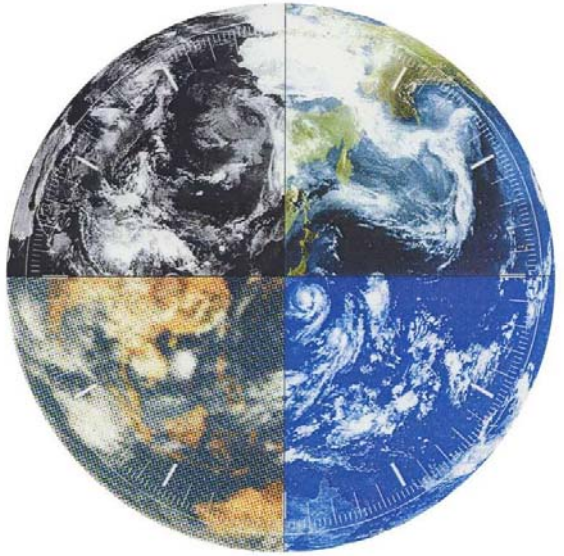
JCAP II
JAPAN CLEAN AIR PROGRAM

Further Challenges in
Automobile and Fuel Technologies
for Better Air Quality

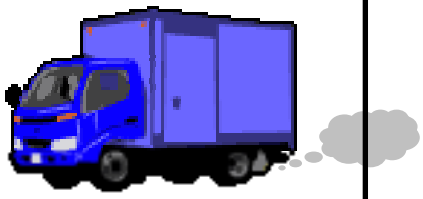
5th JCAP Conference

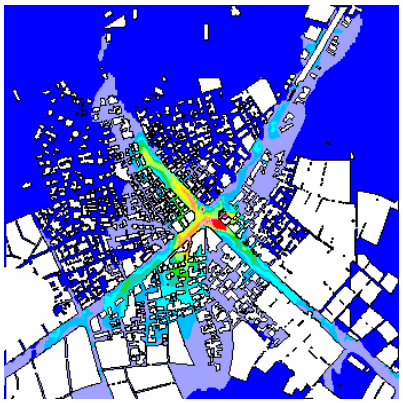
Health Effects Study WG Report

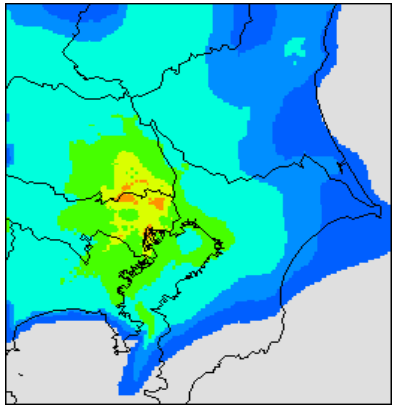
February 22, 2007



Roles of Air Quality Planning, Unregulated Material and Health Effects Study WGs







Engine exhaust → **Roadside**

Urban area

PM (incl. fine particles)

Unregulated Materials

SPM (incl. Fine particles)

NOx

SPM

NOx, VOC, CO etc.

(Incl. photochemical reactions)

Human Health Effects of Fine Particles

Unregulated Material WG

Air Quality Model Planning WG (Air Quality Model Study Group)

Health Effects Study WG

Roles and Tasks of Health Effects Study WG

[Roles]

Illuminate the necessity and importance of JCAP II fine particle study (incl. UFP) from the viewpoint of health effects

Established in FY 2004, 3rd year of JCAP II

[Tasks]

Study domestic and international research trends on fine particles (incl. UFP), collect and analyze the latest findings

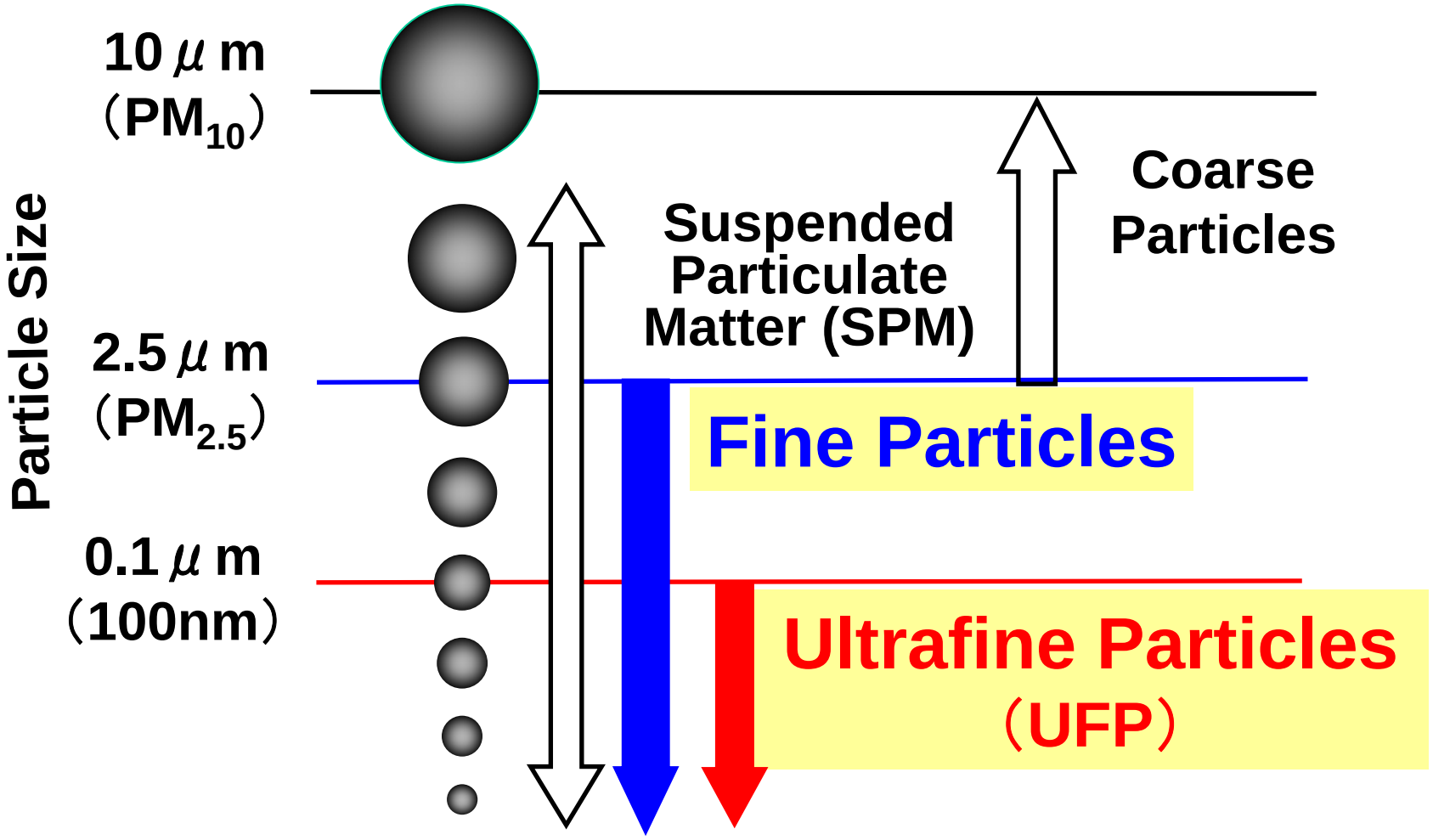
↓

Examine relationship with UFPs in auto emissions

Contents

- **Prior to Reporting Research Results**
  - What are fine particles?
  - Research trends on fine particles
- **Research Method**
  - Point, Method and Flow
- **Research Results**
  - Results focused on endpoint
  - Results focused on UFP concentrations
- **Summary**

What are fine particles?



Trend of Fine Particle Research

（Refer to the site of National Institute for Environmental Studies）

	Trend
USA	Air quality standards for PM2.5 were established based on epidemiological study results by Harvard University. In subsequent researches, possibility of health effects incl. effects on cardiac function, autonomic nervous system and blood clotting which facilitates thrombus formation has been reported. Recently, health effects of ultrafine particles are reported.
EU	Vigorous studies on $PM_{2.5}$ and Diesel particulates are being pursued under the leadership of Germany, the Netherlands, France and the UK.
Japan	Carcinogenic experiment using rats has been conducted at JARI as a part of inhalation exposure research of diesel exhaust (1982~). For health effects on PM2.5 in the ambient air, animal exposure research has been made, and effect analysis of disease model animals in respiratory and cardiovascular systems has been made. At NIES, an exposure system to analyze health effects of nanoparticles was developed, and the world's first research on health effects of nanoparticles in auto emissions has been initiated. (Full scale exposure test was started in 2005)

JARI: Japan Automobile Research Institute

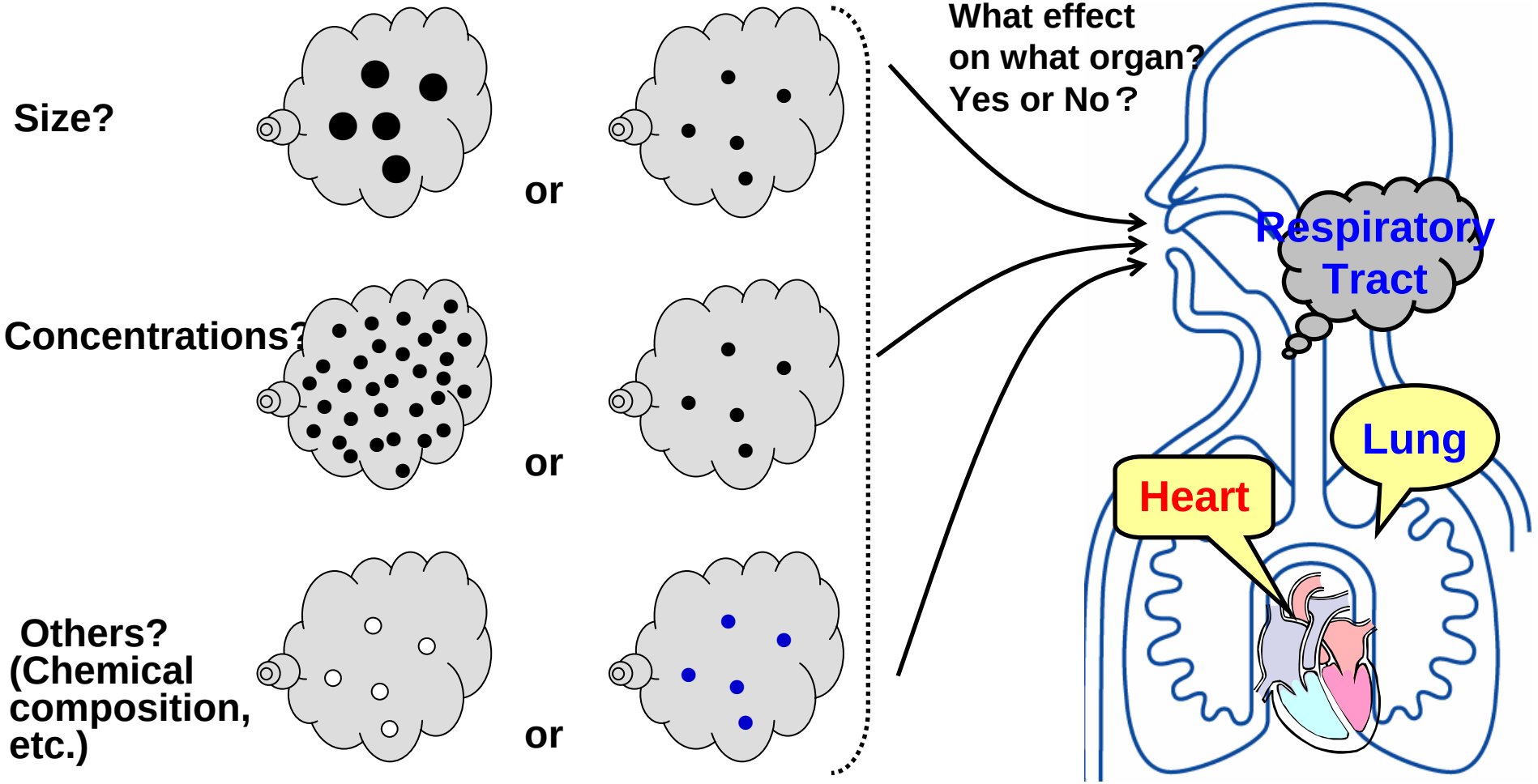
NIES: National Institute for Environmental Studies

Contents

- **Prior to Reporting Research Results**
  - What are fine particles?
  - Research trends of fine particles
- **Research Method**
  - Point, Method and Flow
- **Research Results**
  - Results focused on endpoint
  - Results focused on UFP concentrations
- **Summary**

Points of the Research

What properties (size, concentrations, etc.) of FP (especially UFP) in auto emissions have health effects? What type of health effects are caused by FP? What human organs (lungs, heart, etc.) are affected by FP?



Research Method

- Conduct literature researches through database retrieval
- Conduct researches of the latest research trends through participation in various academic conferences and visits to research institutes

Literature researches ・・・Total number of literatures: 240

- US.EPA：Air Quality Criteria for Particulate Matter. October 2004
- Pub Med Database (http://www.ncbi.nlm.nih.gov)
- Particulate Matter Research Activity Database (http://www.pmra.org/)
- EU：AIRNET (http://airnet.iras.uu.nl/)

Information acquisition from various academic conferences and research institutes

- Japan Society for Atmospheric Environment（Nagoya: Sep. 7-9, 2005; Tokyo: Sep. 20-22, 2006)
- Mechanisms of Action of Inhaled Fibers, Particles, and Nanoparticles in Lung and Cardiovascular Disease（US EPA: October 25-28, 2005）
- 10th International Inhalation Symposium (Hanover: May 30- June 4, 2006）

Research Flow

Health effects of fine particles → **Health effects of ultrafine particles** (Result organized by endpoint) → **Health effects of ultrafine particles** (Result organized by particle number concentration)

	FY 2004	FY 2005	FY 2006
Purpose	・Research health effects of fine particles based on EPA documents ・Grasp key points of UFP researches	・Conduct health effects survey focusing on UFP ・Sort out relationship of factors by endpoint and research method	・Attempt to wrap up research results in terms of UFP number concentrations ・Scrutinize relationship level of effect factors
Overview	・Acquire and organize information relating to health effects and chemical composition of PM（up to PM_{10})	・Compile domestic and international research trends	・Conduct final wrap-up including wrap-up of UFP number concentrations
Major activities	・Review of EPA criteria documents ・Visit to exposure facility of JARI ・Lecture on “Air quality standard for PM”	・Establish an advisory committee, receive advices from outside experts ・Acquire Information from literatures and academic conferences ・Acquire information through overseas researches	・Conduct research to obtain the latest information ・Analyze and assess research results in terms of UFP number concentrations ・Conduct final wrap-up

Contents

- **Prior to Reporting Research Results**
  - What are fine particles?
  - Research trends of fine particles
- **Research Method**
  - Point, Method and Flow
- **Research Results**
  - Results focused on endpoint
  - Results focused on UFP concentrations
- **Summary**

Results Focused on Endpoint - 1

Health Effect Endpoint of Ultrafine Particles (Assessment indicator of health effects)

	Endpoint
Respiratory system	Compromised pulmonary function, lung injury, exacerbation of respiratory symptoms (cough, sputum, shortness of breath, etc.), effects on mortality
Cardiovascular system	Inflammation･blood coagulation, abnormal ECG (heart rate variability, myocardial ischemia, etc.), blood pressure abnormality, hospitalization due to heart disease, effects on mortality
Reproduction & development	Low birth weight, premature birth, intrauterine fetal growth retardation
Cranial nerve system	Effects on brain tissue
Carcinogenicity	Gene damage

Results Focused on Endpoint - 2

	Research Method
Epidemiologic research	Research to elucidate the causal agents of disease of human populations by investigating the statistical associations between health outcome and exposure to potential causal agents
Human exposure study	Research to study the effects of pollutants on human subjects by examining the short-term effects, causality and mechanisms observed in the epidemiological and animal studies in human subjects directly exposed to the pollutants
Animal experiment	Research to examine effects, disposition and mechanisms of pollutants by exposing animals to the pollutants

Results Focused on Endpoint - 3

— Summary —

- There was no direct research on human health effects of ultrafine particles in auto emissions
- Therefore, we examined the literatures on ultrafine particles in the ambient air (incl. UFP from non-auto sources such as stationary sources) and simulated ultrafine particles
- We considered the results of the epidemiological research most important. The majority of such researches were assessing short-term effects on sensitive groups

Results Focused on Endpoint - 4

Some epidemiological literatures show the presence of effects on respiratory and cardiovascular systems

Number of literatures Total: 240 Applicable: 52	Epidemiological research*		Human exposure		Animal experiment	
	Presence of association	Absence of association	Presence of effects	Absence of effects	Presence of effects	Absence of effects
Respiratory system	5	4	1	2	14	0
Cardiovascular system	9	3	2	1	7	1
Cranial nerve system	0	0	0	0	0	0
Reproduction & development	0	0	0	0	1	0
Carcinogenicity	2	0	0	0	0	0

*** The majority of the literatures covers short-term effects on sensitive groups**

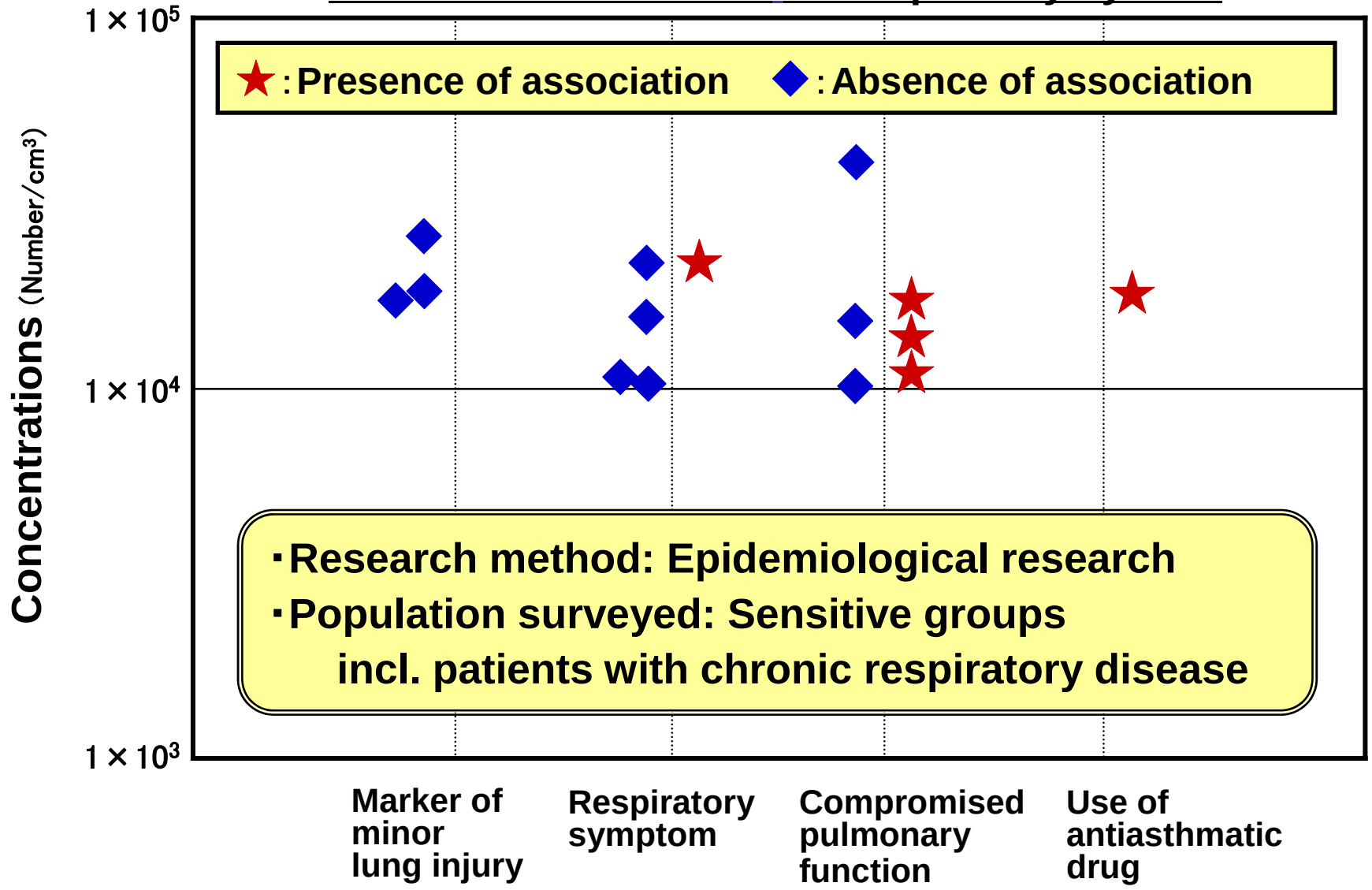
Results Focused on UFP Concentrations

- Relationship study between concentrations and effects (endpoints) -

In the results focused on endpoints, some epidemiological literatures described the presence of association between UFP exposure and respiratory and cardiovascular systems. Therefore relationships of such effects and UFP concentrations were analyzed.

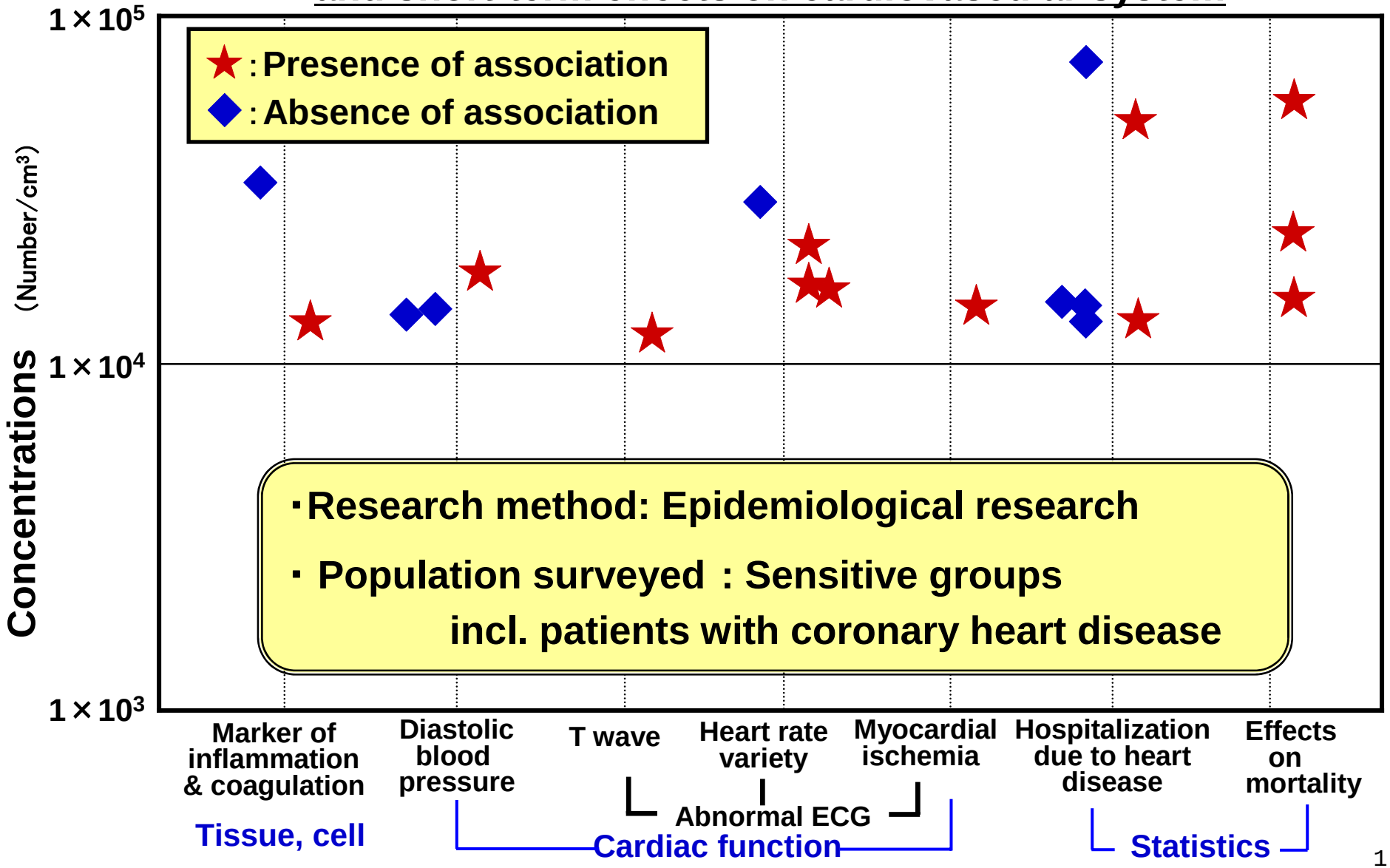
Results Focused on UFP Concentrations - Result 1

Relationship between particle number concentrations and short-term effects on respiratory system



Results Focused on UFP concentrations of - Result 2

Relationship between particle number concentrations and short-term effects on cardiovascular system



Results Focused on UFP concentrations
- Important points -

- **In epidemiological research, populations are exposed to the whole ambient air incl. UFP, fine and coarse particles. Research to expose solely to UFP cannot be conducted.**

- **UFP in the ambient air are from various emission sources such as stationary sources, mobile sources incl. motor vehicles and other sources, their contribution ratio varies by area.**

Results Focused on UFP concentrations
- Discussion -

- **Although an analysis of relationships between particle number concentrations and endpoints was attempted in epidemiological researches, there was no relationship found.**

  “Absence of association” was observed in some cases of exposure to high concentrations, while “presence of association” was observed in some cases of exposure to low concentrations.

- **Limited epidemiological researches focused on UFP, and very little research addressed chemical component of UFP, consideration of parameters other than particle number concentrations was difficult to conduct.**

Contents

- **Prior to Reporting Research Results**
  - What are fine particles?
  - Research trends on fine particles
- **Research Method**
  - Point, Method and Flow
- **Research Results**
  - Results focused on endpoint
  - Results focused on UFP concentrations
- **Summary**

Summary

Following results were obtained.

【Results Focused on Endpoint】

- **No research report was found using PMs in auto emissions strictly in UFP size range.**
- **Therefore, research reports about UFP in the ambient air and simulated UFPs were examined.**
  - **When research reports were anallyzed according to the method and endpoint, most of the reports were on respiratory or cardiovascular systems.**
  - **Most of epidemiological researches were conducted for sensitive groups and covering short-term effects of UFPs.**
  - **Although epidemiological studies focusing on UFPs has a short history and the number of reports was limited, some reports suggested the "presence of association" of UFP on cardiovascular system .**

【Results Focused on UFP concentrations】

- **Attempted analysis of relationship between particle number concentrations and endpoints revealed no relationship in epidemiological research reports on respiratory and cardiovascular systems.**

Future Highlight

Research covering the following unresolved or poorly resolved issues are expected.

- **Research on direct health effects of UFPs in auto emissions**
- **Research to show coherence in health effects of UFPs among epidemiological research, human exposure testing and animal experiment**
- **Research on chemical components of UFPs and their effects**
- **Elucidation of possible translocations of UFPs and mechanisms of the effects**
- **Research on effects of long-term exposure**
- **Effects on normal subjects**
- **Research focusing on relationship between short-term variability of particle number concentrations and health effects**
- **Establishment of standard measurement method of UFPs in epidemiological researches**