

# Environmental and Occupational Epidemiology, Exposure Assessment, Environmental Psychology

- As Environmental Health I (3) on 13 May 2026
- Chapter 4, 8 and 9 in the Frumkin's textbook 3<sup>rd</sup> Ed.
- Key Concepts
  - Epidemiology: study of distribution and determinants of health and disease in human populations (incl. causal inference)
  - Environmental/Occupational epidemiology studies the role of exposures in the general environment/workplace by common methods
  - Epidemiological data complement other data (incl. toxicological data)
  - Optimal study design depends mainly on population's feature, exposure, and disease
  - Strength of conclusion is based on large sample size, accurate and precise measurement of exposure and disease
  - Avoiding bias (selection bias, information bias, and confounding) is important for valid causal inference
  - Necessary for risk assessment, determination of criteria/standard, policy-making

# An introduction to epidemiology

- Epidemiology pursues causal inference on exposure and disease: philosophical framework was given by Karl Popper's "Conjectures and Refutations" (Popper, 1963)
  - All hypotheses are tentative and may be disproved by further testing
  - A hypothesis has a greater scientific value when it has more possibility (test methods) of disproof
  - (ref.) Rothman KJ (2024) Epidemiology: An Introduction 3<sup>rd</sup> ed. Oxford Univ. Press – If you like to learn epidemiology, I recommend you to read this or WHO's free textbook of "Basic Epidemiology" (<https://apps.who.int/iris/handle/10665/43541>).
- Hill's checklist of causation (Hill, 1965) contains ...
  - Temporal relationship (absolutely required!): Exposure must precede disease
  - Consistency: The association is repeatedly observed in many studies
  - Large effect size: The exposed have much more disease than nonexposed
  - Positive dose-response: More exposure causes more disease
  - Biological plausibility: Some biological explanation makes it reasonable that A (exposure) causes B (disease)
  - (ref.) Rothman KJ & Greenland S <https://www.rtihs.org/sites/default/files/26902%20Rothman%201998%20The%20encyclopedia%20of%20biostatistics.pdf>

# Types of epidemiological studies

- Descriptive studies
- Analytical studies for aggregated data
  - Ecological studies (correlation studies in group level) → making hypothesis
  - Meta-analysis → Assuming common tendency/mechanism for all population, generates strong evidence
- Analytical studies for individual level data
  - Clinical trials (typical intervention studies)
  - Observational studies
    - Natural experiments: eg. John Snow's comparison of cholera deaths between water-supply companies
    - Cohort studies: Comparison of disease occurrence between exposed cohort and nonexposed cohort, using Incidence Rate Ratios, Incidence Rate Differences, Risk Ratios, Risk Differences
    - Case-control studies: Comparison of past exposures between cases and controls, using Odds Ratios, special attention must be paid for recall bias
    - Cross-sectional studies: Studies of relationship between exposed status and disease status at same time data, using Odds Ratio

# Types of bias

- Selection bias: the relationship between exposure and disease in the study population doesn't represent that in general population
  - Self-selection bias of the volunteer
    - eg. ethylene oxide → breast cancer ?: If response was obtained from only 20% of the study population, the subjects who feel anxiety about breast cancer respond more, then the effect is overestimated
  - Healthy worker effect
    - Workers tend to be healthier than the general population because the general population include originally unhealthy people who cannot work. But it doesn't mean that working make the people healthy.
- Information bias
  - Mismeasurement / misclassification: Whether differential or nondifferential is important
  - Recall bias
- Confounding: relating with both exposure and disease, and not the result of exposure
  - Controllable by stratified analysis, restriction, and multivariate analysis

# Types of data analyses

- For category variables (esp. dichotomous variables)
  - Rate Ratios, Odds Ratios with confidence intervals: For relative levels of the effects
  - Rate Differences with confidence intervals: For absolute levels of the effects
  - Fisher's exact test - calculating p-values (probability of getting the actual data under the null-hypothesis of independence): Larger sample size improves statistical power and enables normal approximation using chi-square test. For small sample or rare event, Fisher's exact test is necessary to test the independence between 2 categorical variables.
- For continuous variables
  - Typically regression analysis (for exposure and disease) or analysis of variance
    - linear regression model
    - logistic regression model
    - poisson regression model
    - multilevel model (mixed model)
    - One-way ANOVA
    - Multi-way ANOVA
    - etc.

# Environmental epidemiology

- Environmental agents, large number of people are exposed involuntarily (vs. individual voluntary exposure to tobacco, alcohol)
- Both possibility to cause epidemics and endemic diseases
  - Neuropathy outbreak in Madrid in 1981 ← Oil contaminant
    - McMurray and Rice, Nature, 1981 (<https://doi.org/10.1038/293332c0>)
    - Case-control study, de la Paz et al., 1999 (<https://www.jstor.org/stable/3702474>)
  - Gastrointestinal illness outbreak in Milwaukee in 1993 ← Drinking water contamination by cryptosporidium
    - MacKenzie et al., NEJM, 1994 (<https://doi.org/10.1056/NEJM199407213310304>)
    - <https://www.youtube.com/watch?v=1yyXHqkl9bc>
  - Endemic diseases are caused by constant, low level exposure
    - Possible contribution of radon gas in homes to lung cancer
    - Dioxin in the diet contributing to cancer rates
    - Environmental lead exposure to children causes neurological deficits
  - Relationship between environmental agents and background levels of disease in developed countries is a kind of endemic diseases' study (becoming a large study focus, but difficult to detect such associations)

# Lead poisoning by polluted drinking water in Flint City, Michigan, USA

## Source:

<https://pubs.acs.org/doi/ipdf/10.1021/acs.estlett.7b00226>

<https://www.pbs.org/newshour/science/study-confirms-lead-got-flints-water>

<https://edition.cnn.com/2016/03/04/us/flint-water-crisis-fast-facts/>

[https://cdn.knightlab.com/libs/timeline3/latest/embed/index.html?source=1qIKcxYQhkjwsuCFQ5uQ0y7\\_GEQ3pNyGeCm5ooBqFhDA](https://cdn.knightlab.com/libs/timeline3/latest/embed/index.html?source=1qIKcxYQhkjwsuCFQ5uQ0y7_GEQ3pNyGeCm5ooBqFhDA) (see, below timeline)

<https://www.epa.gov/flint>

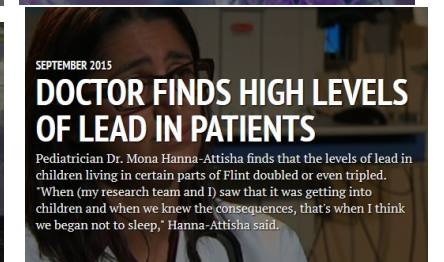
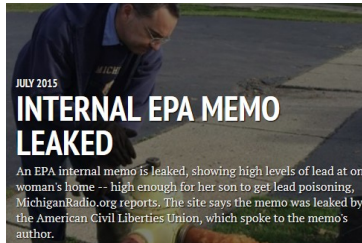
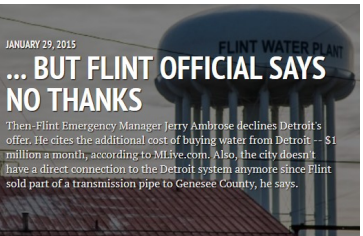
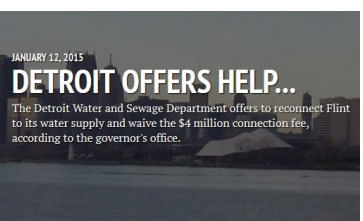
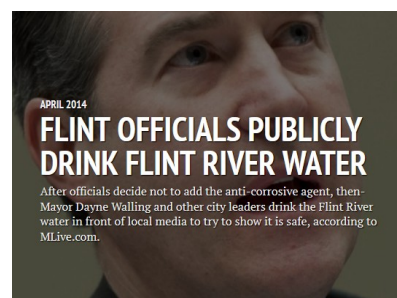
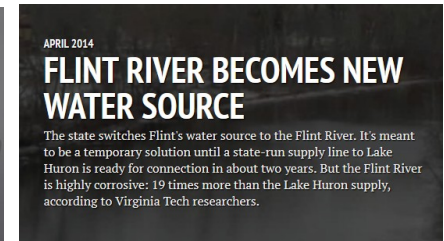
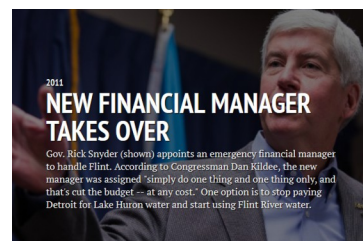
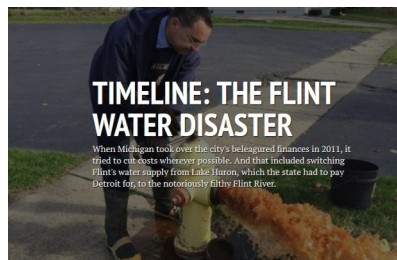
<https://doi.org/10.1021/acs.est.0c07614> (Evaluation of at-home test kits)

## Symptoms, cause and action:

Rashes in children, which may be caused by lead in drinking water

Lead contamination of drinking water came from old pipes, triggered by switching source water from Lake Huron to Flint River. This switch was due to poor financial situation of the city. After the finding of lead intoxication (2015), the use of Flint River water was stopped.

Flint residents now drink bottled mineral water instead of piped water, while the water quality is almost recovered in 2017.



# Occupational epidemiology

- Illness or injury associated with workplace exposures
  - Stressful repetitive motion ~ carpal tunnel syndrome (手根管症候群 in Japanese)
  - Welding ~ lung cancer
  - Silica ~ kidney disease
  - Poor office ventilation ~ respiratory illness
- Relatively high level exposure to relatively small number of people, comparing with the target of environmental epidemiology
- Scientifically easy to study, but economically and politically controversial (often faces conflict of interest)
- Historically, occupational cancer was studied in relation to high level exposure to many kinds of occupational contaminants (asbestos, aniline dyes, silica, nickel, cadmium, arsenic, dioxin, beryllium, acid mists, radon gas, diesel fumes): It's already clear. Studies completed.
  - Much lower level environmental exposure has the same carcinogenicity? is still the target of the study (radon gas in homes, arsenic in water, asbestos are already clear, but dioxin's low level carcinogenicity is still unclear)
- Nowadays, subjects of occupational epidemiology involves issues more difficult to study (job stress ~ heart disease?, lifting ~ back strain?)

# Finding the disease clusters

- In both environmental and occupational epidemiology, finding disease clusters is important
- Cluster: an apparently elevated number of disease cases in a limited area over a limited period, suggests common cause
  - Sometimes difficult to find: eg. 3 cases of childhood leukemia were found in the same street → unusual, but not found due to the ward of disease statistics being composed of a dozen streets
  - For rare diseases, statistical power is too small to detect the effect by cohort study, so that only case-control study is applicable to such situation
  - In most cases, researchers cannot find common cause from the cluster. (exceptions) Cluster of asthma in Barcelona in the early 1980s had common cause of soybean dust in the air.

# Measuring exposure

- Measuring exposure with sufficient accuracy is very important (see, next topic)
- Most difficult exposure assessment may occur in the retrospective case-control study (avoiding recall bias is difficult)
  - Constructing job-exposure matrix (JEM) → cross classification of jobs and exposure levels across time → Based on recent exposure data, researcher can extrapolate past exposure by jobs
  - Measuring the biomarker of exposure → alternative method to estimate past exposure
    - pesticide exposure ~ Parkinson's disease: organophosphate pesticide is rapidly metabolized, so that difficult to detect as biomarker, but organochlorine pesticide has longer biological half life and easy to detect. DDE is the principal metabolite of DDT, being still detected in serum of US population, though DDT use is already prohibited

# Occupational epidemiology example

- Based on National Death Index (in USA), death certificate to determine cause of death for 4626 workers in the cohort, exposed to different silica level
- Stratified analysis to control confounding by age, race, sex, calender time
- 109 workers were killed by lung cancer
- 23 workers were killed by end-stage kidney disease
- End-stage kidney disease and silicosis were strongly related with the exposure
- (Source: Table 3.1 of Frumkin's textbook 2<sup>nd</sup> Ed., pp.95)

	Exposure levels (Figures are rate ratio to national general population, same age, actual numbers of death are shown with parenthesis)			
Cause	Q1 low	Q2	Q3	Q4 high
Lung cancer	1.00 (17)	0.78 (21)	1.51 (20)	1.57 (16)
End-stage kidney disease	1.00 (2)	3.09 (5)	5.22 (6)	7.79 (5)
Silicosis	1.00 (1)	1.22 (2)	2.91 (4)	7.39 (7)

# Environmental epidemiology examples

- Air pollution (mostly sulfur dioxide excreted from petroleum complex since 1957) caused asthma outbreak in Yokkaichi city, Japan in 1960's.
  - (Yoshida et al., 1964) <https://doi.org/10.2486/indhealth.2.87>
  - (Kitagawa, 1984) <https://doi.org/10.1080/00022470.1984.10465807>
  - (Guo et al., 2008) <https://doi.org/10.1186/1476-069X-7-8>
  - (Guo and Yokoyama, 2012) <http://dx.doi.org/10.4236/jep.2012.329142>
- Recreational water quality: the number of gastroenteritis outbreaks ~ exposure to recreational water in USA → increased 3-4 times from 1978 to 2004
  - [https://www.cdc.gov/healthywater/surveillance/pdf/mmwr/MMWR\\_WBDOSS\\_Summary\\_1978.pdf](https://www.cdc.gov/healthywater/surveillance/pdf/mmwr/MMWR_WBDOSS_Summary_1978.pdf)
  - <https://www.cdc.gov/mmwr/pdf/ss/ss5512.pdf>
- Haile RW et al. (1999): gastrointestinal illness ~ swimming in marine waters incl. untreated runoff from storm drains in Santa Monica Bay?
  - <https://www.jstor.org/stable/3703553>
  - Are there different risks of adverse health outcomes among subjects swimming at different distances from the storm drains?
  - Are risks of specific health outcomes associated with the concentration of specific bacterial indicators of water quality or with the presense of enteric viruses?
    - Adjusted RR for 400 yards away from drains: 1.2 for eye discharge, sore throat, HCGI (highly credible gastrointestinal illness), 2.3 for earache
    - Adjusted RR for within 50 yards from drains: 1.2 for cough, diarrhea, chills, 1.9~2.3 for eye discharge, vomiting, HCGI

# Epidemiology and risk assessment

- Past: Qualitative systematic literature review
- Nowadays:
  - Quantitative **meta-analysis**: Weighted average of quantitative results (already published) across studies. (Originally used in clinical trials, but now used for observational studies too, it can combine different kinds of studies and measures.)  
(see, <https://doi.org/10.1007/s11301-021-00247-4>)
  - **Pooled analysis**: If **raw data** are available, this gives **a common exposure-response coefficients**.
  - Risk assessment: Determination of tolerable (acceptable) exposure level. **Occupational exposure usually permit higher level than general public.**

# Exposure assessment, industrial hygiene, and environmental management (Chapter 8)

- Key Concepts
  - Assessment of env. Exposure → Identify hazards → understand the effect of hazards on health → control the hazards → monitor
  - Industrial hygiene: anticipation, recognition, evaluation, control of workplace hazards
    - using air sampling, biomonitoring
    - hierarchical control: eg. substitution - ventilation - personal protection
  - Exposure science = new field: tools of industrial hygiene → general environment, leading to environmental management

# Exposure assessment

- Start from industrial hygiene (exposure at workplace)
- Know the hazard of exposures
  - Quantify the hazardous exposures
    - eg. CO = asphyxiant (material to stop breathing)
      - How much CO exposure can be tolerated or dangerous? / How to measure, where and when they occur? → We can understand biological effect of CO exposure completely
    - In turn, we can identify acceptable level, set standard, monitor environments to be safe

# Four profession's paradigms of industrial hygiene

- **Anticipation:** Proactive estimation of health and safety concerns (commonly or potentially) related with a given occupational or environmental setting
- **Recognition:** Identification of potential and actual hazards in a workplace
- **Evaluation:** Visual or instrumental monitoring of a site, measuring exposures
- **Control:** Reduction of risk to health and safety through administrative or engineering measures

# Anticipation: Pre-preliminary assessment

- Traditional two focus areas: safety and health
- Safety hazards → Needs safety engineering
  - Insufficient emergency egress (exit)
  - Slippery surfaces / risks of trips and falls
  - Chemical storage posing fire/explosion risk
  - Moving machinery
  - Unguarded catwalks
- Health hazards
  - Physical hazards: high noise levels, elevated temperatures and humidity, radiation, repetitive motion, ...
  - Chemical hazards
    - Acute: high level chlorine gas → disability, death
    - Chronic: low level solvent exposure → neurological damage / benzene → bone marrow dysfunction, aplastic anemia / uranium → lung cancer, ...
- New focus: environmental hazards (chlorine tank ruptures → endangered safety, plume of organic wastes → polluted drinking water, smokestack → tree damage, ecological damage (reduced O<sub>2</sub> in water), land deterioration by heavy metals)

# Recognition

- After anticipation of potential hazard → Recognition of actual hazard
- By a site visit or walk-through (visual inspection of the facility)
  - both qualitative and quantitative info about occupational and environmental hazard
  - review job category, number of workers in each, job description, health/safety program
  - identify hazardous physical/chemical/biological exposures and mechanical/psychological factors
  - find subpopulations with different hazard levels

# Evaluation

- Where to sample?
  - area sampling: at a part of workplace
  - personal sampling: vicinity of individual workers
  - biological sampling: bodies of individual workers
- How to sample?
  - "representative of population" vs "worst case"
- Instruments
  - Direct reading instruments: eg. digital thermometer, hygrometer, noise monitor, Geiger counter, GC-on-a-tip for organic vapors, ...
  - Sample collection instruments: collect air sample on absorbing media (active vs passive sampling) → measuring at laboratory
  - Biological monitoring: human hair, saliva, blood or urine are common to be used for exposure (nails for long-term exposure)

# Control

- Control = Primary prevention
- Approaches to modify workplaces (in Japanese, 作業環境管理)
  - Substitution: replacing hazardous material / process with a less hazardous one (eg. replace benzene by toluene)
  - Isolation: limiting access to the hazardous process (eg. place metal cage around moving parts to reduce the likelihood of clothes catching on the parts)
  - Ventilation: eg. introduction of fresh air, local exhaust ventilation, cool air
- Use protective devices
  - Fail-safe instruments: using two-buttons for operation
  - Personal protective equipments: gloves, safety glasses, ...
  - Administrative strategies: rotating workers to limit aggregation, ...(in Japanese, 作業管理)
- Example: Health hazard and control in painting  
[https://www.youtube.com/watch?v=G4CE\\_dHBONs](https://www.youtube.com/watch?v=G4CE_dHBONs)

# Exposure science



- Quantifying the contaminant exposures in daily activities
  - Magnitude, frequency and duration of exposure (exposure profile): the difference of peak and mean concentrations is important
  - Acute/chronic/subchronic exposures
  - Route and pathways of exposure: inhalation? ingestion? dermal?
  - Various methods
    - imputing or modeling (indirect exposure assessment, exposure scenarios, job-exposure matrix)
    - measuring environmental exposures (eg. environmental monitor NO<sub>2</sub>, PM)
    - measuring personal exposures (eg. air monitor during work: see photo above, source: [https://www.cameco.com/uranium\\_101/mining-milling/more-topics/safety/](https://www.cameco.com/uranium_101/mining-milling/more-topics/safety/))
    - aggregate and cumulative exposure assessment (cf. TDI / ADI)
    - measuring biomarkers (contaminants or its metabolic products in human body)
- Evaluating factors that influence exposures
- Exploring new measuring method: ingestion and skin absorptions are challenges. duplicate diet study, dietary diaries, and FFQ for ingestion, wearing skin patch for dermal exposure
- Exposure assessment ~ quantification of exposures in both occupational and environmental settings
- Example: Mercury exposure through fish consumption  
<https://www.youtube.com/watch?v=MavZrSTDySY>  
<https://www.youtube.com/watch?v=IDRS0YUgqLw>



# Environmental Psychology and Toxicology

- Both focus on the influence of physical environment on human health and well-being
  - Minamata bay's methylmercury contamination by Chisso Corp. caused bioaccumulation of methylmercury in fish and shellfish, which resulted in mercury poisoning among people with neurological syndrome (Minamata disease)

(cited from Frumkin, Table 9.1)	Toxicology	Environmental Psychology
Ecological perspective	Direct relations	Broader, ecological context
Outcomes of interest	Singular focus, typically physiological	Broader focus, including mental health, social interaction, stress
Health promotion	Pathogenesis	Pathogenesis and salutogenesis
Exposure	Singular effects, ambient environmental exposure	Synergic effects, built environment, movement between settings
Humans as dynamic organisms	Biological effects on passive organisms	Coping strategies used by humans
Direct/indirect effects	Predominantly direct effects, few indirect path models or consideration of moderators	Predominantly indirect effects, consideration of moderator models

- Prolonged exposure to excessive noise (90 dB(A) for 8 hrs or 105 dB(A) for 1 hr) causes NITTS → NIPTS → **sensorineural hearing loss**.  
<https://www.mountsinai.org/health-library/symptoms/sensorineural-deafnesshttps://doi.org/10.1097%2FMAO.0000000000001071>

# Field definition of environmental psychology

- Assuming that a dynamic and reciprocal relationship exists between individual and groups and the environment where they live
- Sociophysical contexts affect the behavior and health: eg. the kind of dwelling, social and physical aspects of **neighborhood (social capital)**.
  - "Sociophysical environment" means interdependent social and physical dimensions of settings jointly influencing an individual's psychological and physical well-being
- "Environment and behavior studies (EBS)" is alternative term.
- Direct/Indirect effects should be considered

# Neighborhood – basis of social capital

- Functions of both real and virtual neighborhood

- Affiliation
- Identity
- Social support
- Community
- Information
- Daily life
- Recreation



- Problems

- Conflict of real/virtual
- Stimulation overload
- Attentional fatigue
- Digital divide



<https://www.realtor.com/advice/move/what-does-neighborhood-mean-anyway/>

# Social Capital

Among socioeconomic factors...

micro (individual, family): income, education, etc.

meso: social capital ( ~ social integration), etc.

macro (population): population density, income inequality (measured as Gini coefficient) etc.

Social capital: focused as a multi-level factor

Example: confiding relationships with neighbors, social network, reciprocity

Umbrella term: Social cohesion, social support, social integration and/or participation, among other social determinants of health (Almedom AM, 2005).

# Findings related to social capital

Durkheim E: “Depression and suicide are linked to the weakening of social bonds” (1897) based on the macro-level observation, “The lowest rates of suicide occurred in societies with the highest degrees of social integration”. (In: Kawachi I, Kennedy BP “The health of nations”, The New Press, 2002, pp.122)

Spending time with our loved ones as well as being engaged in social activities are among the surest ways to prolong life and enhance the QOL (House JS, et al., 1988: cited in *ibid.*).

Social isolated (network size measured by MSSSI  $\leq 3$ ) CAD patients are at elevated risk for mortality (Brummet BH, et al., 2001), where MSSSI is the abbreviation of Mannheim Social Support Interview and the network size is the total number of distinct individuals who are listed either of the following 6 types: (1) like to talk and do things with, (2) invited during last 4 weeks, (3) can borrow things from and ask favors of, (4) help them make a very important personal decision, (5) could talk with and who would understand if very close friend or relative was extremely ill or died, (6) would talk to, encourage, make them feel better about themselves when everything goes wrong and they feel down and discouraged and even doubt their own worth.

# Definitions of “social capital” summarized in Islam MK et al. 2006.

<https://doi.org/10.1186/1475-9276-5-3>

Bourdieu P (1980) defined social capital as “the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition.”

Coleman JS (1990) “consist of some aspect of social structure and they facilitate certain actions of individuals who are within the structure”

Putnam RD et al. (1993) “refers to features of social organization, such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions”

Portes A (1998) “refers to the capacity of individuals to command scarce resources by virtue of their membership in networks or broader social structure”

Four (partly overlapping) main theoretical ingredients: [1] social trust/reciprocity, [2] collective efficacy, [3] participation in voluntary organizations, [4] social integration for mutual benefit.

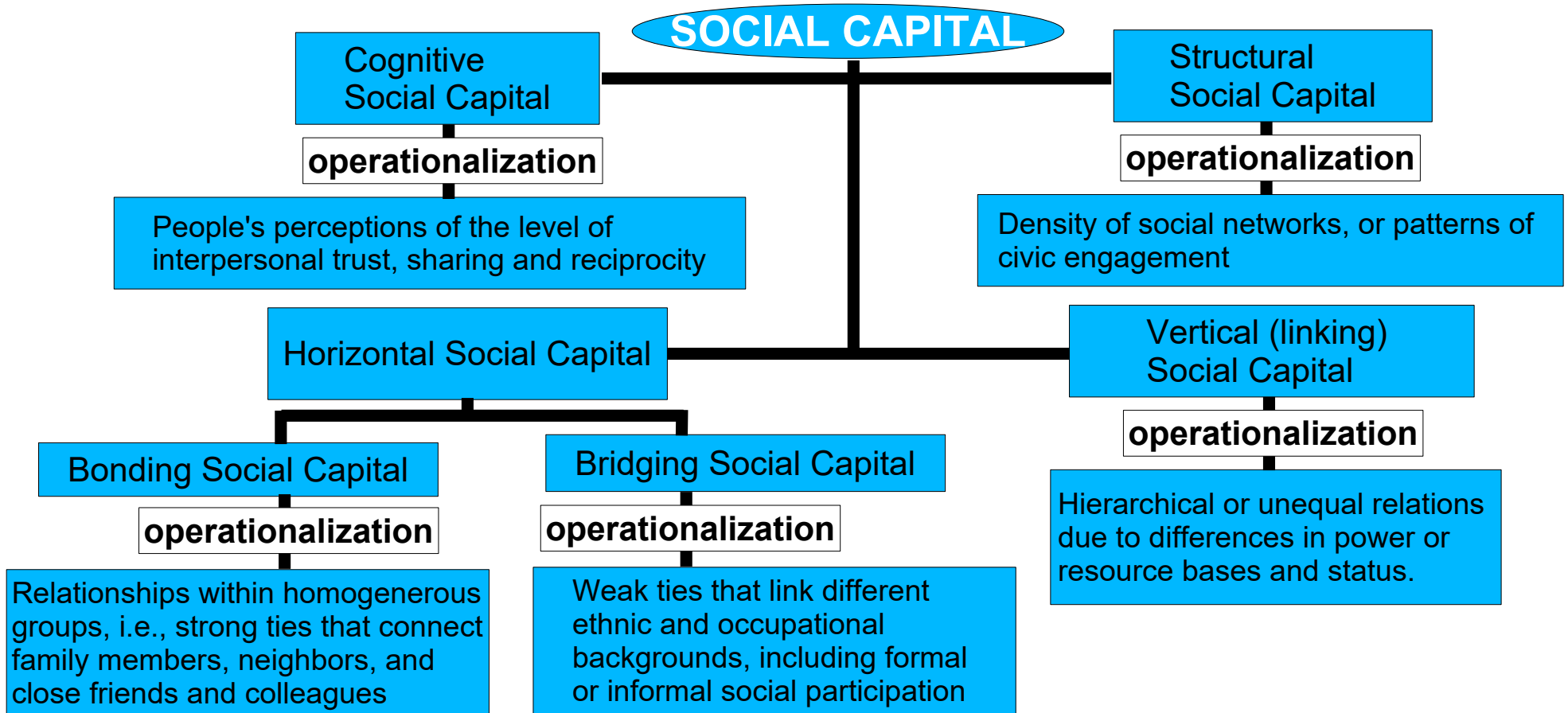
# Biological background

- Social capital reduces psychological stress, subsequently strengthen immune system which keeps the individual healthy (the concept of psychosomatic medicine)
  - Cohen S, et al. (1997): Healthy volunteers were more susceptible to experimental rhinovirus infection when they have less social relationships (social relationships were measured by the cumulative number of individuals who are categorized in one of 12 types of social relationships and speak with the subject at least once within 2 weeks)

# The way of social constructs influencing physical health (Cohen S, 2004)

- Social support [stress buffering]: eliminates or reduces effects of stressful experiences by promoting less threatening interpretations of adverse events and effective coping strategies
- Social integration / Social capital [independent of stress]: promotes positive psychological states that include health-promoting physiological responses.
  - See, Figure 1 of Berkman and Syme (1979)  
<https://doi.org/10.1093/oxfordjournals.aje.a112674>
- Negative interactions [relationships as a source of stress]: elicits psychological stress and in turn behavior and physiological concomitants that increase risk for disease.

# Framework for social capital study



Source: Figure 1, Islam MK et al., 2006. <https://doi.org/10.1186/1475-9276-5-3>

# Components of “social capital” (in Islam MK et al., 2006)

Cognitive: norms, values, attitudes, beliefs (i.e., perceptions of the level of interpersonal trust, sharing, and reciprocity)

Structural: externally observable aspects of social organization (ex. density of social networks, patterns of civic engagement)

Horizontal: ties existing among individuals or groups of equals or near-equals / “bonding” within homogeneous, “bridging” in heterogeneous groups.

Vertical (Linking): stemming from hierarchical or unequal relations due to differences in power or resource bases and status.

Measurement scales for social capitals  
(Almedom AM, 2005)

<https://doi.org/10.1016/j.socscimed.2004.12.025>

- Informal social control (ISC)
- Social cohesion and trust scales (SC&T)
- Neighborhood social capital scale (NSC)
- Kinship social support (KSS)
- Fear of calamity scale (FOC)
- Adapted social cohesion and trust scale (A-SCAT)
- Interviews with youth, teachers and parents;  
    Psychological sense of community (PSOC)
- Puttnam's community social capital benchmark  
    survey

# Examples of questions

Lochner KA, et al. (2003)

[https://doi.org/10.1016/s0277-9536\(02\)00177-6](https://doi.org/10.1016/s0277-9536(02)00177-6)

**Resident's perceptions of reciprocity:** The proportion of residents in each Neighborhood Cluster (NC) answering strongly agree/agree to the question that “People around here are willing to help their neighbors”

**Resident's perceptions of trust:** The proportion of residents in each NC answering strongly agree/agree to the question that “People in this neighborhood can be trusted”

**Associational membership:** Number of memberships in variety of voluntary associations (incl. religious organizations, neighborhood associations, business or civic groups, neighborhood ethnic or nationality clubs, local/political organizations) was asked.

# Personal On-Offline Social Capital Brief Scale (Menardo et al, 2022)

<https://doi.org/10.1371/journal.pone.0272454.s001>

The individual is asked to read each question and check the box that best represents their answer on a **5-point Likert scale (A few/None – A lot/All)**.

**1. Number of people in the individual's social network for each of the following three categories**

- 1). Friends
- 2). Work colleagues/fellow students
- 3). Online contacts (i.e., persons met and with whom interact only online)

**2. Number of people in each of the following three categories who the individual can trust**

- 1). Friends
- 2). Work colleagues/fellow students
- 3). Online contacts (i.e., persons met and with whom interact only online)

**3. Number of people in each of the following three categories who will definitely support the individual upon their request**

- 1). Friends
- 2). People in the neighborhood
- 3). Online contacts (i.e., persons met and with whom interact only online)

**4. Number of people in all the following categories – individual's friends, work colleagues/fellow students, people in the neighborhood, online contacts, and family members, relatives, fellow citizens or childhood friends/old classmates – who possess the following assets/resources**

- 1). Broad connections with others
- 2). High reputation/influence

**5. Number of the following two types of associations/groups in the individual's community**

- 1). Community service associations/groups (for example: groups, including youth organizations offering caregiving, assistance, shelter, soup kitchen, nursing home, environmental protection, trade union representation, cooperative associations, men's groups, women's groups, community committee/groups, local tourism promotion groups, student organizations)
- 2). Cultural associations/groups including those having only online activities (for example: theatre or dance groups, music bands, choirs or orchestras, arts and crafts groups, traditional folk groups, promotional associations for cultural events, senior citizens' study programs, youth-oriented cultural associations, Facebook/online discussion groups)

**6. Number of each of the two types of associations/groups in the individual's community that represent their rights and interests**

- 1). Community service associations/groups (for example: groups, including youth organizations offering caregiving, assistance, shelter, soup kitchen, nursing home, environmental protection, trade union representation, cooperative associations, men's groups, women's groups, community committee/groups, local tourism promotion groups, student organizations)
- 2). Cultural associations/groups including having only online activities (for example: theatre or dance groups, music bands, choirs or orchestras, arts and crafts groups, traditional folk groups, promotional associations for cultural events, senior citizens' study programs, youth-oriented cultural associations, Facebook/online discussion groups)

**7. Number of each of the two types of associations/groups in the individual's community that will support them upon their request?**

- 1). Community service associations/groups (for example: groups, including youth organizations offering caregiving, assistance, shelter, soup kitchen, nursing home, environmental protection, trade union representation, cooperative associations, men's groups, women's groups, community committee/groups, local tourism promotion groups, student organizations)
- 2). Religious or political associations/groups

**8. Number of associations/groups in the individual's community of the following categories– community service, cultural, religious, political, recreational, leisure, and economic and professional associations/groups (e.g., Chamber of Commerce) – that possess the following assets/resources**

- 1). Broad social connections
- 2). Extensive social influence

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# Typical approaches of environmental psychology

- Concerned with the behavioral, emotional, and health outcomes of people's transactions with everyday environments
- Naturalistic field studies, emphasizing multidisciplinary perspective (incl. psychology, environmental design, geography, sociology, **human ecology**, natural resource management, government, public health)
- Behavior and health outcomes in relation to objective and subjective meanings
- User-oriented studies
- Events naturally occur, conditions may change during the course of the events
- Holistic and longitudinal approach  
→ **Sharing the focus with human ecology!!**  
**(Only the nominal difference?)**

# Five underlying processes of environmental psychology (1) Physical layout

- Rearranging furniture → certain seating configurations facilitate social interaction (sociopetal), others impede it (sociofugal – eg, straight rows of seating) In church or library, designer uses sociofugal setting, but in cafes or meeting rooms, sociopetal setting is favorable.
- Social capital: community cohesion, informal social control, neighborhood interaction → supports physical and psychological well-being and buffers some of the adverse effects of risks
- Proxemics: the study of how people use space to communicate nonverbally
- Personal space: the area or bubble around our body to maintain between ourselves and others → Hall ET (1966) "The hidden dimension", Garden City: NY, Doubleday.  
[https://www.academia.edu/43785083/The\\_Hidden\\_Dimension\\_Edward\\_Hall](https://www.academia.edu/43785083/The_Hidden_Dimension_Edward_Hall)
  - Closely related with "social distance", which depends on cultural norm. In Asian culture, personal space is wider than Western culture, and thus natural social distance seems wider than Western culture. This difference may affect the difference of COVID-19 spread in Asia and in Europe/USA.
- Defensible space – Crime prevention through environmental design – Layout of interior and exterior of the complex contributes to resident's lack of territoriality (sense of spatial ownership and its nonverbal expression)
  - (cf) Broken window hypothesis: Once a place is slightly degraded, people will regard litter and disrepair as the norm and will further degrade the area
  - Principles: Enhance a sense of territoriality, Use environmental design elements to create a continuum of spaces from public to semipublic to semiprivate to private, Limit the scale of buildings to 3-5 floors, Increase visual surveillance, Foster an ambience of caring

# Five underlying processes of environmental psychology (2) Stress and coping

- Stress: Occurring when environmental demands exceed personal coping resources, transactional process between person and environment.
- Within body, stress response includes hypothalamic-pituitary-adrenal (HPA) axis, elevated sympathetic nervous system activity, behavioral response (anxiety, perceived distress, diminished ability to sustain task performance at high level)
- Examples of environmental stress
  - Crowding → Difficulty to complete complex tasks, Difficulty to maintain positive social relationships
  - Noise exposure → Lower auditory discrimination → Lower reading acquisition
  - Housing in bad neighborhood conditions
- Measuring stress
  - Bio-monitoring of salivary amylase, cortisol, chromoglanin-A, etc.
  - Heart rate variability
  - Questionnaire
    - PSS-10 (Perceived Stress Scale)  
<https://www.das.nh.gov/wellness/docs/percieved%20stress%20scale.pdf>
- Measuring stress-coping
  - Questionnaire (See, review by Kato 2005 <https://doi.org/10.1002/smi.2557>)
    - WCQ <https://prevention.ucsf.edu/sites/prevention.ucsf.edu/files/uploads/tools/surveys/pdf/Ways%20of%20coping.pdf>
    - COPE <https://www.psy.miami.edu/faculty/ccarver/copefull.html>

# Five underlying processes of environmental psychology (3) Diet and physical activity

- Obesity pandemic is related with dietary change and physical inactivity
- Child care outdoor learning environments
  - Behavior settings: Physical and social contexts where behavior occurs
  - Affordances: Possible uses or functions that the arrangement of physical features in the environment conveys to the user
- Commuting environment and physical activity – Active transport (walking or biking) contributes increased activity
- Neighborhood food environment
  - Presence of supermarkets increases intake of fruits and vegetables
- School cafeteria as food environments
  - In terms of convenience, attractiveness, and normativeness, various nudgings are possible and done

<https://doi.org/10.1111/josh.12861>

# Five underlying processes of environmental psychology (4) Pro-environment behavior

- Growing concerns about finite natural resources, environmental degradation, impact of climate change on human health → Interest in how to encourage people to engage in pro-environment behaviors
- Various behaviors can help to alleviate environmental problems
- Strategies to induce pro-environment behavior
  - Changing personal and social norms
  - Altering environmental cues or on the nature of reinforcements (reward and punishment)
    - A waste setup providing a physical cue to encourage recycling (eg.)  
Univ. Washington's recycle box  
<https://facilities.uw.edu/services/recycling>
- No one strategy is singularly effective

# Five underlying processes of environmental psychology (5) Light and color

- Aesthetic preference
  - People universally prefer natural light, most people dislike fluorescent light
  - For color, preferences of people vary more, but with some evidence of preference for the blue-green
  - For facial color, people universally prefer redder skin hues (probably looks healthy)
  - For object color, blue attracts attention, but cross-culturally diversified
- Health and behavior
  - Light affects comfort, health, well-being
    - Eye strain results from fluorescent lights' flickering at a slow rate, glare is a reliable cause of physical discomfort
    - Text legibility is a function of luminance (brightness), contrast, font size and the age of the viewer
    - Insufficient daylight causes feelings of negative affect, low energy, anxiety, worry: Seasonal affective disorder (SAD)
  - The effects of colors are less known
    - Red increases brain activity
    - Blue facilitates performance on tasks requiring cognitive flexibility
    - For colorblind people, some kinds of color combination are difficult to distinguish. Thus, Color Universal Design (CUD) is proposed ([https://www2.cudo.jp/wp/?page\\_id=1936](https://www2.cudo.jp/wp/?page_id=1936)), which is developed in Japan (See, <https://jfly.uni-koeln.de/color/> for additional information).

# Possible interventions by environmental psychology

- Environmental psychology reduces crime: Creation of mini-neighborhoods in Five Oaks  
<https://www.huduser.gov/portal/publications/pdf/defch2.pdf>
- Environmental psychology reduces infections in hospitals: Design and hospital hand washing
  - Several studies such as
    - <https://doi.org/10.1186/1471-2334-13-510>
    - <https://doi.org/10.1007/s10729-013-9254-y>
- Environmental psychology saves energy
  - Neighbor comparison  
[https://docs.oracle.com/en/industries/energy-water/energy-efficiency/her-configuration/Content/Customr\\_Experience/Neighbor\\_Comparison\\_\\_HERv2\\_.htm](https://docs.oracle.com/en/industries/energy-water/energy-efficiency/her-configuration/Content/Customr_Experience/Neighbor_Comparison__HERv2_.htm)

# Related issues

- Universal design and barrier-free design
  - Important research topic in ergonomics
  - Fail-safe / Fool-proof consider the human nature of unintentionally making mistakes
  - It considers human diversity
- "Affordance" concept by Gibson JJ (1979) *The ecological approach to visual perception*. Houghton, Mifflin and Company.
  - Defined as "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill"
  - Related with cognitive ability
  - Scarantino A (2003) "Affordance explained" *Philosophy of Sciences*, 70: 949-61. <https://www.journals.uchicago.edu/doi/full/10.1086/377380>
  - Heft H (1989). Affordances and the body: An intentional analysis of Gibson's ecological approach to visual perception. *Journal for the Theory of Social Behaviour*, 19: 1–30. <https://doi.org/10.1111/j.1468-5914.1989.tb00133.x>

# Levels of environmental analysis in sociophysical context

- **Elemental:** natural scents and natural objects (eg, water, air, soil)
- **Individual:** an individual's (1) body and physical, perceptual and cognitive abilities, (2) intellectual abilities, personal beliefs, values, attitudes, emotions, memories and experiences (eg, clothing choices, eating choices)
- **Stimuli:** recognizable features of an environment that cause a personal perception or physical and/or psychological reaction (eg, natural sounds like bird songs, natural surfaces such as wood or rock, natural colors and textures, views of nature through windows)
- **Situation:** sequences of individual or group activities and events occurring at a particular time and place (eg, outdoor meetings, meals, entertainment, gardening)
- **Settings:** socially structured and geographically bounded locations where certain kinds of activities and events regularly recur (eg, college classroom, recreation)
- **Life domain:** spheres of a person's life that encompass multiple situations and settings; occupations or location (eg. home, workplace, school, ...)
- **Societal:** overarching systems of beliefs and values, social and cultural norms, and social, political, and economic institutions that integrate life domains for large groups of people (eg, natural preserves, wilderness areas)

# Four different "world views" (Altman and Rogoff, 1987)

- **Trait** worldview tries to understand and predict the enduring, consistent features of physical settings and people as individual factors
- **Interactional** worldview posits stable relationships among traits and proposes basic "laws" that describe these relationships
- **Organismic** worldview tries to understand larger, more complete, more complex aggregates of factors, acknowledging that these factors may change or evolve over time
- **Transactional** worldview proposes that the factors that affect behavioral phenomena are part of a constant, dynamic, reciprocal milieu

# Hurricane "Katrina" example

- Three parts of the event
    - awareness and preparation
    - immediate response ~ focusing on the use of common setting features as "affordances" (possibilities for action that are latent in an environment)
    - aftermath
  - Environmental psychology's comprehensive approach
    - sense of place
    - place attachment
    - contextual transformation (sudden and dramatic context changes, resulting in fundamental behavior modification)
- \* Please consider any other example you are familiar with.

# Three principles of contextual analysis

- 1. The relationship between environment and health is influenced by interdependencies among immediate situations, immediate settings, and more remote environmental conditions
- 2. The different environments in which an individual participants exert a cumulative, synergistic effect on his or her health
- 3. Health is the result of an interaction among the objective features of the environments in which individuals participate, individual's perceptions of those features, and individuals' personal attributes

# Behavioral impacts of displacement due to climate change

- Global: Massive population dislocation
- National: Changes to and disruption in food production and distribution
- Regional: Increased cardiovascular and respiratory disease
- Community: Functional disruption leading to scarcity of necessary resources (portable water, electricity, gas, sanitation), damage to and inaccessibility of health care facilities
- Neighborhood: Inability of neighborhood to recover, neighborhood decay, disruption of social networks
- Residential (family): Family separation, conflict, deprivation, long-term negative economic impact, educational disruption
- Individual: Dramatic increase in environmental (psychological) stress, malnutrition, loss of income, poverty, inadequate medical care