.5) | |
| Daejeon/Chungcheong/Sejong | 158 | 42 (26.7) | 72 (45.5) | 44 (27.8) | |
| Gwangju/Jeolla | 147 | 39 (26.3) | 62 (42.0) | 47 (31.7) | |
| Daegu/Gyeongbuk | 147 | 31 (21.1) | 65 (44.5) | 51 (34.5) | |
| Busan/Ulsan/Gyeongnam | 227 | 53 (23.3) | 103 (45.2) | 71 (31.5) | |
| Gangwon/Jeju | 63 | 15 (24.4) | 26 (41.0) | 22 (34.6) | |

Values are presented as number (%). -=not available.

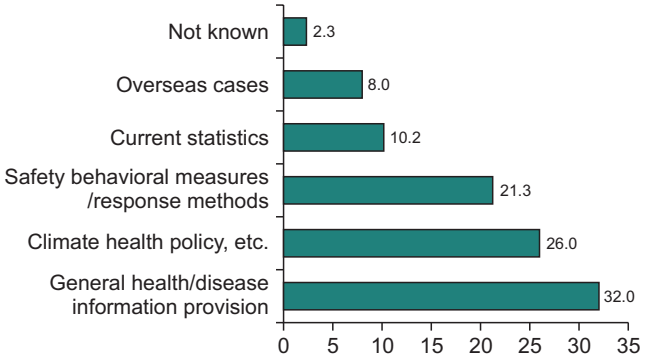


Figure 1. Sectors of interest as impact of climate change to health

## Discussion

This research studied the perception on climate health policy and the health impact by the public according to climate risk based on the public perception climate health survey results from the first Climate Health Impact Assessment. There was a lower level of public recognition in the 'health impact according to climate change', compared to the 'concern on climate change'. Overall, the difference in sex and regional perception was insignificant, but the female recognition tended to be lower than that of males. The recognition increased with age. In particular, a significantly low recognition was shown from the 20–30 generation compared to the ≥60 age group. Thus, the perception gap between the two generations was more significant in public health impact risk (21.45%) than in the concern from climate change (11.95%), and it was determined that customized policies and improvement in climate health risk perception were required for the middle-aged population as the future generation. In the climate change survey of the 1,600

Table 5. Level of climate health impact assessment recognition

| Classification | N | Number of cases (%) | | | p-value |
|---|---|---|---|---|---|
| | | Did not know | Knew about it but not in detail | Knew well about it | |
| Total | 1,500 | 666 (44.4) | 604 (40.3) | 137 (9.1) | - |
| Sex | | | | | |
| Male | 744 | 302 (40.6) | 319 (42.9) | 92 (12.4) | <0.001 |
| Female | 756 | 364 (48.1) | 285 (37.7) | 45 (6.0) | |
| Age (yr) | | | | | |
| 19–29 | 254 | 124 (48.8) | 85 (33.5) | 27 (10.6) | 0.033 |
| 30–39 | 223 | 118 (52.9) | 68 (30.5) | 23 (10.3) | |
| 40–49 | 275 | 138 (50.2) | 83 (30.2) | 28 (10.2) | |
| 50–59 | 295 | 116 (39.3) | 143 (48.5) | 23 (7.8) | |
| ≥60 | 453 | 172 (38.0) | 225 (49.7) | 35 (7.7) | |
| Region | | | | | |
| Seoul | 283 | 129 (45.6) | 113 (39.9) | 22 (7.8) | 0.206 |
| Incheon/Gyeonggi | 475 | 216 (45.5) | 185 (38.9) | 45 (9.5) | |
| Daejeon/Chungcheong/Sejong | 158 | 74 (46.8) | 63 (39.9) | 13 (8.2) | |
| Gwangju/Jeolla | 147 | 67 (45.6) | 56 (38.1) | 11 (7.5) | |
| Daegu/Gyeongbuk | 147 | 66 (44.9) | 56 (38.1) | 15 (10.2) | |
| Busan/Ulsan/Gyeongnam | 227 | 85 (37.4) | 103 (45.4) | 28 (12.3) | |
| Gangwon/Jeju | 63 | 30 (47.6) | 29 (46.0) | 3 (4.8) | |

Values are presented as number (%). -=not available.

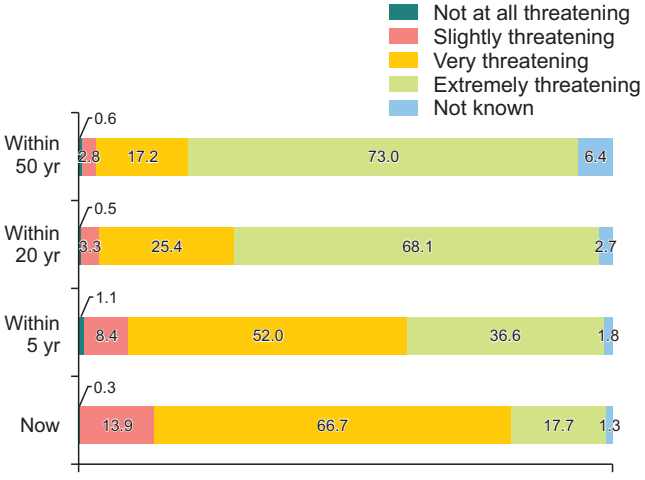


Figure 2. Health risk recognition of climate change for each period

general public released by Korea Environment Institute in 2022, 90.4% of participants aged 60 or above responded that the severity of climate risk was significant among the results of climate risk severity for each generation, which was higher than the 81.5% from the 20–30 generation, which was similar to the results of this research [14]. In the first Climate Health Impact Assessment (2021, published in 2022), the results of the recent 10 years (2011–2020 year) showed that the heat illnesses caused by heat waves increased deaths, hospitalizations, and emergency room visits, from which males and those aged 65 or above accounted for the majority. In addition, the age group with the highest incidence of patients experiencing death from ozone exposure, tsutsugamushi as a tick-borne infectious disease, and severe fever thromboctyopenia syndrome (SFTS) was 65 or above. Therefore, it can be concluded that the results highly correlate [15]. However, compared to the interest on climate change, the public recognition on the first Climate Health Impact Assessment was low (9.1%). In particular, compared to

the level of interest in climate change, the level of recognition from the first Climate Health Impact Assessment results was lowest among ≥60 age group (37.9%).

A comparative analysis was performed with the public climate change and health impact perception survey proceeded in the United Kingdom in 2021 (3,000 participants aged 16 or above), and the results showed that the concern for climate risks (82%) and the health impact according to climate change (73%) were similar to those of The ROK [16]. In the survey on the health risk for each period, nearly half (48%) of participants responded that the impact was current, 64% of respondents predicted that climate change will impact health in the near future (within five years), and approximately 88% of respondents predicted that climate change will impact health in the far future (within 50 years) [16]. The increasing trend of the perception of increasing threat to health was similar to the results from The ROK's survey, but the current perception of threat to health by the ROK's public was 84.4%, which was 36.4% higher than that of the United Kingdom (48%), and the difference in recognition between now and the far future (within 50 years) was only 5.8% in the ROK. This shows that the level of recognition on the health risk for all age groups was overall higher than that of the United Kingdom (40%) [16]. If climate change as a global phenomenon progressed at the current rate it was perceived that the majority of the population would experience health damages in the far future.

The change in perception of climate health issues to an urgent personal health problem is significant. The majority of the survey targets (79.3%) demanded preventive safety tips, climate health policies, and various general health information regarding climate change health information. Key nations, including the United Kingdom and the United States, operate various campaigns (https://breathelife2030.org) and programs (Climate.gov Home, https://climateforhealth.org) to strengthen communication, improve the capacity of information comprehension, and improve the recognition for various targets. These include health and medical experts, policy makers, and general health-sector students. KDCA promotes visual contents for each target including the general public (booklets, videos), policy makers (card news), and experts (lecture slides), based on climate health impact assessment results. The agency also develops customized educational and promotional data for improving the recognition and regional participation and climate health information literacy of various parties of interest. The public perception survey of climate health conducted in 2022 was proceeded to identify the climate health policy direction and the level of demand for various customized information based on the first Climate Health Impact Assessment results. The level of awareness on the severity of climate change and health impact from the Korean public was identified through the climate change adaptation perception survey results, and it was identified that various health information provision and climate health policy promotions were necessary. The effectiveness of the national climate change adaptation measures and the success were determined based on the extent of the understanding of climate change adaption and the political participation of the general public. In the future, the endeavors of the KDCA will include the preparation of preliminary data for establishing climate health policies through cooperation with relevant departments and active communication for improving the recognition of climate health.

## Supplementary Materials

Supplementary data are available online.

## Declarations

**Ethics Statement:** Not applicable.

**Funding Source:** None.

**Acknowledgments:** None.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

**Author Contributions:** Conceptualization: JHK, HJK, YA. Data curation: HJK, SSH. Formal analysis: JYH, HK. Investigation: JYH, HJK, SSH. Methodology: All. Project administration: JYH, JHK, HK, YA. Resources: HJK, SSH. Supervision: JHK, SSH, YA. Visualization: JYH. Writing-original draft: JYH, JHK. Writing-review & editing : JHK, YA.

## References

1. Canon G. Record Death Valley flooding 'a once-in-1,000-year event'. The Guardian [Internet]. 2022 Aug 10 [cited 2023 Jan 23]. Available from: https://www.theguardian.com/us-news/2022/aug/10/death-valley-floods-climate-crisis
2. Watts J. Climate scientists shocked by scale of floods in Germany. The Guardian [Internet]. 2021 Jul 16 [cited 2023 Jan 23]. Available from: https://www.theguardian.com/environment/2021/jul/16/climate-scientists-shocked-by-scale-of-floods-in-germany
3. Masson-Delmotte V, Zhai P, Pirani A, et al. Climate change 2021: the physical science basis [Internet]. IPCC; 2021 [cited 2023 Jan 23]. Available from: https://www.ipcc.ch/
4. Climate and Health Alliance. Framework for a national strategy on climate, health and well-being for Australia. Climate and Health Alliance; 2017.
5. Sullivan H. 'Code red for humanity': what the papers say about the IPCC report on the climate crisis. The Guardian [Internet]. 2021 Aug 10 [cited 2023 Jan 23]. Available from: https://www.theguardian.com/environment/2021/aug/10/code-red-for-humanity-what-the-papers-say-about-the-ipcc-report-on-the-climate-crisis
6. The 27th conference of the parties to the United Nations Framework Convention of Clilmate Change (COP27) [Internet]. COP27; 2022 [cited 2023 Jan 23]. Available from: https://cop27.eg/
7. World Health Organization. Compendium of WHO and other UN guidance on health and environment, 2022 update [Internet]. World Health Organization; 2022 [cited 2023 Jan 23]. Available from: https://www.who.int/
8. Korea Meteorological Administration. Korean climate change assessment report. Korea Meteorological Administration; 2020.
9. Moulton AD, Schramm PJ. Climate change and public health surveillance: toward a comprehensive strategy. J Public Health Manag Pract 2017;23:618-26.
10. European Climate and Health Observatory. Climate change and health: the national policy overview in Europe. European Climate and Health Observatory; 2022.
11. Akerlof K, Debono R, Berry P, et al. Public perceptions of climate change as a human health risk: surveys of the United States, Canada and Malta. Int J Environ Res Public Health 2010;7:2559-606.
12. Kim H, Park S, Lee Y, Kim JH, Kim Y, Kwon H. The first national climate health impact assessment in the Republic of Korea: key findings and scientific issues. Public Health Wkly Rep 2022;15:1463-75.
13. Korea Disease Control and Prevention Agency. Development of public communication contents on the first climate change and health impact assessment. Korea Disease Control and Prevention Agency; 2022.
14. Lee SY, Yang YK, Kim SH. 2050 Net-zero awareness survey. Korea Environ Inst Focus 2022;10:1-16.
15. Korea Disease Control and Prevention Agency. The 1st climate health impact assessment report. Korea Disease Control and Prevention Agency; 2022.
16. Ipsos MORI; Health Foundation. Public perceptions of climate change and health. Health Foundation; 2021.

리뷰와 전망
eISSN 2586-0860
https://doi.org/10.56786/PHWR.2023.16.21.2

PHWR
Public Health Weekly Report

# 미세먼지로 인한 건강영향 저감을 위한 중재연구 동향

권은진[1], 김환철[2], 김영열[1]*

[1]국립보건연구원 만성질환융복합연구부 호흡기·알레르기질환연구과, [2]인하대학교 의과대학 직업환경의학과

## 초 록

대기오염, 특히 미세먼지는 공중보건의 주요 위험인자 중 하나이다. 전세계 인구의 91% 이상이 세계보건기구(World Health Organization, WHO)의 연간 평균 대기오염 제한 기준을 초과하는 지역에서 거주한다. 또한, WHO는 대기오염으로 인해 매년 420만 명이 사망하는 것으로 추정하였다. 미세먼지가 건강에 심각한 영향을 미친다는 연구결과는 꾸준히 보고되고 있다. 특히 호흡기 및 심혈관계 질환의 발생뿐만 아니라, 사망률의 증가와는 밀접한 관련성을 보인다. 반면 미세먼지 노출로 인한 건강피해를 저감하는 중재연구는 많지 않다. 현재 미세먼지 건강피해 저감을 위한 방안으로 공기청정기, 마스크, 행동 및 기타 중재, 식이 및 약물 등이 권고되고 있으나, 그 중재효과에 대한 과학적 근거는 부족한 상태이다. 이 글에서는 미세먼지 중재방안을 전반적으로 고찰하고, 최신 연구동향을 파악하고자 하였다. 그 결과, 공기청정기 사용 시 미세먼지 농도가 뚜렷한 감소를 보이고, 그로 인한 염증 수치 및 혈압 감소를 보였다. 마찬가지로, 마스크 착용 시 폐 기능 변화 및 혈압 감소를 보였으나, 심혈관계 영향은 뚜렷한 변화를 보이지 못했다. 따라서, 중재연구가 제한적으로 시행되고 있어 더 많은 연구가 필요하다.

주요 검색어: 미세먼지, 중재연구, 건강영향

## 서 론

미세먼지(particulate matter, PM)는 다양한 크기와 구성, 발생원을 가지고 있는 입자상물질로, 직경이 10 μm 이하의 입자는 $PM_{10}$, 직경이 2.5 μm 이하의 입자는 $PM_{2.5}$로 정의한다. 미세먼지는 호흡기를 통해 체내로 흡수되어 인체에 유해한 영향을 미친다. 2013년 국립암연구소에서 미세먼지를 1군 발암물질로 지정한[1] 이래 미세먼지에 대한 환경보건학적 중요성이 대두되었다. 2016년 기준 세계 인구의 91% 이상이 세계보건기구(World Health Organization, WHO)에서 제시한 대기오염 제한 기준을 초과하는 지역에 살고 있으며, 미세먼지와 같은 대기오염에 의한 조기사망이 연간 420만 명에 이른다[2].

미세먼지는 모든 원인에 의한 사망, 호흡기 및 심뇌혈관질환 등의 위험을 높일 수 있는 것으로 보고되고 있다[3-5]. 최근에는 신경퇴행성질환, 정신질환 및 당뇨에도 영향을 미치는 것으로 확인되었다. 미세먼지가 건강영향에 미치는 기전으로는 염증반응, 활성산소의 생성, 내독소 효과 및 DNA 손상 등

Received March 3, 2023 Revised April 6, 2023 Accepted April 17, 2023
*Corresponding author: 김영열, Tel: +82-43-719-8450, E-mail: youngyk07@korea.kr

**핵심요약**

① 이전에 알려진 내용은?

미세먼지가 건강에 미치는 영향은 잘 알려져 있다. 그러나, 미세먼지 노출로 인한 건강피해를 저감하는 중재연구는 많지 않다.

② 새로이 알게 된 내용은?

현재 미세먼지 건강피해 저감을 위한 방안으로 공기청정기, 마스크, 행동 및 기타중재, 식이 및 약물등이 있다. 공기청정기 사용 시 미세먼지 농도가 뚜렷한 감소를 보이고, 그로 인한 염증 수치 및 혈압 감소를 보였다. 마찬가지로, 마스크 착용 시 폐기능 변화 및 혈압 감소를 보였으나, 심혈관계 영향은 뚜렷한 변화를 보이지 못했다.

③ 시사점은?

중재연구가 제한적으로 시행되고 있어 더 많은 연구가 필요하다.

이 알려져 있다[6,7].

국내에서는 미세먼지가 다양한 질환 악화에 미치는 영향 연구를 진행하고 있으나, 서구 및 중국에 비하여 미비한 실정이다. 특히, 미세먼지 노출로 인한 건강피해를 저감하기 위한 중재연구가 많지 않다. 미세먼지 건강피해 저감을 위한 방안으로 실외활동제한, 외출시 보건용 마스크 착용, 공기청정기 사용을 통한 실내공기질 개선 등을 권고하고 있다. 미세먼지 대응 중재방안으로 미세먼지를 줄일 수 있으나, 그로 인한 건강 효과에 대한 연구는 아직 논란이 있다. 국내 연구에서, 천식 아동을 대상으로 공기청정기를 사용할 시 실내 미세먼지 농도가 감소하였고, 그로 인한 최대호기유량도 감소하였다[8]. 또한 Lim 등[9]의 연구에서, 마스크 착용이 미세먼지 농도 감소뿐만 아니라 혈압 감소 등의 개선효과를 보였다. 그러나, 천식환자에서 미세먼지 증가 시 공기청정기 사용 및 마스크 착용에 대한 과학적 근거수준이 높지 않다[10]. 지금까지 국내 · 외에서 수행된 중재효과 연구에서 대부분 건강효과보다는 공기질에 초점이 되어 있다. 따라서 이 글에서는 문헌을 토대로 미세먼지 중재방안을 검토하고, 최신 연구 동향을 파악하고자 한다.

## 본 론

### 1. 국내·외 미세먼지와 건강영향

최근 정부의 적극적인 감축 노력으로 국내 미세먼지의 연평균 농도가 점점 개선되고 있으나, 국민의 체감효과는 미흡하다. 환경과학원 연구보고서에 따르면, 전국 연평균 농도는 2002년 이후 꾸준히 감소추세이나, WHO 권고기준(10 μg/m$^3$)이나 선진국(미국 7.4 μg/m$^3$, 일본 11.9 μg/m$^3$)에 비하면 여전히 2배 이상으로 심각한 수준이다[11]. 메타연구에서 대기오염 노출이 만성폐쇄성폐질환(Chronic Obstructive Pulmonary Disease, COPD) 환자의 입원률 및 사망률에 미치는 영향을 조사했다[12]. $PM_{10}$, $PM_{2.5}$ 농도의 증가가 COPD 환자의 호흡기 관련 입원을 증가시킬 수 있음을 보고하였다. 특히, COPD 환자에서 $PM_{2.5}$ 농도가 10 μg/m$^3$ 증가할 때마다 입원율이 3.1%, 사망률은 2.5% 증가하였다[13]. 또한 $PM_{2.5}$ 일평균 농도가 10 μg/m$^3$ 증가할 때마다 1-4주 후 발생하는 급성하기도감염 환자수가 15-32% 증가하였다[14]. 미세먼지로 인한 심혈관질환과의 밀접한 관련성은 역학연구에서 많이 보고되고 있다. Pope 등[15]은 단기 $PM_{2.5}$ 노출 시(10 μg/m$^3$ 증가당) 급성관상동맥증후군이 4.5% 증가함을 보고하였다. 이는 미세먼지 농도의 단기간 변화에도 질병의 위험이 증가할 수 있음을 의미한다. 메타 연구에서 $PM_{2.5}$가 10 μg/m$^3$ 증가 시 수축기혈압 1.393 mmHg와 이완기혈압 0.895 mmHg가 증가하여 고혈압과 양의 관련성을 확인하였다[16]. 이외에도 미세먼지는 내분비계를 교란시켜 비만이나 당뇨와 같은 대사질환의 발병에도 영향을 미친다[17-19]. 최근 연구에서는 $PM_{2.5}$가 뇌신경질환 및 정신질환에도 영향을 미친다고 보고하고 있다[20]. 메타분석 결과에 따르면, 50세 이상 노인 피험자 1,200만 명을 포함하여 $PM_{2.5}$에 장기간 노출 시 치매 위

험이 3배(hazard ratio [HR] 3.26), 알츠하이머병 위험(HR 4.82)이 약 5배 증가하였다[20]. 또한, $PM_{2.5}$에 10 μg/$m^3$ 증가당 우울증(odds ratio [OR] 1.19)과 자살(OR 1.05)의 위험확률이 증가한 반면 $PM_{10}$ 노출에 대한 연관성은 발견되지 않았다[21]. 그 밖에 미세먼지가 조산, 저체중아 출산의 위험에도 영향을 미친다는 보고가 나오고 있다[22].

## 2. 국내·외 중재연구 동향

### 1) 연구 방법

비체계적 고찰을 통한 미세먼지 중재연구 관련 최신연구 동향 및 중재방안을 조사하였다. MEDLINE, EMBASE, CINAHL 및 Cochrane Library 데이터베이스를 검색하였으며, 1989년부터 2020년까지 발행된 문헌을 대상으로 하였다. 검색어로는 "air pollution", "particulate matter", "trial/intervention" 등의 단어를 조합하여 키워드로 사용하였다. 정보가 충분하지 않은 경우 더 많은 정보를 수집하기 위해 수기로 검색하는 과정을 추가하였다.

### 2) 연구 분석

두 명의 평가자가 참여하여 독립적으로 수행한 뒤 일치여부를 확인하였다. 수집된 논문의 선정기준은 다음과 같다. (1) 미세먼지 장단기 노출에 따른 건강지표 변화를 분석한 연구, (2) 영어나 한국어로 된 연구, (3) 인간을 대상으로 한 연구, (4) 미세먼지의 중재방안 적용 전과 적용 후 노출에 따른 급/만성 건강영향 비교 분석한 연구였다. 반면 제외기준은 (1) 연구결과가 보고되지 않은 논문, (2) 중재방안을 제시하지 않은 연구였다. 연구대상을 PICO (Patient, Intervention, Comparison, Outcome) 형식으로 나타내면 표 1과 같다.

#### (1) 개인기반 중재연구 현황

① 공기청정기

소아를 대상으로 한 연구에서는 공기청정기를 사용할 경

**표 1.** 문헌고찰의 핵심질문

| 구분 | 세부내용 |
|---|---|
| 연구대상자(patient) | • 취약인구<br>- 호흡기/심혈관 질환자<br>- 고령자, 어린이, 빈곤층<br>- 임산부<br>- 대기 미세먼지 고농도 지역 거주자<br>- 교통량이 많은 지역 거주자<br>- 산업단지 주변 지역 거주자<br>- 직업적 고노출군<br>• 일반인구 |
| 중재방안(intervention) | • 공기청정기<br>• 마스크<br>• 행동 지침<br>• 식이/약물 |
| 비교(comparison) | • 미세먼지 노출량<br>• 중재방안 전/후 |
| 결과지표(outcome) | • 일반적 증상(눈, 코, 목 따가움, 기침, 가래, 가슴 답답함, 호흡곤란 등)<br>• 응급실 내원(천식 발작, 급성기관지염, 호흡기 감염, 부정맥 등)<br>• 외래방문율<br>• 이환율<br>• 사망률 |

우 가정 내 $PM_{2.5}$ 농도가 현저히 감소하고, 그로 인한 최대 호기량 증가 및 폐 염증이 감소하는 결과를 보였다[8,23,24]. 성인 및 노인을 대상으로 한 연구에서는, 공기청정기 사용 시 블랙 카본, $PM_{2.5}$ 농도 감소로 인해 수축기/이완기 혈압이 감소하는 결과를 확인하였다[25,26].

② 마스크

대기오염 노출저감을 위한 행동으로 보건용 마스크 착용을 권장하고 있으나 마스크의 저감 실효성에 대한 연구는 많지 않다. Lim 등[9]의 연구에서 마스크 단기 착용이 폐기능 뿐만 아니라 혈압 감소 등의 개선효과를 확인하였다. 건강한 일반인을 대상으로 한 연구에서, 마스크를 착용한 집단에서 혈압 감소 및 심박동수 변이 증가를 보였다[27,28]. 또한, 관동맥성심장병이 있는 환자군에서도 마스크 착용시 우울증 감소뿐만 아니라 혈압 감소 및 심박동수 변이가 증가한 결과를 보였다[29]. 반면 교통관련 지하철에서 마스크 착용 시에는 심혈관계 영향에 뚜렷한 변화가 없었다[28,30].

③ 개인행동 및 기타 중재

대기오염과 관련 행동지침를 평가하는 연구는 많지 않다. COPD 환자 대상으로 자기관리행동 교육을 수행한 군에서 미세먼지 노출 수준이 감소하였고, 일부 증상이 개선되었다[31]. 또한 임산부에서는 대기오염 지수와 발생 지역, 기간에 대한 정보를 문자 송부를 통한 교육을 한 결과, 미세먼지에 대한 문제 인식도, 예방 행동에 대한 변화 및 자기효능감 등에 유의한 차이를 보였다[32,33]. 규칙적인 운동은 심혈관질환 예방을 줄여주고 저강도 운동은 심폐질환의 부담을 줄여준다는 사실은 밝혀졌으나, 고강도 운동인 경우 오염물질의 흡입을 증가시킬 수 있어서[34-36] 장소와 대기오염 노출량의 고려가 필요하다.

④ 식이 · 약물 중재

대기오염 노출과 이에 대한 건강 악화를 최소화할 수 있는 식이 및 약물의 효과를 입증하는 연구는 많지 않다. 성인을 대상으로 비타민 B를 4주간 복약하면 고농도의 미세먼지에 노출되어도 심장 자율신경 기능(심박수, 심박동수 변이) 및 염증에 미치는 영향이 완화됨을 보고하였다[37]. 또 다른 연구에서도 오메가-3를 복용하면 혈중 산화손상지표들이 개선되는 효과를 관찰하였다[38].

(2) 국가/지역사회 기반 중재연구 현황

미세먼지로 인한 건강영향을 예방하기 위한 국가 및 지역 단위 중재 정책으로는 발생을 저감시키는 방안이 있다. 발생 저감을 위해 차량 제한, 자동차와 버스 등 운송수단의 연료 대체 정책, 공장의 오염제한을 위한 산업 규제정책 등이 있다. 또한 발생원에 대한 정책 개입 및 규제는 농도 감소 및 건강영향에 긍정적인 영향을 주는 것으로 나타났다.

## 결 론

국외에서는 미세먼지 민감 · 취약계층 대상으로 미세먼지의 건강영향에 대한 다수의 연구가 수행되고 있으나, 국내에서는 제한적으로 연구가 진행되어 다양한 민감 · 취약계층에 대한 연구가 보다 활발히 진행되어야 한다. 또한, 국내뿐만 아니라 국외에서도 미세먼지에 의한 건강피해를 줄이기 위한 중재연구가 제한적으로 보고되고 있기 때문에, 국민들이 생활 속에서 실천할 수 있는 대처방안에 대한 과학적 근거가 부족한 상황이다. 현재, 중재방안으로는 공기청정기, 마스크, 행동 및 기타 중재, 식이 및 약물 등이 있으나, 개별 중재방안별 효과뿐만 아니라 다양한 중재방안이 복합적으로 적용했을 때의 효과 연구도 필요하다. 본 글을 통해 미세먼지로 인한 건강피해 최소화를 위한 중재연구 방안을 검토함으로써 새로운 중재방안을 개발하고, 국민들의 위험인식도를 낮추는 기틀을 마련하는데 기여할 수 있을 것으로 기대한다.

## Declarations

**Ethics Statement:** Not applicable.

**Funding Source:** We have summarized the some results of research conducted through the 'Research planning and pilot study of intervention study on health effects of fine particulate matter'(2021-ER1211-00).

**Acknowledgments:** None.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

**Author Contributions:** Conceptualization: EK. Data curation: HCK. Formal analysis: HCK. Resources: HCK. Supervision: YYK. Writing – original draft: EK. Writing – review & editing: EK, YYK.

## References

1. Loomis D, Grosse Y, Lauby-Secretan B, et al. The carcinogenicity of outdoor air pollution. Lancet Oncol 2013;14:1262-3.
2. WHO. Factsheet: ambient (outdoor) air pollution [Internet]. WHO; 2022 [cited 2022 Dec 19]. Available from: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
3. Thurston GD, Kipen H, Annesi-Maesano I, et al. A joint ERS/ATS policy statement: what constitutes an adverse health effect of air pollution? An analytical framework. Eur Respir J 2017;49:1600419.
4. Du Y, Xu X, Chu M, Guo Y, Wang J. Air particulate matter and cardiovascular disease: the epidemiological, biomedical and clinical evidence. J Thorac Dis 2016;8:E8-19.
5. Brook RD, Rajagopalan S, Pope CA 3rd, et al. Particulate matter air pollution and cardiovascular disease: an update to the scientific statement from the American Heart Association. Circulation 2010;121:2331-78.
6. Gan WQ, FitzGerald JM, Carlsten C, Sadatsafavi M, Brauer M. Associations of ambient air pollution with chronic obstructive pulmonary disease hospitalization and mortality. Am J Respir Crit Care Med 2013;187:721-7.
7. Lawal AO. Air particulate matter induced oxidative stress and inflammation in cardiovascular disease and atherosclerosis: the role of Nrf2 and AhR-mediated pathways. Toxicol Lett 2017;270:88-95.
8. Kim S, Lee J, Park S, et al. Association between peak expiratory flow rate and exposure level to indoor PM2.5 in asthmatic children, using data from the escort intervention study. Int J Environ Res Public Health 2020;17:7667.
9. Lim YH, Kim W, Choi Y, et al. Effects of particulate respirator use on cardiopulmonary function in elderly women: a quasi-experimental study. J Korean Med Sci 2020;35:e64.
10. Yang HJ, Kim SH, Jang AS, et al. Guideline for the prevention and management of particulate matter/yellow dust-induced adverse health effects on the patients with bronchial asthma. J Korean Med Assoc 2015;58:1034-43.
11. Joo HS, Shin DW, Choi KC, et al. Study on integrated management strategies for PM(particulate matter). KEI; 2018.
12. Moore E, Chatzidiakou L, Kuku MO, et al. Global associations between air pollutants and chronic obstructive pulmonary disease hospitalizations. A systematic review. Ann Am Thorac Soc 2016;13:1814-27.
13. Li MH, Fan LC, Mao B, et al. Short-term exposure to ambient fine particulate matter increases hospitalizations and mortality in COPD: a systematic review and meta-analysis. Chest 2016;149:447-58.
14. Horne BD, Joy EA, Hofmann MG, et al. Short-term elevation of fine particulate matter air pollution and acute lower respiratory infection. Am J Respir Crit Care Med 2018;198:759-66.
15. Pope CA 3rd, Muhlestein JB, May HT, Renlund DG, Anderson JL, Horne BD. Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. Circulation 2006;114:2443-8.
16. Liang R, Zhang B, Zhao X, Ruan Y, Lian H, Fan Z. Effect of exposure to PM2.5 on blood pressure: a systematic review and meta-analysis. J Hypertens 2014;32:2130-40;discussion 2141.
17. Coogan PF, White LF, Jerrett M, et al. Air pollution and incidence of hypertension and diabetes mellitus in black women living in Los Angeles. Circulation 2012;125:767-72.
18. Dubowsky SD, Suh H, Schwartz J, Coull BA, Gold DR. Diabetes, obesity, and hypertension may enhance associations between air pollution and markers of systemic in-

flammation. Environ Health Perspect 2006;114:992-8.
19. Rajagopalan S, Brook RD. Air pollution and type 2 diabetes: mechanistic insights. Diabetes 2012;61:3037-45.
20. Fu P, Guo X, Cheung FMH, Yung KKL. The association between PM2.5 exposure and neurological disorders: a systematic review and meta-analysis. Sci Total Environ 2019;655:1240-8.
21. Khreis H, Bredell C, Fung KW, et al. Impact of long-term air pollution exposure on incidence of neurodegenerative diseases: a protocol for a systematic review and exposure-response meta-analysis. Environ Int 2022;170:107596.
22. Qian Z, Liang S, Yang S, et al. Ambient air pollution and preterm birth: a prospective birth cohort study in Wuhan, China. Int J Hyg Environ Health 2016;219:195-203.
23. Barkjohn KK, Norris C, Cui X, et al. Real-time measurements of PM2.5 and ozone to assess the effectiveness of residential indoor air filtration in Shanghai homes. Indoor Air 2021;31:74-87.
24. Cui X, Li Z, Teng Y, et al. Association between bedroom particulate matter filtration and changes in airway pathophysiology in children with asthma. JAMA Pediatr 2020;174:533-42.
25. Morishita M, Adar SD, D'Souza J, et al. Effect of portable air filtration systems on personal exposure to fine particulate matter and blood pressure among residents in a low-income senior facility: a randomized clinical trial. JAMA Intern Med 2018;178:1350-7.
26. Liu S, Chen J, Zhao Q, et al. Cardiovascular benefits of short-term indoor air filtration intervention in elderly living in Beijing: an extended analysis of BIAPSY study. Environ Res 2018;167:632-8.
27. Langrish JP, Mills NL, Chan JK, et al. Beneficial cardiovascular effects of reducing exposure to particulate air pollution with a simple facemask. Part Fibre Toxicol 2009;6:8.
28. Shi J, Lin Z, Chen R, et al. Cardiovascular benefits of wearing particulate-filtering respirators: a randomized crossover trial. Environ Health Perspect 2017;125:175-80.
29. Langrish JP, Li X, Wang S, et al. Reducing personal exposure to particulate air pollution improves cardiovascular health in patients with coronary heart disease. Environ Health Perspect 2012;120:367-72.
30. Zhang Y, Chu M, Zhang J, et al. Urine metabolites associated with cardiovascular effects from exposure of size-fractioned particulate matter in a subway environment: a randomized crossover study. Environ Int 2019;130:104920.
31. Guo SE, Chi MC, Hwang SL, Lin CM, Lin YC. Effects of particulate matter education on self-care knowledge regarding air pollution, symptom changes, and indoor air quality among patients with chronic obstructive pulmonary disease. Int J Environ Res Public Health 2020;17:4103.
32. Jasemzadeh M, Khafaie MA, Jaafarzadeh N, Araban M. Effectiveness of a theory-based mobile phone text message intervention for improving protective behaviors of pregnant women against air pollution: a randomized controlled trial. Environ Sci Pollut Res Int 2018;25:6648-55.
33. Araban M, Tavafian SS, Zarandi SM, Hidarnia AR, Burri A, Montazeri A. A behavioral strategy to minimize air pollution exposure in pregnant women: a randomized controlled trial. Environ Health Prev Med 2017;22:26.
34. Strak M, Boogaard H, Meliefste K, et al. Respiratory health effects of ultrafine and fine particle exposure in cyclists. Occup Environ Med 2010;67:118-24.
35. Giles LV, Koehle MS. The health effects of exercising in air pollution. Sports Med 2014;44:223-49.
36. Kim SR, Choi S, Kim K, et al. Association of the combined effects of air pollution and changes in physical activity with cardiovascular disease in young adults. Eur Heart J 2021;42:2487-97.
37. Zhong J, Trevisi L, Urch B, et al. B-vitamin supplementation mitigates effects of fine particles on cardiac autonomic dysfunction and inflammation: a pilot human intervention trial. Sci Rep 2017;7:45322.
38. Barkhordari S, Mirmosayyeb O, Mansourian M, et al. Omega 3 supplementation can regulate inflammatory states in gas station workers: a double-blind placebo-controlled clinical trial. J Interferon Cytokine Res 2020;40:262-7.

# Trends in Intervention Research for Reducing Health Effects of Particulate Matter

Eunjin Kwon[1], Hwan-Cheol Kim[2], Young Youl Kim[1]*

[1]Division of Allergy and Respiratory Disease Research, Department of Chronic Disease Convergence, National Institute of Health, Cheongju, Korea
[2]Department of Occupational and Environmental Medicine, Inha University School of Medicine, Incheon, Korea

## ABSTRACT

Air pollution, especially particulate matter (PM), is one of the major public health risk factors. More than 91% of the global population lives in areas where air pollution exceeds the World Health Organization (WHO) recommended limits. WHO estimated that air pollution is responsible for approximately 4.2 million deaths every year. PM has serious effects on health outcomes (especially in respiratory and cardiovascular diseases and all-cause morbidity). However, there are few intervention studies on the reduction of PM-exposure related health effects. Currently, air purifiers, masks, behavior and other interventions, diet and medications are the recommended interventions for reducing the effect of PM on health; however, scientific evidence for the effects of these interventions are lacking. Here, we review the intervention studies on PM and aim to identify the recent research trends. Using air purifiers significantly lowered the concentration of PM, resulting in a decrease in inflammation and blood pressure. Similarly, wearing a mask showed changes in lung function and blood pressure; however, there was no remarkable changes in the effects on the cardiovascular system. Therefore, intervention studies are limited and more research is needed.

**Key words:** Particulate matter; Intervention study; Health effect

*Corresponding author: Young Youl Kim, Tel: +82-43-719-8450, E-mail: youngyk07@korea.kr

## Introduction

Particulate matter (PM) refers to particles with various sizes, compositions, and sources. Particles with a diameter of 10 μm or less and 2.5 μm or less are defined as $PM_{10}$ and $PM_{2.5}$, respectively. Inhalation of PM has adverse effects on the human body. Since the International Agency for Research on Cancer designated PM as a Group 1 carcinogen in 2013 [1], the environmental and public health importance of PM has increased. As of 2016, over 91% of the global population lived in areas where the air pollution levels exceeded the limits established by the World Health Organization (WHO), and the number of premature deaths caused by air pollutants, such as PM, was estimated to be 4.2 million [2].

PM can reportedly increase the risk of all-cause mortality, as well as that of respiratory and cardiovascular diseases [3-5].

**Key messages**

① What is known previously?

The effects of PM on health are well known. However, there are few intervention studies on the reduction of PM-exposure related health effects.

② What new information is presented?

Currently, air purifiers, masks, behavior and other interventions, diet, and medications are the recommended interventions for reducing the health effects of PM. Using air purifiers significantly lowered the concentration of PM, resulting in a decrease in inflammation and blood pressure. Similarly, wearing a mask showed changes in lung function and blood pressure; however, there was no significant change in the effects on the cardiovascular system.

③ What are implications?

Intervention studies are limited; therefore, more research is warranted.

Recently, PM has also been shown to be associated with neurodegenerative diseases, mental illness, and diabetes. The mechanisms by which PM affects human health include inflammation, generation of active oxygen species, endotoxin effects, and DNA damage [6,7].

Although some studies in the Republic of Korea have investigated the effects of PM on the progression of various diseases, the number of studies on this subject is inadequate compared to that in Western countries and China. In particular, the number of intervention studies to reduce the human health effects caused by PM exposure is insufficient. Measures such as limiting outdoor activities, wearing masks outdoors, and improving indoor air quality through the use of air purifiers are recommended to reduce the health effects of PM. The PM concentration can be reduced by intervention methods; however, their effects on human health remain controversial. In a domestic study in which air purifiers were used for children with asthma, the indoor PM concentration decreased, thereby reducing the peak expiratory flow [8]. In a study by Lim et al. [9] wearing a mask reduced PM exposure as well as the blood pressure among users. Nonetheless, in areas with high PM levels, there is no reliable scientific evidence supporting the efficacy of using air purifiers and wearing masks in preventing the exacerbation of symptoms in patients with asthma [10]. Previous domestic and international studies on intervention effects have mainly focused on air quality rather than on the corresponding health effects. Therefore, in this study, the interventions used for reducing the PM concentrations were examined based on relevant literature to identify the latest research trends in this field.

## Results

### 1. Domestic/international PM and Health Effects

In recent years, active efforts by the Korean government to reduce PM levels have led to a gradual improvement in the annual average PM concentrations; however, the perceived effect on public health remains insufficient. According to a report by the National Institute of Environmental Research, the annual average PM concentration in the Republic of Korea has steadily decreased since 2002 but is still more than twice as high as the level recommended by the WHO (10 $\mu g/m^3$) or those of other advanced countries (7.4 $\mu g/m^3$ in the United States and 11.9 $\mu g/m^3$ in Japan) [11]. In a meta-analysis, the effect of air pollution exposure on the hospitalization and mortality rates of patients with chronic obstructive pulmonary disease (COPD) was investigated [12]. Elevated concentrations of $PM_{10}$ and $PM_{2.5}$ have been shown to increase the hospitalization rate of

patients with COPD for respiratory-related issues. Particularly, the hospitalization and mortality rates of patients with COPD increased by 3.1% and 2.5%, respectively, as the $PM_{2.5}$ concentration increased by 10 μg/$m^3$ [13]. Moreover, the number of patients with acute lower respiratory tract infections increased by 15% to 32% from week 1 to week 4 when the daily average $PM_{2.5}$ concentration increased by 10 μg/$m^3$ [14]. Epidemiological studies have frequently reported a close and direct correlation between PM and cardiovascular diseases. Pope et al. [15] reported that a 10 μg/$m^3$ increase in the short-term $PM_{2.5}$ exposure increased the incidence of acute coronary syndrome by 4.5%. This indicates that even short-term changes in PM concentrations can increase the risk of certain diseases. In a meta-analysis, the systolic and diastolic blood pressures of the study subjects were observed to increase by 1.393 and 0.895 mmHg, respectively, when the $PM_{2.5}$ concentration increased by 10 μg/$m^3$, demonstrating the positive correlation between $PM_{2.5}$ and hypertension [16]. In addition, PM also disrupts the endocrine system, thereby affecting the incidence of metabolic diseases, such as obesity and diabetes [17-19]. A recent study reported that $PM_{2.5}$ also affects the incidence of neurological and mental diseases [20]. According to the results of a meta-analysis, long-term exposure of 1.2 million elderly participants aged ≥50 years to $PM_{2.5}$ increased the risk of dementia and Alzheimer's disease by three times (hazard ratio [HR] 3.26) and almost five times (HR 4.82) [20]. In addition, the risk of depression (odds ratio [OR] 1.19) and suicide (OR 1.05) increased when the $PM_{2.5}$ concentration increased by 10 μg/$m^3$; however, no correlation was found between the incidence of these diseases and $PM_{10}$ exposure [21]. PM also affects the risk of premature birth and low birth weight [22].

## 2. Domestic/international Trends in Intervention Research

### 1) Research method

The latest research trends and intervention methods used in intervention research related to PM were investigated through a non-systematic review. The MEDLINE, EMBASE, CINAHL, and Cochrane Library databases were searched for studies published from 1989 to 2020. Keywords such as "air pollution", "particulate matter", and "trial/intervention" and their combinations were used. If the information obtained using this search strategy was inadequate, a manual search process was employed to collect more information.

### 2) Research analysis

Two evaluators conducted the evaluation independently, and the agreement was subsequently examined. The selection criteria for the collected articles were the following: (1) studies that analyzed the changes in health indicators according to the short- and long-term exposure to PM; (2) studies written in English or Korean; (3) studies on humans; and (4) studies that compared the acute/chronic health effects of PM exposure before and after the implementation of the intervention methods. Conversely, the exclusion criteria were (1) papers in which research results were not reported and (2) studies that presented no intervention methods. The research targets are presented in the PICO (Patient, Intervention, Comparison, Outcome) format in Table 1.

#### (1) Status of individual-based intervention studies

① Air purifier

In the studies on children, the use of air purifiers considerably reduced the $PM_{2.5}$ concentration in their homes, increased

Table 1. Key questions in literature review

| Category | Detailed content |
|---|---|
| Patient | • Vulnerable population<br>– Patients with respiratory/cardiovascular diseases<br>– The elderly, children, and the poor<br>– Pregnant women<br>– Residents of areas with high PM concentrations<br>– Residents of areas with heavy traffic<br>– Residents of areas close to industrial complexes<br>– Occupational group exposed to high PM levels<br>• General population |
| Intervention | • Air purifier<br>• Mask<br>• Behavioral guidelines<br>• Diet and medications |
| Comparison | • PM exposure<br>• Before/after applying the intervention methods |
| Outcome | • General symptoms (e.g., itchy eyes, nose, and throat; cough; phlegm; chest tightness; and difficulty in breathing)<br>• Emergency room visit (e.g., asthma attack, acute bronchitis, respiratory infection, and arrhythmia)<br>• Outpatient visit rate<br>• Morbidity<br>• Mortality |

PM=particulate matter.

the peak expiratory flow, and decreased pulmonary inflammation [8,23,24]. In the studies on adults and elderly people, the use of air purifiers reduced the black carbon and $PM_{2.5}$ concentrations, decreasing the systolic and diastolic blood pressures of the subjects [25,26].

② Mask

Wearing a mask is recommended to reduce the exposure to air pollution; however, the number of studies on the efficacy of face masks for reducing the health effects of PM is insufficient. A study by Lim et al. [9] confirmed that the short-term use of masks improves lung function and decreases blood pressure. In studies on healthy adults, the group that wore masks exhibited a decreased blood pressure and an increased heart rate variability [27,28]. Wearing a mask also reduced the incidence of depression and the blood pressure and increased the heart rate variability in patients with coronary heart disease [29]. Conversely, wearing a mask while using the subway showed no clear impact on the cardiovascular system of individuals wearing mask [28,30].

③ Individual behavior and other interventions

Not many studies have evaluated the behavioral guidelines related to air pollution. A study involving a group of patients with COPD were educated on COPD self-management behavior demonstrated a decrease in the level of PM exposure and an improvement in some of their symptoms [31]. In addition, pregnant women who received educational text messages regarding air pollution levels, duration, and affected areas demonstrated considerable improvement in their awareness of the risks associated with PM, their preventive behavior, and self-efficacy [32,33]. Regular exercise prevents cardiovascular

diseases and low-intensity exercise reduces the burden of cardiopulmonary diseases; however, high-intensity exercise may increase the inhalation of pollutants [34-36]; therefore, the location and corresponding level of air pollution need to be considered beforehand.

④ Diet and medication interventions

Studies focusing on the effectiveness of diet and medications that can minimize the exposure to air pollutants and their adverse health effects are inadequate. A study reported that taking vitamin B for 4 weeks can alleviate the effects of the exposure to high PM concentrations on the cardiac autonomic nervous system functions (heart rate and heart rate variability) and inflammation in adults [37]. Another study reported that taking omega-3 resulted in an improvement in oxidative damage biomarkers in the blood [38].

(2) Status of the national/regional community-based intervention research

National and regional intervention policies have been implemented to reduce the generation of PM to prevent the associated adverse health effects. They include vehicle restrictions, fuel substitution policies for cars and buses, and industrial regulation policies to limit the pollution generated by factories. Policy intervention and regulations of emission sources can effectively reduce the PM concentrations and the associated adverse health effects.

## Conclusion

Several international studies have investigated the health effects of PM on individuals who are sensitive and vulnerable to its exposure. In contrast, research on this topic in the Republic of Korea has been relatively limited. Therefore, more comprehensive research is warranted for various populations that are sensitive and vulnerable to PM exposure. Due to limited intervention studies on reducing the health effects of PM in the Republic of Korea and other countries, there is a lack of scientific evidence supporting countermeasures that individuals can implement in their daily lives. Currently, various intervention methods, such as air purifiers, masks, certain behaviors and other interventions, and diet and medications can be used to reduce the effects of PM on human health. However, it is imperative to conduct research on the health effects of the combined application of various intervention methods, as well as the effects of individual intervention methods. In this study, the trends in intervention research to minimize the health effects of PM were examined. The findings of this study will contribute to the development of new intervention methods and the establishment of a foundation for increasing public awareness of the health risks associated with PM.

## Declarations

**Ethics Statement:** Not applicable.

**Funding Source:** We have summarized the some results of research conducted through the 'Research planning and pilot study of intervention study on health effects of fine particulate matter'(2021-ER1211-00).

**Acknowledgments:** None.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

**Author Contributions:** Conceptualization: EK. Data curation: HCK. Formal analysis: HCK. Resources: HCK. Supervision: YYK. Writing – original draft: EK. Writing

– review & editing: EK, YYK.

## References

1. Loomis D, Grosse Y, Lauby-Secretan B, et al. The carcinogenicity of outdoor air pollution. Lancet Oncol 2013;14:1262-3.
2. WHO. Factsheet: ambient (outdoor) air pollution [Internet]. WHO; 2022 [cited 2022 Dec 19]. Available from: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
3. Thurston GD, Kipen H, Annesi-Maesano I, et al. A joint ERS/ATS policy statement: what constitutes an adverse health effect of air pollution? An analytical framework. Eur Respir J 2017;49:1600419.
4. Du Y, Xu X, Chu M, Guo Y, Wang J. Air particulate matter and cardiovascular disease: the epidemiological, biomedical and clinical evidence. J Thorac Dis 2016;8:E8-19.
5. Brook RD, Rajagopalan S, Pope CA 3rd, et al. Particulate matter air pollution and cardiovascular disease: an update to the scientific statement from the American Heart Association. Circulation 2010;121:2331-78.
6. Gan WQ, FitzGerald JM, Carlsten C, Sadatsafavi M, Brauer M. Associations of ambient air pollution with chronic obstructive pulmonary disease hospitalization and mortality. Am J Respir Crit Care Med 2013;187:721-7.
7. Lawal AO. Air particulate matter induced oxidative stress and inflammation in cardiovascular disease and atherosclerosis: the role of Nrf2 and AhR-mediated pathways. Toxicol Lett 2017;270:88-95.
8. Kim S, Lee J, Park S, et al. Association between peak expiratory flow rate and exposure level to indoor PM2.5 in asthmatic children, using data from the escort intervention study. Int J Environ Res Public Health 2020;17:7667.
9. Lim YH, Kim W, Choi Y, et al. Effects of particulate respirator use on cardiopulmonary function in elderly women: a quasi-experimental study. J Korean Med Sci 2020;35:e64.
10. Yang HJ, Kim SH, Jang AS, et al. Guideline for the prevention and management of particulate matter/yellow dust-induced adverse health effects on the patients with bronchial asthma. J Korean Med Assoc 2015;58:1034-43.
11. Joo HS, Shin DW, Choi KC, et al. Study on integrated management strategies for PM(particulate matter). KEI; 2018.
12. Moore E, Chatzidiakou L, Kuku MO, et al. Global associations between air pollutants and chronic obstructive pulmonary disease hospitalizations. A systematic review. Ann Am Thorac Soc 2016;13:1814-27.
13. Li MH, Fan LC, Mao B, et al. Short-term exposure to ambient fine particulate matter increases hospitalizations and mortality in COPD: a systematic review and meta-analysis. Chest 2016;149:447-58.
14. Horne BD, Joy EA, Hofmann MG, et al. Short-term elevation of fine particulate matter air pollution and acute lower respiratory infection. Am J Respir Crit Care Med 2018;198:759-66.
15. Pope CA 3rd, Muhlestein JB, May HT, Renlund DG, Anderson JL, Horne BD. Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. Circulation 2006;114:2443-8.
16. Liang R, Zhang B, Zhao X, Ruan Y, Lian H, Fan Z. Effect of exposure to PM2.5 on blood pressure: a systematic review and meta-analysis. J Hypertens 2014;32:2130-40; discussion 2141.
17. Coogan PF, White LF, Jerrett M, et al. Air pollution and incidence of hypertension and diabetes mellitus in black women living in Los Angeles. Circulation 2012;125:767-72.
18. Dubowsky SD, Suh H, Schwartz J, Coull BA, Gold DR. Diabetes, obesity, and hypertension may enhance associations between air pollution and markers of systemic inflammation. Environ Health Perspect 2006;114:992-8.
19. Rajagopalan S, Brook RD. Air pollution and type 2 diabetes: mechanistic insights. Diabetes 2012;61:3037-45.
20. Fu P, Guo X, Cheung FMH, Yung KKL. The association between PM2.5 exposure and neurological disorders: a systematic review and meta-analysis. Sci Total Environ 2019;655:1240-8.
21. Khreis H, Bredell C, Fung KW, et al. Impact of long-term air pollution exposure on incidence of neurodegenerative diseases: a protocol for a systematic review and exposure-response meta-analysis. Environ Int 2022;170:107596.
22. Qian Z, Liang S, Yang S, et al. Ambient air pollution and preterm birth: a prospective birth cohort study in Wuhan, China. Int J Hyg Environ Health 2016;219:195-203.
23. Barkjohn KK, Norris C, Cui X, et al. Real-time measurements of PM2.5 and ozone to assess the effectiveness of residential indoor air filtration in Shanghai homes. Indoor Air 2021;31:74-87.

24. Cui X, Li Z, Teng Y, et al. Association between bedroom particulate matter filtration and changes in airway pathophysiology in children with asthma. JAMA Pediatr 2020;174:533-42.
25. Morishita M, Adar SD, D'Souza J, et al. Effect of portable air filtration systems on personal exposure to fine particulate matter and blood pressure among residents in a low-income senior facility: a randomized clinical trial. JAMA Intern Med 2018;178:1350-7.
26. Liu S, Chen J, Zhao Q, et al. Cardiovascular benefits of short-term indoor air filtration intervention in elderly living in Beijing: an extended analysis of BIAPSY study. Environ Res 2018;167:632-8.
27. Langrish JP, Mills NL, Chan JK, et al. Beneficial cardiovascular effects of reducing exposure to particulate air pollution with a simple facemask. Part Fibre Toxicol 2009;6:8.
28. Shi J, Lin Z, Chen R, et al. Cardiovascular benefits of wearing particulate-filtering respirators: a randomized crossover trial. Environ Health Perspect 2017;125:175-80.
29. Langrish JP, Li X, Wang S, et al. Reducing personal exposure to particulate air pollution improves cardiovascular health in patients with coronary heart disease. Environ Health Perspect 2012;120:367-72.
30. Zhang Y, Chu M, Zhang J, et al. Urine metabolites associated with cardiovascular effects from exposure of size-fractioned particulate matter in a subway environment: a randomized crossover study. Environ Int 2019;130:104920.
31. Guo SE, Chi MC, Hwang SL, Lin CM, Lin YC. Effects of particulate matter education on self-care knowledge regarding air pollution, symptom changes, and indoor air quality among patients with chronic obstructive pulmonary disease. Int J Environ Res Public Health 2020;17:4103.
32. Jasemzadeh M, Khafaie MA, Jaafarzadeh N, Araban M. Effectiveness of a theory-based mobile phone text message intervention for improving protective behaviors of pregnant women against air pollution: a randomized controlled trial. Environ Sci Pollut Res Int 2018;25:6648-55.
33. Araban M, Tavafian SS, Zarandi SM, Hidarnia AR, Burri A, Montazeri A. A behavioral strategy to minimize air pollution exposure in pregnant women: a randomized controlled trial. Environ Health Prev Med 2017;22:26.
34. Strak M, Boogaard H, Meliefste K, et al. Respiratory health effects of ultrafine and fine particle exposure in cyclists. Occup Environ Med 2010;67:118-24.
35. Giles LV, Koehle MS. The health effects of exercising in air pollution. Sports Med 2014;44:223-49.
36. Kim SR, Choi S, Kim K, et al. Association of the combined effects of air pollution and changes in physical activity with cardiovascular disease in young adults. Eur Heart J 2021;42:2487-97.
37. Zhong J, Trevisi L, Urch B, et al. B-vitamin supplementation mitigates effects of fine particles on cardiac autonomic dysfunction and inflammation: a pilot human intervention trial. Sci Rep 2017;7:45322.
38. Barkhordari S, Mirmosayyeb O, Mansourian M, et al. Omega 3 supplementation can regulate inflammatory states in gas station workers: a double-blind placebo-controlled clinical trial. J Interferon Cytokine Res 2020;40:262-7.

질병 통계
eISSN 2586-0860
https://doi.org/10.56786/PHWR.2023.16.21.3

PHWR
Public Health Weekly Report

# 익수사고 발생현황, 2017–2021년

## 1. 성·연령별 발생 현황

응급실손상환자심층조사(23개 참여병원에서 실시)에 의하면 2017년부터 2021년까지 불의의 익수사고로 인해 응급실에 내원한 환자 수는 746명이었으며, 남자가 531명(71.2%), 여자가 215명(28.8%)이었다(그림 1). 연령별로는 9세 이하에서 발생빈도가 가장 높았고(전체 환자의 29.5%), 50대 이후 증가하였다. 익수사고 환자 중 19.6%가 사망하며, 70세 이상 사망분율이 36.2%로 가장 높았다.

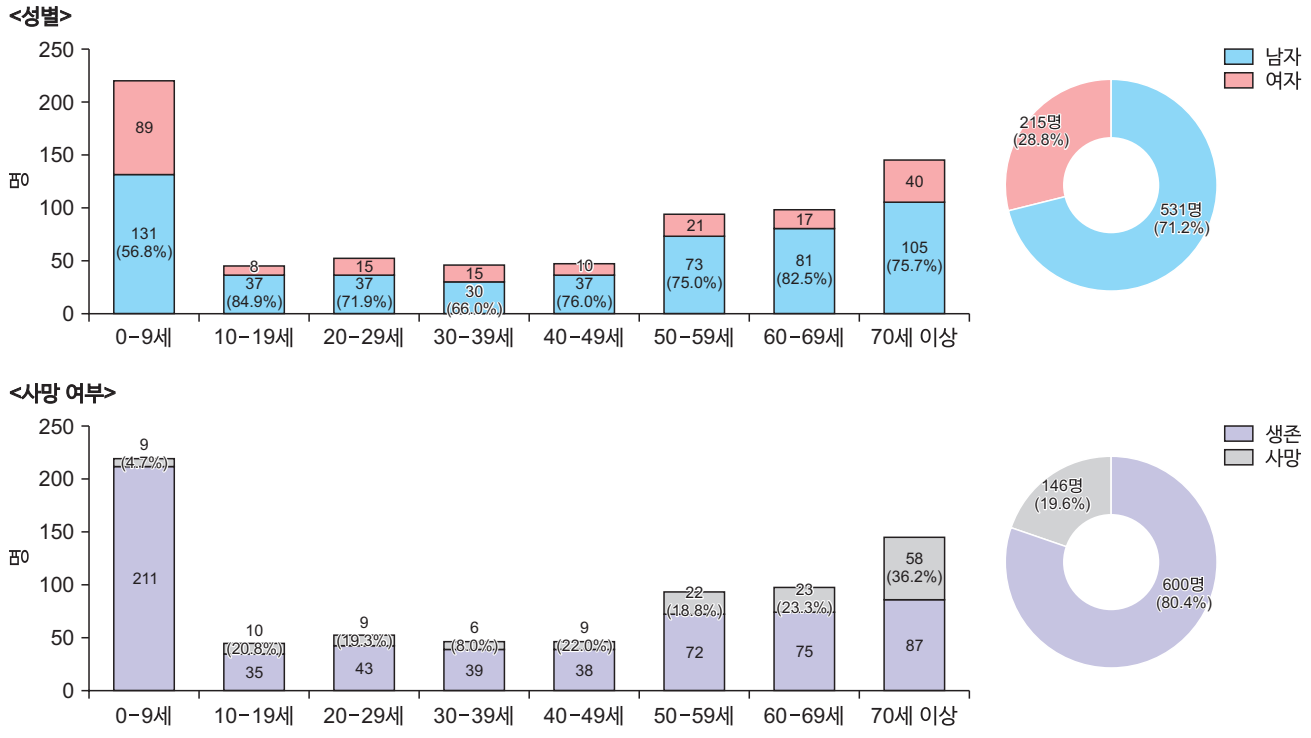


**그림 1.** 연령별 익수사고로 인한 응급실 내원 환자 수(2017–2021년 자료 통합분석)

*자료원 : 응급실손상환자심층조사 2017–2021년

*분석대상 : 불의의 사고로 인한 익수사고만 포함, 자해·자살·폭력·타살 등 제외

*자료이용 시 주의: 응급실손상환자심층조사는 23개의 참여병원에서만 수행 중이므로 제시된 값이 우리나라 전체 익수사고 발생건수를 반영하는 것은 아님



KDCA
Korea Disease Control and Prevention Agency

## 2. 발생 장소 및 시기

익수사고는 바다, 강을 포함한 야외에서 발생한 경우가 52.0%로 가장 많았고, 7, 8월에 많이 발생하였다(그림 2).

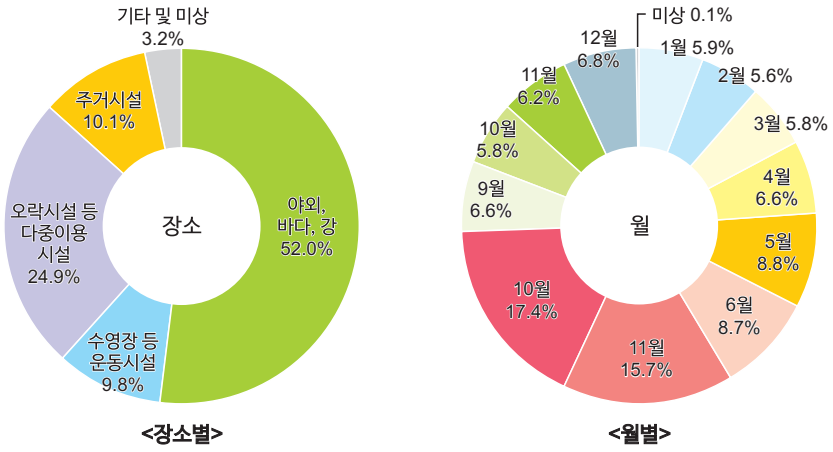


**그림 2.** 익수사고 발생 장소 및 시기(2017–2021년 자료 통합분석)

*자료원 : 응급실손상환자심층조사 2017–2021년

*분석대상 : 불의의 사고로 인한 익수사고만 포함, 자해·자살·폭력·타살 등 제외

*자료이용 시 주의: 응급실손상환자심층조사는 23개의 참여병원에서만 수행 중이므로 제시된 값이 우리나라 전체 익수사고 발생건수를 반영하는 것은 아님

[참고] 응급실손상환자심층조사

◦2006년에 도입하여 2023년 현재 23개 병원에서 응급실 내원 손상환자 대상 조사 실시

◦손상 발생 기전, 사고 시 활동 · 장소, 치료 내용 및 결과 등을 조사하여 손상예방관리 방안 개발에 필요한 통계 제공

**작성부서:** 질병관리청 건강위해대응관 손상예방관리과

QuickStats

# Occurrence of Drowning Accidents

## 1. Occurrence of drowning accidents by gender and age group

From 2017 to 2021, a total of 746 patients (531 men and 215 women) visited the emergency room of 23 participating hospitals, which joined the Emergency Department In-depth Injury Survey, due to drowning accidents (Figure 1). By age group, the occurrence of drowning was more frequent in children aged <9 years (29.5% of total cases), and increased after the age of 50s. The proportion of death was 19.6%, and that of the ≥70-year-old age group was 36.2%.

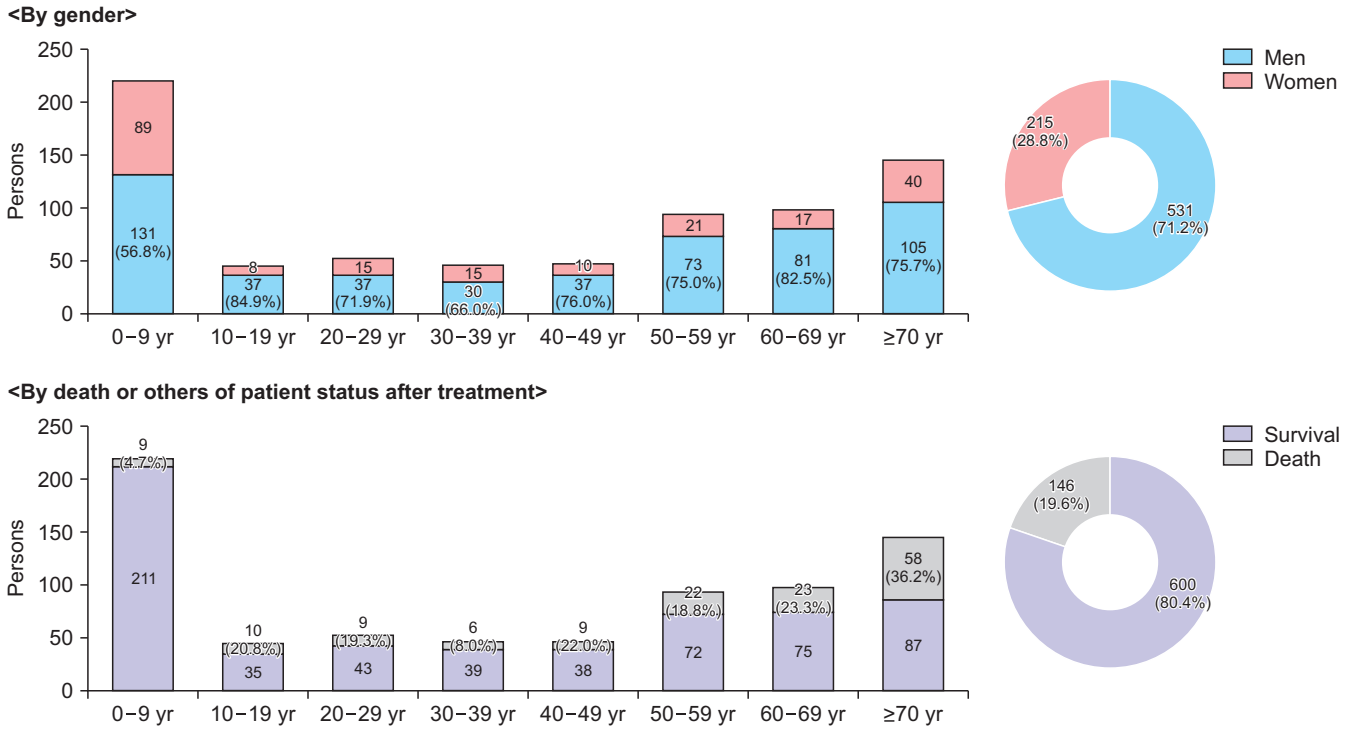


Figure 1. Occurrences of drowning accidents by age group in the Emergency Department In-depth Injury Survey, 2017–2021

*Source: Emergency Department In-depth Injury Survey, from 2017 to 2021

*Subjects: Patients induced by drowning accidents except those involving situations such as self-harm, suicide, violence, homicide, etc.

*Attention: Emergency Department In-depth Injury Survey has been conducted in the emergency departments of 23 institutions, the data of which could not represent the nation-wide occurrences.

## 2. Occurrence of drowning accidents by place and time

Drowning accidents primarily occurred outdoors, including in seas and rivers (52.0%), and highly occurred in July and August (Figure 2).

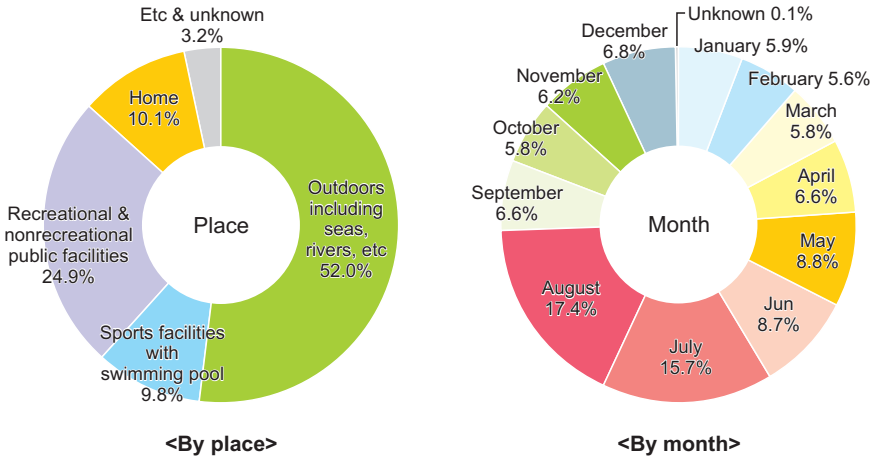


**Figure 2.** Occurrences of drowning accidents by place and month in the Emergency Department In-depth Injury Survey, 2017–2021

*Source: Emergency Department In-depth Injury Survey, from 2017 to 2021

*Subjects: Patients induced by drowning accidents except those involving situations such as self-harm, suicide, violence, homicide, etc.

*Attention: Emergency Department In-depth Injury Survey has been conducted in the emergency departments of 23 institutions, the data of which could not represent the nation-wide occurrences.

[Reference] Emergency Department In-depth Injury Survey (EDIIS)

- EDIIS was introduced for 5 hospitals in 2006, which has been conducted in the emergency departments of 23 institutions since 2015.
- EDIIS has produced statistics, such as those of injury occurrence mechanism, general characteristics of accidents, and status of patients to provide evidence supporting injury prevention and control.

**Reported by:** Division of Injury Prevention and Control, Director General for Health Hazard Response, Korea Disease Control and Prevention Agency