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ADAPTCITY P.T. „ADAPTACJA ODPOWIEDZIĄ
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Epidemiologia a zmiany klimatu Epidemiology and climate change

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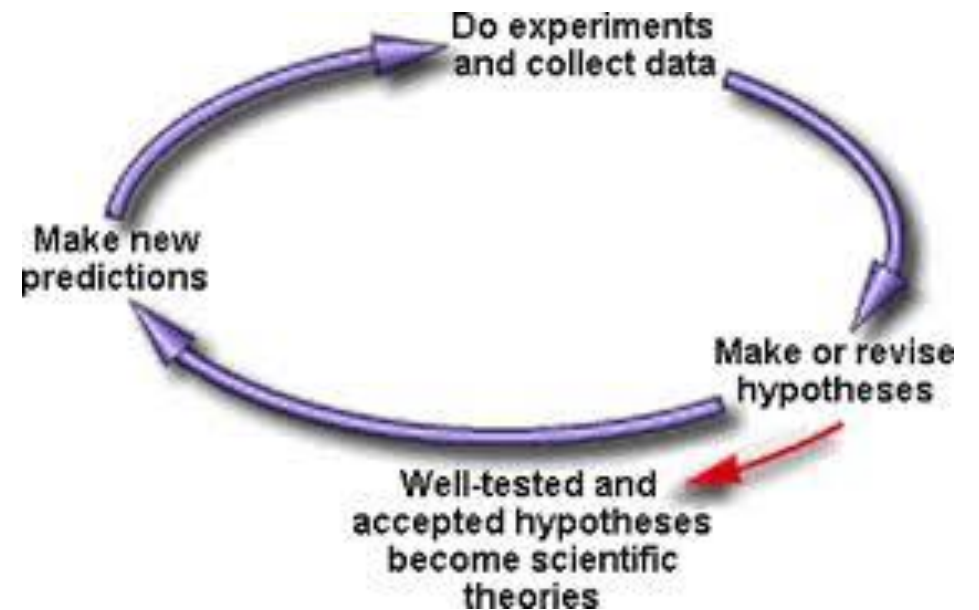
Scope of presentation

- What is the epidemiology ?
- Study designs in epidemiology
- Criteria for causality
- Application of epidemiology for climate change effects
- Green areas epidemiology –
 - Examples
 - Limitations
 - Good practice
- Conclusions

Definition of epidemiology and areas of interests

Epidemiology **is the study of the distribution and determinants of health-related states or events in specified populations and the application of this study to control of health problems** (*Last 1995*).

Hypotheses in environmental epidemiology focus on **associations between carefully specified effects on health and exposure to environmental agents**.



Risk factors and protective factors

- **Risk factor** is an aspect of personal behaviour or lifestyle, an environmental exposure, or an inborn or inherited **characteristic**, which on the basis of epidemiologic evidences known to be associated with health-related condition(s) important to present.
- **Protective factors** refer to variables that **increase the chance of improving health** or decrease the risk of developing diseases as the result of risk factors.

Population at risk

The calculation of appropriate rate requires the information on

- **numerators** - number of deaths, or cases of disease
- **denominators** - the population at risk

Information on the size, sex, and age structure of the population at risk is required for the proper interpretation of mortality and morbidity statistics.

$$\frac{\text{Number of NEW events in a specified period}}{\text{Number of persons exposed to risk during this period}} \times 10^n$$

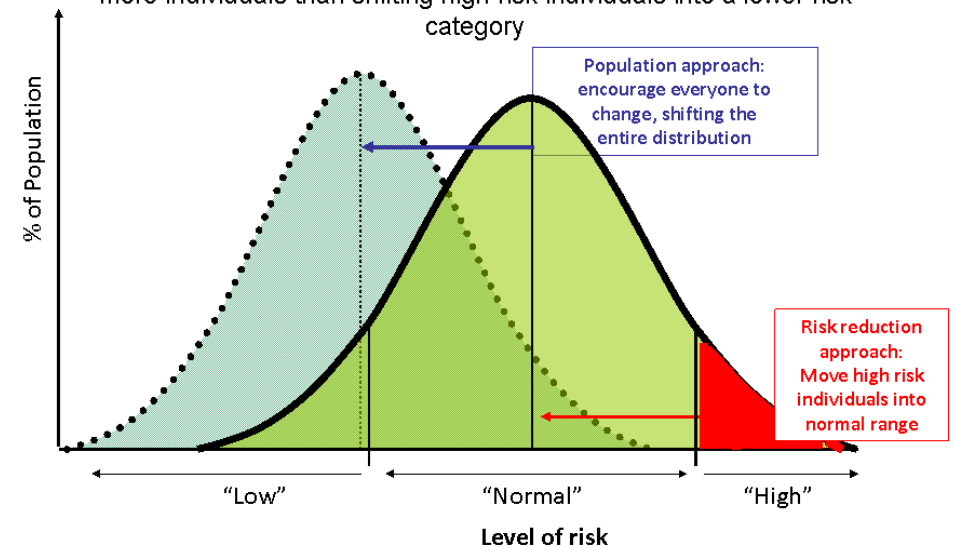
The numerator strictly refers only to first events of disease.

High risk population

- Data on environmental exposure might be helpful for identification of populations that **are more likely to demonstrate an health effect.**
- Effects of exposure are likely to be more evident **in people exposed to higher levels** than in exposed to lower ones.

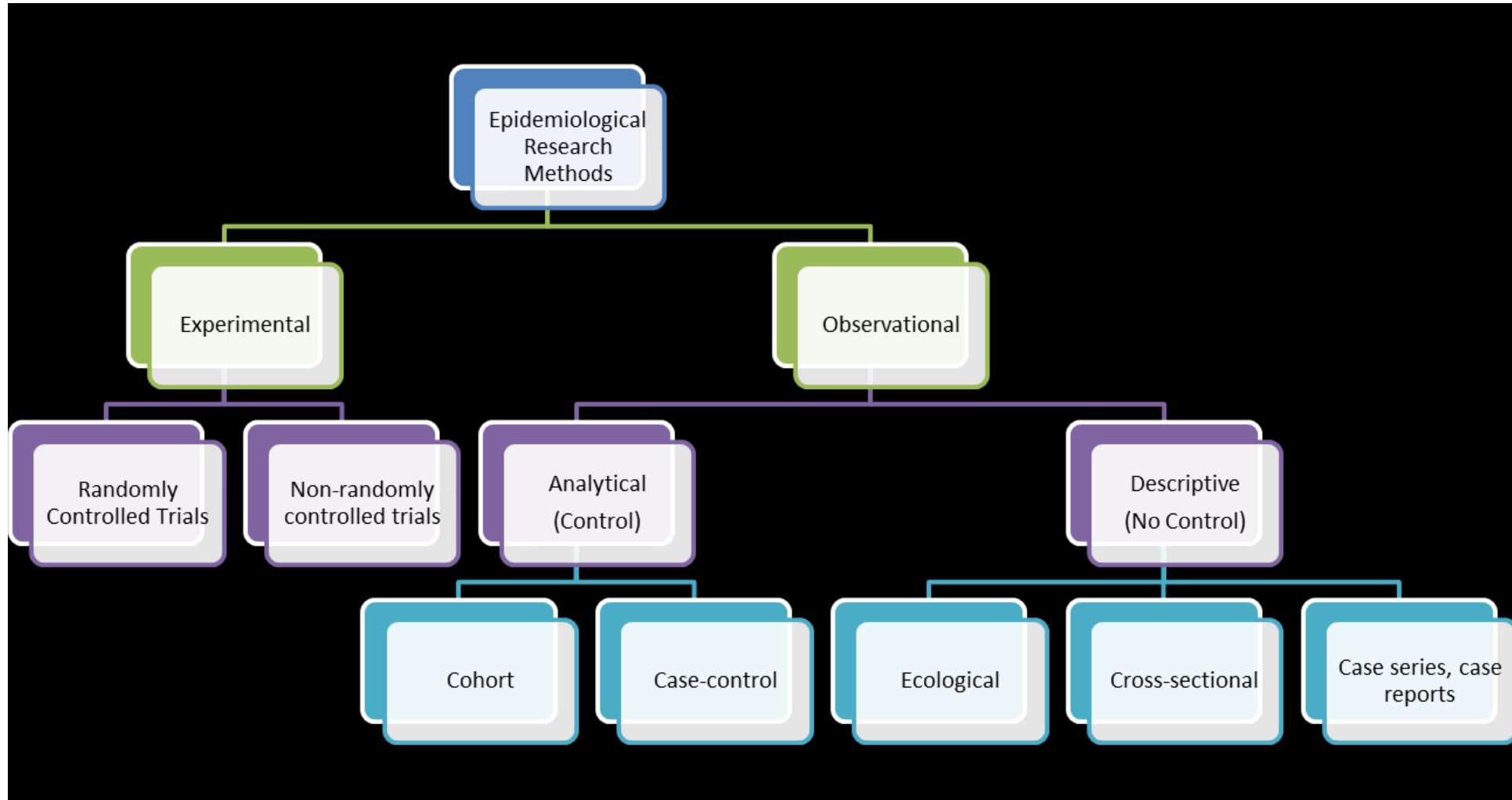
The Bell-Curve Shift in Populations

Shifting the whole population into a lower risk category benefits more individuals than shifting high risk individuals into a lower risk category

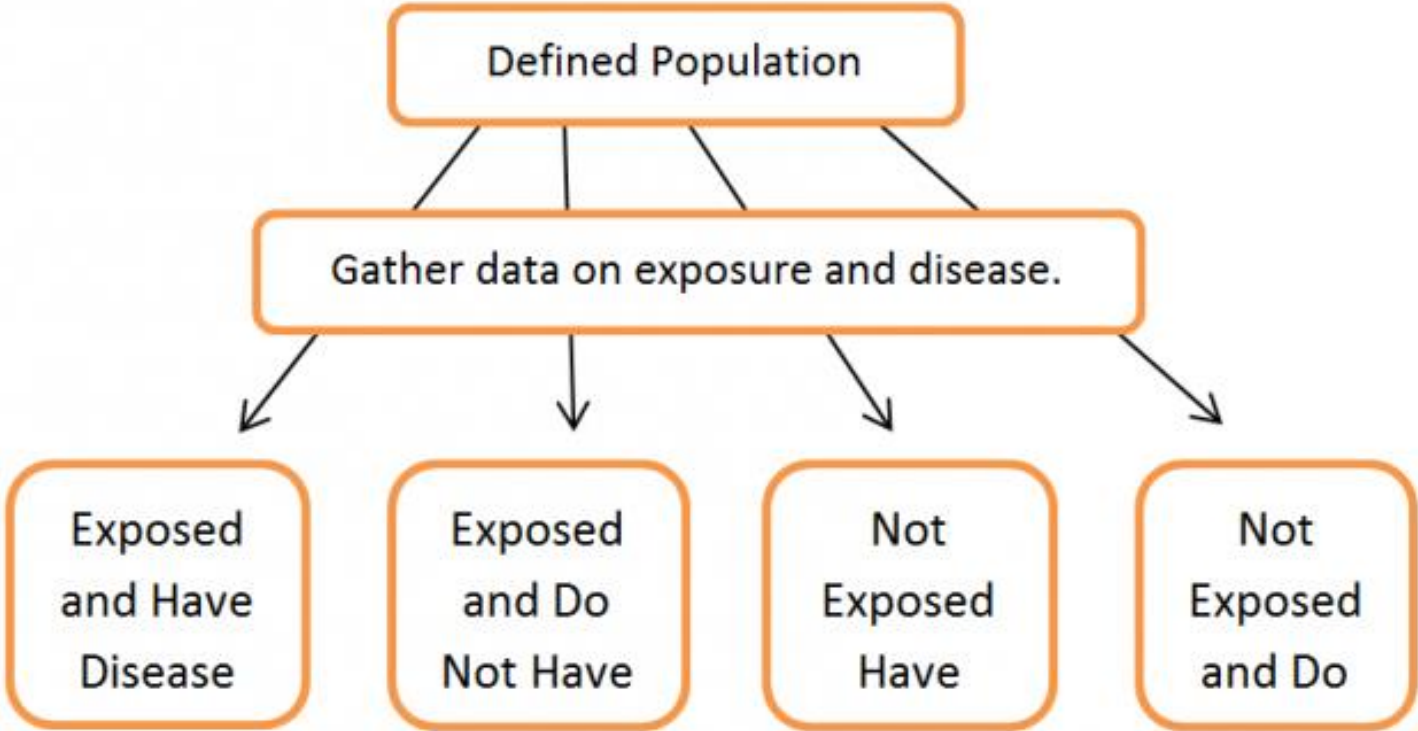


Source: Rose G. Sick Individuals and sick populations. *Int J Epidemiol.* 1985; 12:32-38.

Epidemiological studies – popular designs

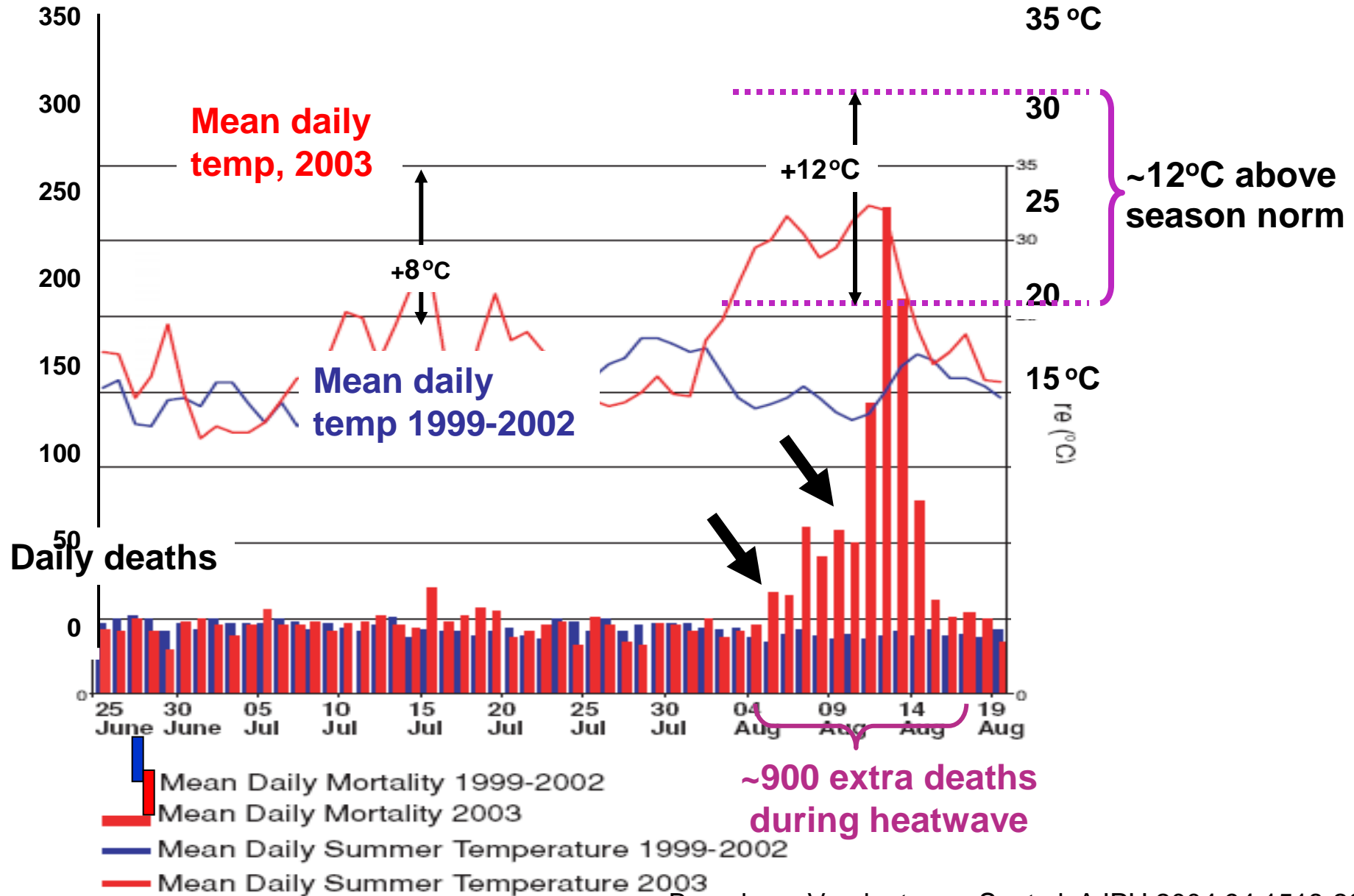


Cross-sectional studies



Cross-sectional studies provide information on disease about frequency (prevalence) at a given time).

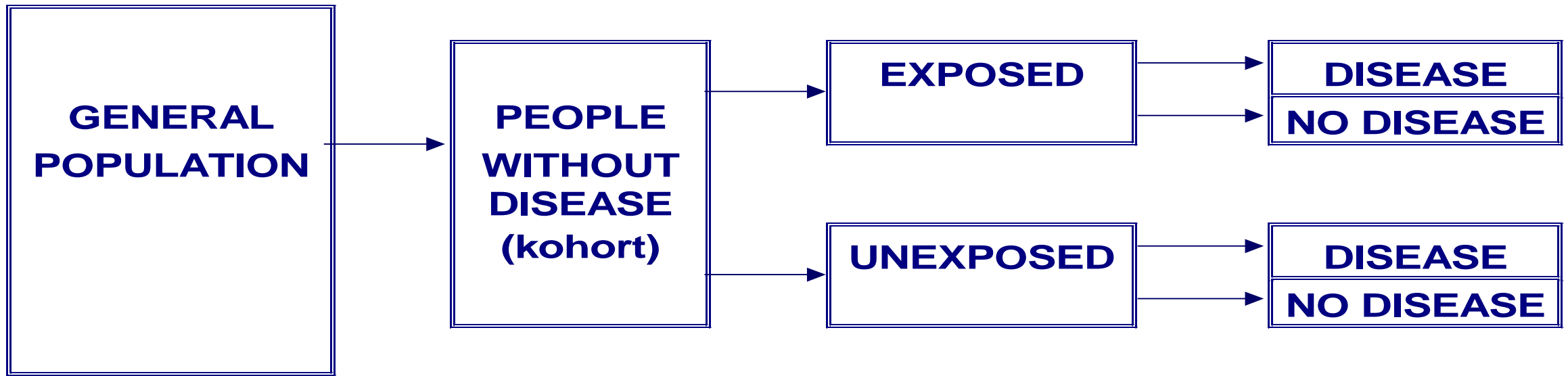
Paris, Heatwave (Aug 2003): Daily Mean Temps and Deaths



Based on: Vandentorren S, et al. AJPH 2004;94:1518-20.

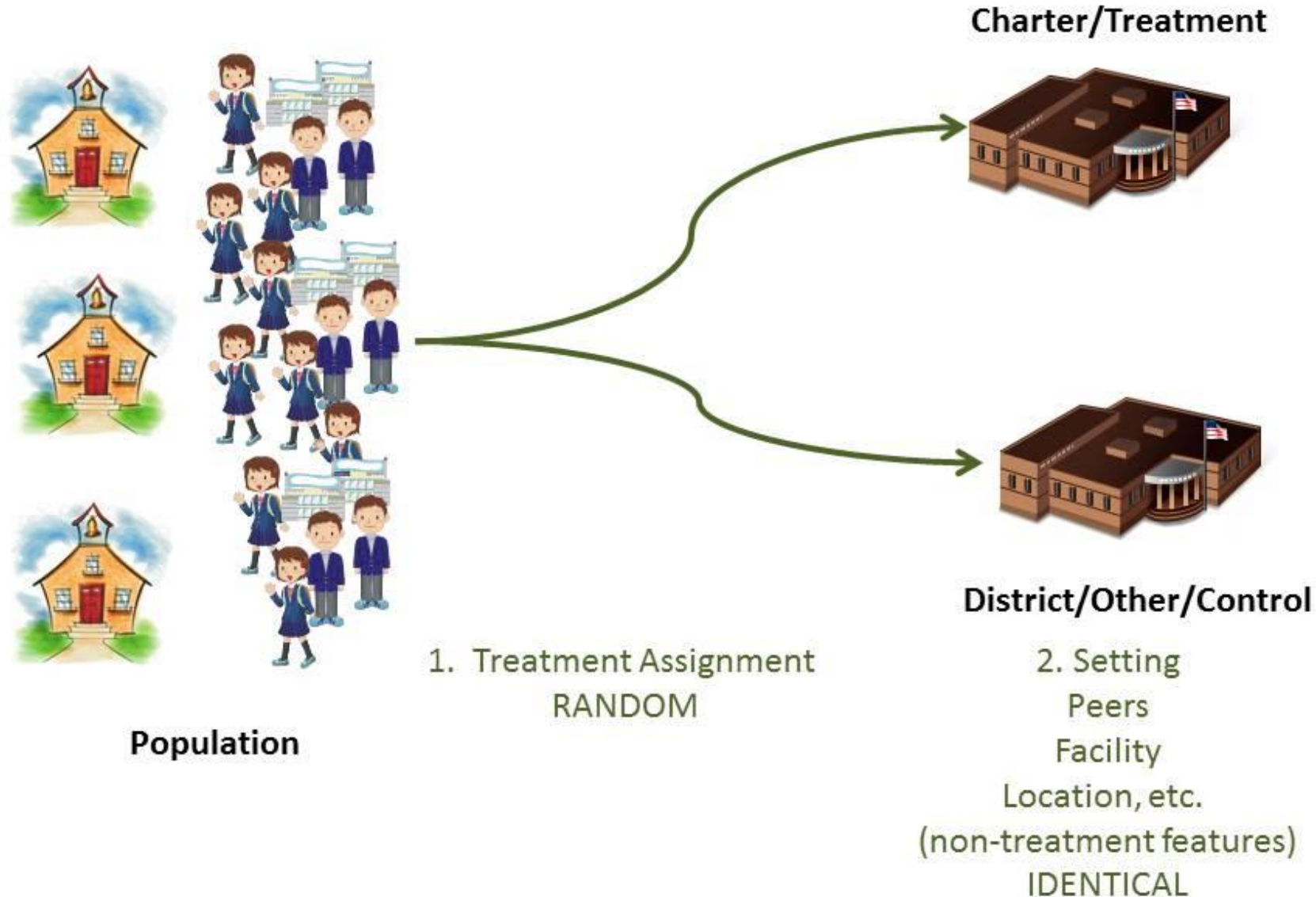
SCHEMATIC DIAGRAM OF A COHORT STUDY

TIME



Experimental Design (Gold Standard)

Treatment = Exposure to Charter School Model/Strategies



A **charter school** is a school that receives government funding but operates independently of the established state school system in which it is located.¹

Controlled exposure studies

- **The demonstration of prevention** of some effect by a well-designed human exposure study is perhaps the most convincing way of showing a relationship between cause and effect.
- Good recent example is study in Wien in which beneficial effects on lung function of improved air quality were demonstrated (Neuberger, 2002)

3 451 Austrian elementary school children

were examined (between 2 and 8 times) by spirometry by standardized methods, over a 5 yr period.

The districts where they lived were grouped into those where **NO₂ declined during this period** (by at least 30 mg/m³ measured as half year means) and **those with less or no decline in ambient NO₂**

M. Neuberger et al. / Atmospheric Environment 36 (2002) 1733–1736

1735

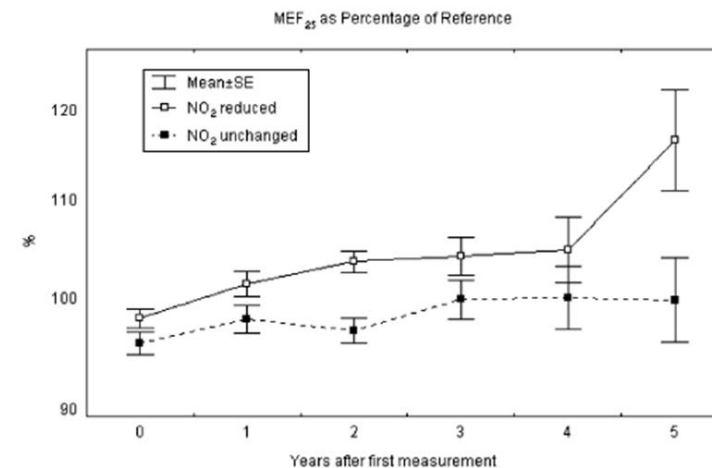


Fig. 2. Development of endexpiratory flow rates (mean \pm SEM of MEF25 standardized according to age, standing height, weight and sex) in different school districts (NO₂ reduced = decrease of winter mean 30 μ g/m³ or more; NO₂ unchanged = decrease < 30 μ g/m³ or any increase).

Causality criteria for epidemiological studies

Epidemiologists generally use a common set of criteria to help judge the evidence

- time sequence
- strength of association
- **dose – response relationship**
- cessation of exposure
- **biologic plausibility**
- specificity of association
- consistency among studies (replication of the findings)
- consonance with existing knowledge

Validity aspects of epidemiological studies

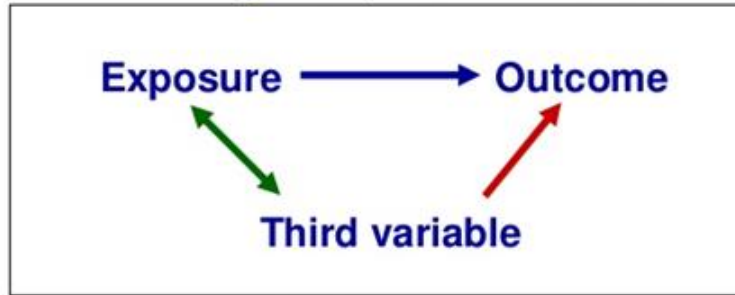
- Because of observational nature of most epidemiological studies, the **estimates derived from epidemiological studies may suffer from bias** (systematic deviation of results from truth).
- **Systematic error** is distinguished from random error in that it would be present in even an infinitely large study, whereas increasing the study size can reduce random error.
- Three types of bias have been distinguished in epidemiological studies (i.e. **information bias, selection bias and confounding**).

Validity aspects - confounding

- **Confounder is a risk factor of disease in question, is associated with exposure in the source population and is not an intermediate step in the causal pathway between exposure and disease.**

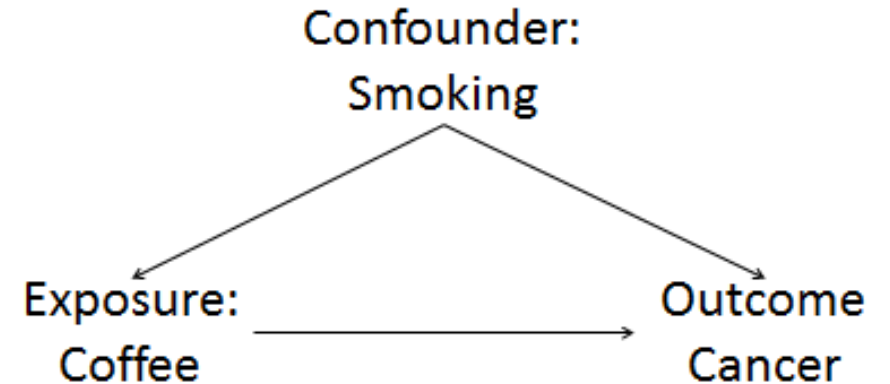
Confounding

To be a confounding factor, two conditions must be met:



Be associated with exposure
- without being the consequence of exposure

Be associated with outcome
- independently of exposure (not an intermediary)



Urban green space interventions

- Urban green space significantly modify green space characteristics through :
 - creating new green space;
 - changing or improving green space characteristics, use and functions; or removing / replacing green space.
- The interventions are **implemented in publicly accessible green space**, including school yards, private parks and similar settings if they are open to the public.
- Urban green spaces in this context are considered as **spaces covered by any type of vegetation**

Green areas epidemiology - priority areas for further research

- **What works, in which circumstances and for whom?**
- A key question for research, is the **required dose of and exposure to urban green space** – what is the minimum amount per person required, and **what is the ideal type of urban green space?**
- **Practical research** to help municipalities choose between urban green space interventions based on the evidence and outcomes would provide useful guidance for action

Health benefits which can be gained due to “natural base solutions” (NBS)

It is expected that: “Actions should deliver visionary and integrated solutions (e.g. **therapy gardens, urban living rooms, creative streets, city farms**) at the intersection of social, cultural, digital and nature-based innovation to increase citizens' health and well-being in cities.”

These solutions should address

- social,
- cultural,
- economic and
- environmental determinants of health and well-being support urban communities in
 - reducing their exposure to climate-related risks, pollution (including noise),
 - environmental stress and social tensions, including the negative effects of gentrification.

What is human well-being?

Human well-being is assumed to have **multiple constituents**, including the ***basic material for a good life***, such as secure and adequate livelihoods

- enough food at all times,
- shelter,
- clothing, and a
- access to goods;

healthy physical environment, such as

- clean air and
- access to clean water;

good social relations, including social cohesion, mutual respect, and the ability to help others and provide for children;

security, including secure access to natural and other resources,

personal safety, and security from natural and human-made disasters; and

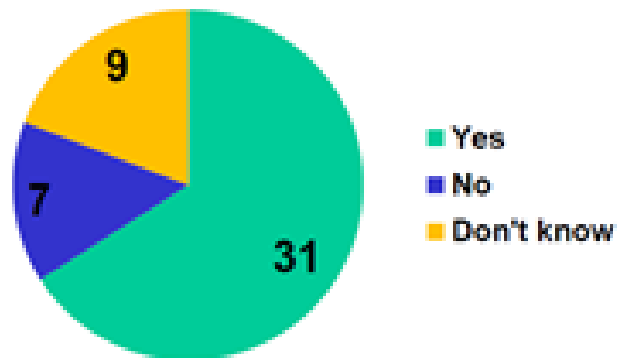
freedom of choice and action, including the opportunity to achieve what an individual values doing and being

Urban green space – when they work?

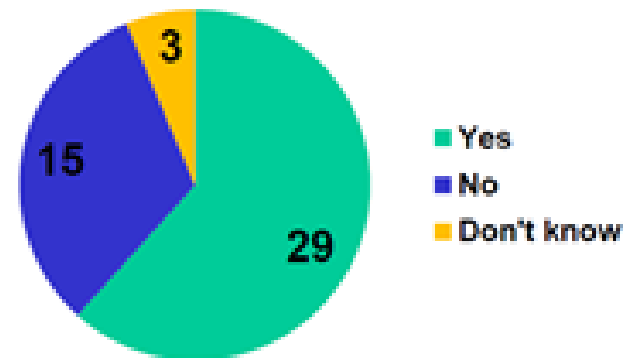
- Urban green space interventions are most effective when a dual approach is adopted where a **physical improvement to the environment is coupled with a social engagement/participation** element.
- Urban green space interventions need **to be planned and designed with the local community and the intended green space users.**
- This will ensure the derivation of benefits for the local community and will aid the delivery of **interventions that serve the needs of the community** -especially in deprived areas.

Process and outcome evaluation of the case studies: an area for improvement!

Process evaluation (n=47)



Outcome evaluation (n=47)



Evidence review on green space intervention effectiveness

Promising evidence

- Park-based interventions combined with social promotion programmes (7/7)
- Greening of vacant lots (4/5) and street trees (4/4)
- Storm water management (6/7)

Mixed/inconclusive evidence

- Park-based interventions without social promotion programmes (2/6)
- Greenways/trails (3/6)

Limited or no evidence

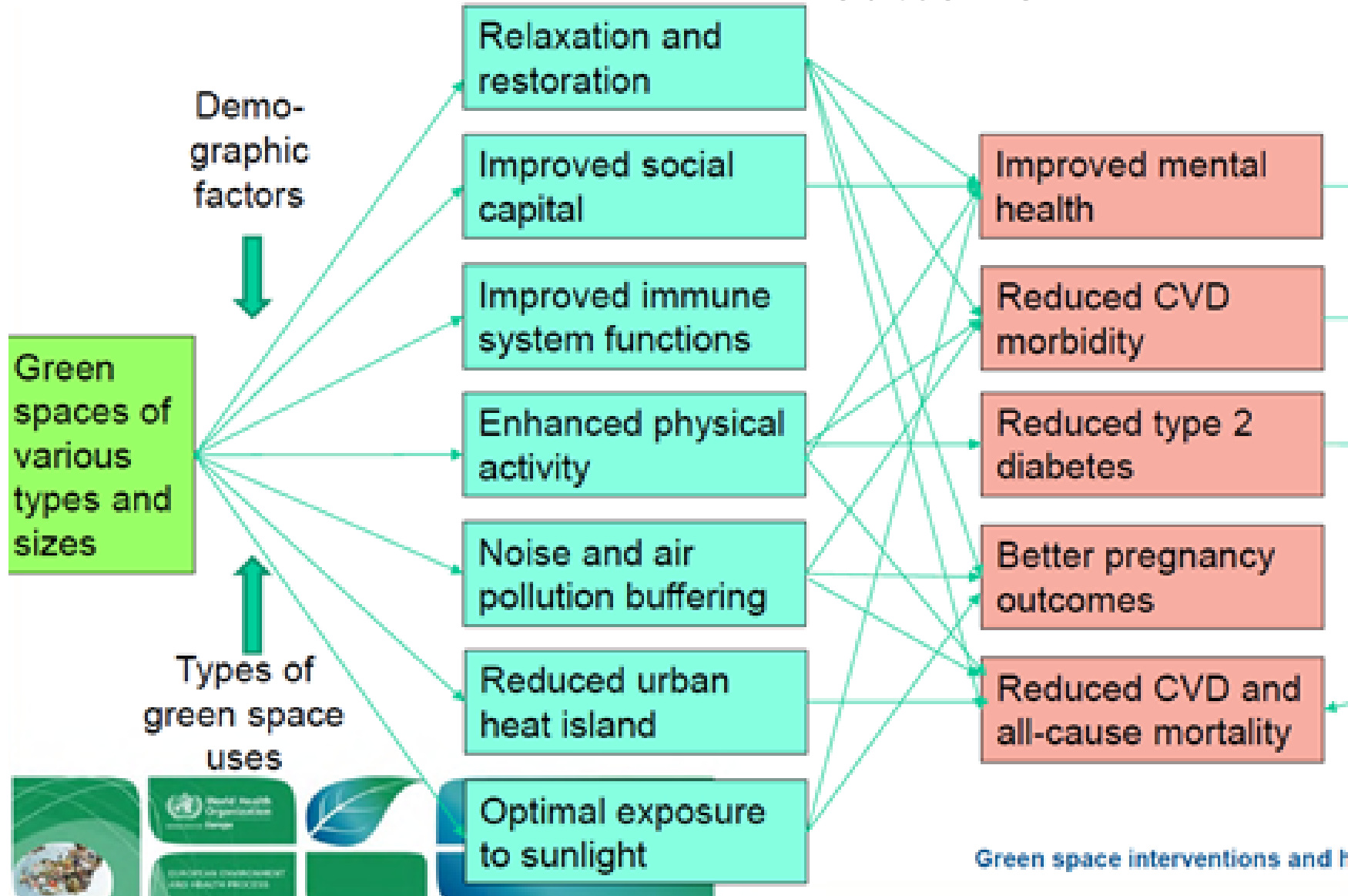
- Cooling buildings (1/1)
- Green walls, allotments, urban agriculture (0/0)
- *Long-term impacts*
- *Economic benefits*
- *Adverse/unintended consequences*
- *Differential impacts on equity factors*

Identify the pathway

- It is important to understand the aims and objectives of the intervention and to **clearly identify the pathway** through which the intervention aims to achieve its main expected outcome.
- This understanding will help **identify relevant indicators** for establishing the baseline data for the intervention.
- For example, if the intervention aims to deliver improved physical health among local residents then indicators such as Body Mass Index and current **levels of physical activity** among local communities would be relevant health baseline data for informing the intervention

Pathways to health

Different pathways – orientation on hazard or/and outcome



Cross-sectional vs prospective approach

Cross-sectional approach – the selection of population living/using NBS opportunities and the comparison one with no access to NBS.

- The H&W status of both population is measured in one point time.
- The prevalence (frequency of given H&W indicators) is compared between two groups.
- Usually adjustment is made to control for socio-economic and life-style factors (confounders).

Exposure to Neighborhood Green Space and Mental Health: Evidence from the Survey of the Health of Wisconsin

- Outcome measures comprise the three scales of the 42-item **Depression Anxiety and Stress Scales** (DASS) instrument.
- Results indicated a largely consistent finding that **higher levels of neighborhood green space are associated with better mental health outcomes**, when considering a range of possible confounding factors.

The Influence of Proximity to City Parks on Blood Pressure in Early Pregnancy

- The effect of **proximity to city parks** on blood pressure categories during the first trimester of pregnancy was investigated.
- The cross-sectional study included 3,416 female residents of the city of Kaunas, Lithuania.
- **The findings of this study suggest a beneficial impact of nearby city parks on blood pressure amongst 20- to 45-year-old women.**

Regina Grazuleviciene Int. J. Environ. Res. Public Health 2014, 11 2959

Other examples of cross-sectional studies

- Population level studies have examined the **role of green space, stress and mental health in**
 - several **European countries** [Roe, J.J 2013; Thompson, C.W.; 2012; Maas, J.2009; and
 - **New Zealand** [Nutsford, D 2013,
 - several **US studies** have examined the health benefits of green space more generally [Donovan, G.H 2011; Donovan, G.H 2013; Almanza, E. 2012; Richardson, E.A 2012)
- A program to green vacant lots in **Philadelphia** significantly reduced stress [Maas, J.; 2009) and another
- a weak association between green space and mental health in **Miami** [Miles, R. 2012).
- a positive impact of green space for stress reduction in **Chicago**,

Prospective cohort

Study pre – and post in intervention and comparison population.

- The first step is selection of **“exposed ”** population and a **comparison one (not exposed)**.
- **A base-line evaluation** of selected Health &Wellbeing (H&W) indicators is performed in both populations.
- The second step is a **second (follow-up) study H&W** within selected time periods sufficient to document a change in health.
- .

Before-After-Control-Impact (BACI-design)

- There is **a need for prospective and intervention studies**, to supplement and strengthen the evidence base (WHO Europe, 2017a).
- This implies that **measurements start before the intervention and continue afterwards**, but also that similar measurements are conducted in reference situations (without intervention).
- It is important that **reference situations are similar in all respects, except for the implementation of the NBS** itself.

Advantages of prospective approach

- In general prospective cohort approach is superior as it allows for **better control selection bias** (persons with poorer health might be more interested in NBS solution than healthier ones or NBS solution might be more promoted by persons with better health than those with poorer ones).
- The prospective approach **allows to better document what is cause and effect**. So we avoid reverse causation trap

Consider the non-users – avoid selection bias

- In addition to monitoring the use of the green space and satisfaction among users it is also important **to collect data from people who aren't using the green space** and to understand what the related barriers.
- **Use observational data of green space** use as a relatively simple and cost-efficient way to assess
 - how many people are using green space?
 - what types of people are using it ?
 - who they are using it with?
 - for what purposes ?

Typical follow-up usually not possible

- Usually, it will not be possible to follow an individual through time, **because a new sample will be drawn for each subsequent measurement wave** (unless it is a panel or cohort-study, in which the same people are approached every time) (Droomers et al. 2016).

Predecessors (mediators) of the anticipated health

- When health aspects cannot be monitored directly/for a sufficiently long period, **impacts on predecessors may be translated to health impacts.**
- What such predecessors are, depends on the **hypothesized pathway or mechanism** by which nature, or contact with nature, might affect health.

Accumulation

- Effects on human health in terms of a lower incidence of diseases and disorders **may only become apparent after quite some time.**
- This may be due to a certain accumulation of exposure being needed to have an impact and/or a long ***incubation period*** before the disease becomes manifest

A response curve

- **Longer periods of measurement**, pre- as well as post NBS-implementation, will help to establish impacts more firmly.
- In the case of post-measurements, this will also **allow to establish a response curve:**
 - do impacts occur right away or
 - only after some time;
 - **are they short-lived or sustained ?** (Alcock et al., 2014)

Options which health data to gather

- A first option is to make use of already regularly gathered (and accessible) data.
- **Registry data are data gathered** by e.g.
 - municipalities (demographics),
 - **GP's (visits, diagnoses, prescriptions),**
 - hospitals (admissions, anamneses, diagnoses, procedures performed, length of stay, prescriptions) and health insurance companies (reimbursements).
- Within the boundaries of the registration, the total population is included, rather than a sample

Type of measurements

- An important difference is that between **self-report measures and more objective ones.**
- By many stakeholders the latter are considered **more reliable and meaningful**, implying that positive outcomes reported in such terms are more likely to be acted upon.
- For example, stress levels are **usually self-reported**, but nowadays may also be measured by the level of cortisol in a hair sample (see Honold et al., 2016).
- The trade-off is usually between level of objectivity and costs of data gathering

The density of street trees in London boroughs and rates of antidepressant prescribing - prospective study

- After adjustment for potential confounders, including unmeasured area-effects using Bayesian mixed effects models, **a small inverse association, with a decrease of 1.18 prescriptions per thousand population per unit increase in trees per km of street** (95% credible interval 0.00, 2.45) was found (2009-2010 data).
- Further research is needed to confirm this and **to investigate mechanisms**, but this study indicates that street trees may be a positive urban asset for mental health

Mark S Taylor Landscape & Urban Planning Volume 136, April 2015, Pages 174–179



Longitudinal Effects on Mental Health of Moving to Greener and Less Green Urban Areas

- The samples were participants in the British Household Panel Survey with mental health data (General Health Questionnaire scores) for five consecutive years, and who relocated to a different residential area between the second and third years ($n = 1064$; observations = 5320).
- Compared to premove mental health scores, **individuals who moved to greener areas** ($n = 594$) **had significantly better mental health** in all three postmove years, supporting a “shifting baseline” hypothesis.
- Individuals who moved to less green areas ($n = 470$) showed significantly worse mental health in the year preceding the move but returned to baseline in the postmove years.
- **Moving to greener urban areas was associated with sustained mental health improvements, suggesting that environmental policies to increase urban green space may have sustainable public health benefits.**

Alcock, I. Environmental science & technology, 48(2), 1247-1255.



The impact of greenery on physical activity and mental health of adolescent and adult residents of deprived neighborhoods: A longitudinal study.

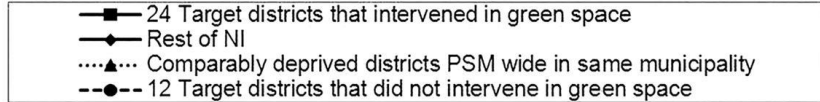
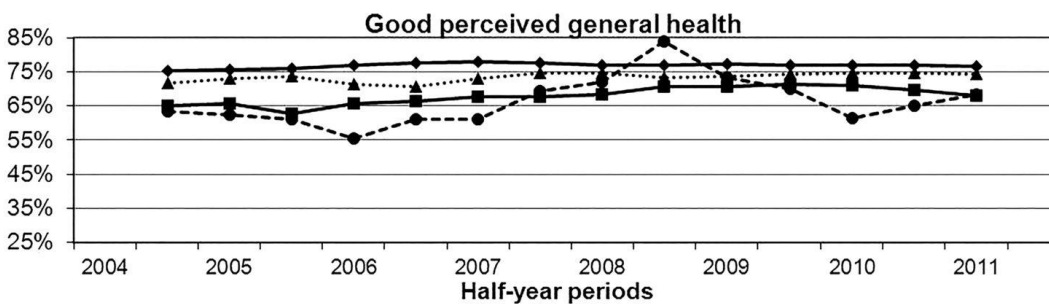
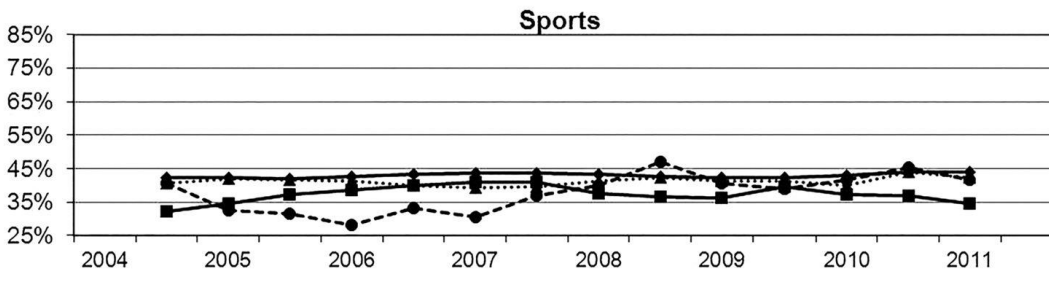
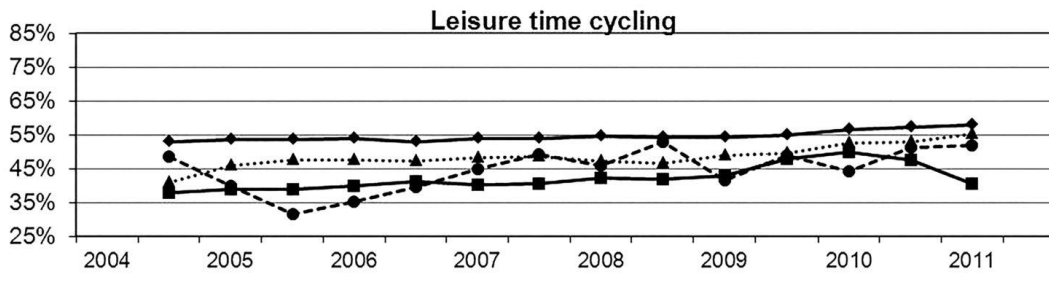
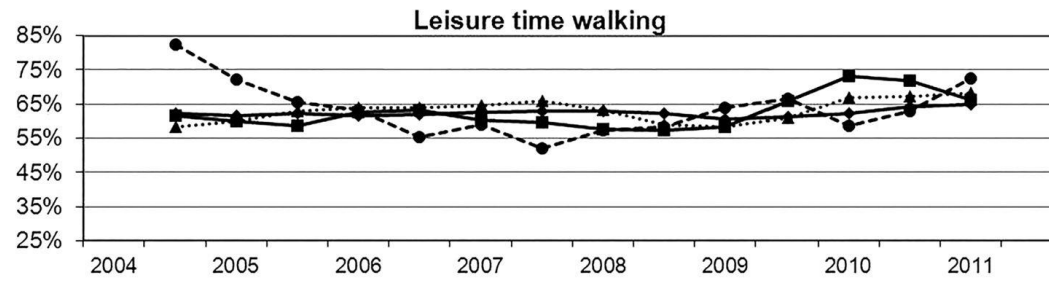
- The aim of the study is **to assess the impact of perceived and objective changes in greenery on physical activity and mental health of adolescents and adults living in severely deprived neighborhoods** in the Netherlands.
- Longitudinal data regarding changes in greenery, walking, cycling, and depressive symptoms (CES-D), were gathered for **401 adolescents and 454 adults**, using questionnaires and interviews with local district managers.
- Multivariate linear regression models examined the association between greenery and outcome variables, correcting for demographic and socioeconomic covariates and season.
- **Overall, the results showed small and non-significant associations, with two exceptions.**
- Objective improvements in greenery were associated with **smaller decline in adolescents' leisure time cycling**, and improvements in perceived greenery were related to a **decrease in adults' depressive symptoms**. In addition, there were several subgroup effects.
- In conclusion, changes in greenery did not yield consistent positive results among residents of severely deprived neighborhoods.

The impact of intervening in green space in Dutch deprived neighbourhoods on physical activity and general health - quasi-experimental URBAN40 study

- **Background** Many problems concentrate in deprived neighbourhoods, among which is poor health. One possible way to address these health problems **is to invest in the green space in deprived neighbourhoods**.
- This study investigated the impact of real-life changes in the quality or quantity of green space in severely deprived neighbourhoods **on physical activity and perceived general health**.
- **Methods** Repeated cross-sectional surveys from 2004 till 2011 yielded self-reported information on leisure time walking, cycling and sports, and perceived general health of 48 132 adult residents.
- **Results** The deprived neighbourhoods that intervened in green space **did not show more favourable changes in the trend of physical activity and good general health** compared to all the different groups of control areas.
- **Conclusions** This suggests that greening interventions that have been carried out in the context of the Dutch District Approach **did not achieve short-term health gains among adults**.

Droomers, M. *J Epidemiol Community Health*, 70(2), 147-154.

The impact of intervening in green space in Dutch deprived neighbourhoods on physical activity and general health



Droomers, M. *J Epidemiol Community Health*, 70(2), 147-154.

The lack of a health impact of improvements

It has been suggested that in the Netherlands, greening of the environment is just

- **the adding of extra green space to the already present green space** and hence,
- is one of **providing a new location for existing physical activity patterns** instead of leading to an increase in the number of people who are physically active

Conclusions

- The epidemiological concept of evaluating the change in health status as consequence of positive/negative changes in environment offers a unique **opportunity to be used in evaluation of benefits of use of NBS**
- **The outcome measurements** are as important as process ones
- To address the “health effects” of green area a **measurable indicators of health & wellbeing** have to be developed.

Conclusions

- In general prospective **cohort approach is superior** as it allows for better control selection bias (persons with poorer health might be more interested in NBS solution than healthier ones).
- The prospective approach allows to **better document what is cause and what is effect**. So we avoid reverse causation trap - Before-After-Control-Impact designs
- The **intervention pathways** should be identified on design level – crucial to select health indicators
- Self-report measures if possible should be replaced by health **measurements tools**

Acknowledges

Dr Sjerp de Vries
Senior Social Scientist
Wageningen Environmental Research
The Netherlands

For valuable discussion on epidemiological
aspects of green areas

ZIP CODE
74137

\$81,322 Median Household Income

8.8% Percent Below Poverty

80.4 Life Expectancy (years)



ZIP CODE
74126

\$25,191 Median Household Income

38.2% Percent Below Poverty

69.7 Life Expectancy (years)

Data based from the years 2011-2013.

Tulsa, Oklahoma

Your zip code may be more important than your genetic code



A TALE OF TWO ZIP CODES

with GEORGE TAKEI



MEET DEB & MARIA

Deb & Maria live one mile apart, but Deb will live 18 years longer than Maria.

Watch to find out why!