Practical Class 4

Risk factors and causality. Measurement of diseases and exposure. Morbidity data sources.

Conspectus topics (14,15,16)

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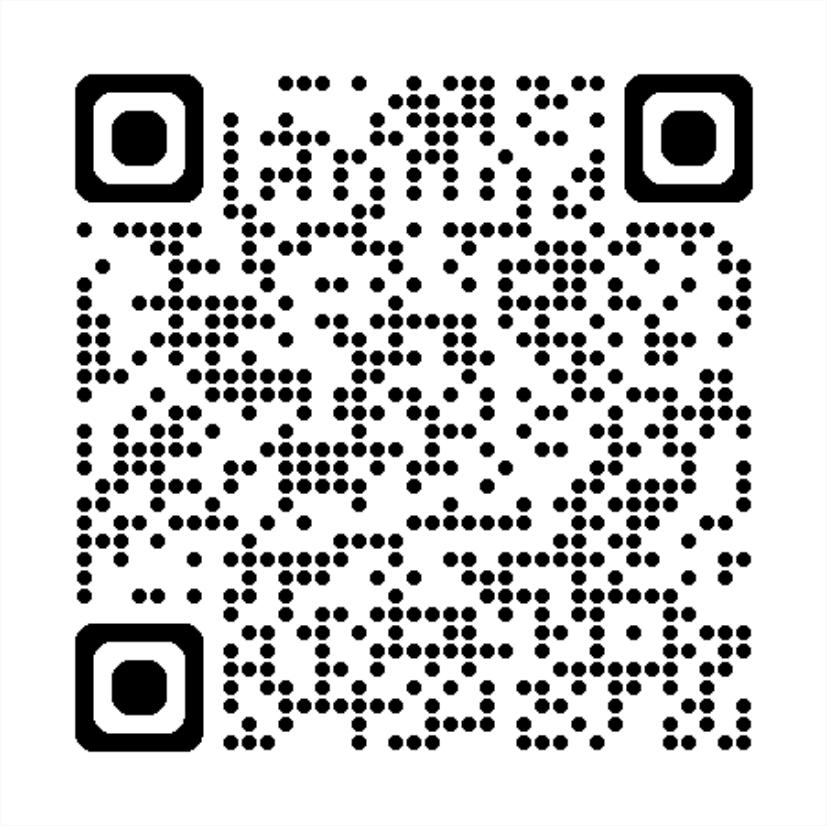
Department of “Social Medicine and Public Health”

download the presentation from https://tinyurl.com/social-med-class-04

15-minutes reading assignment



https://kostadinoff.github.io/learning.html

Group tasks

https://kostadinoff.github.io/tasks.html

Outline

1. Risk Factors & Causality
2. Measurement of Disease & Exposure
3. Case Finding & Case Reporting
4. Morbidity Data Sources
5. National Health Information System (NHIS)

Risk Factors & Causality

Risk Factors — Definition

- A risk factor is any characteristic, condition, or behaviour that increases the probability of developing a specific disease or adverse health outcome.
- Key distinction: association ≠ causation — all causal relationships exhibit statistical association, but not all associations are causal.
- Exposure — the moment and manner of contact with a risk factor; characterised by both **intensity** (power) and **duration** of contact.

Classification of Risk Factors

1. Modifiable (smoking, diet) vs. Non-modifiable (genetics)
2. Behavioural (individual choices) vs. Environmental (pollution, occupational hazards)
3. Biological (hormonal, immunological) vs. Social (poverty, education, access to care)
4. Proximal — direct pathophysiological link (hypertension, hyperglycaemia) vs. Distal — indirect, via intermediate variables (socioeconomic status)
5. Primary — direct causal link (smoking → lung cancer) vs. Secondary — indirect, through primary factors (obesity → insulin resistance → diabetes)

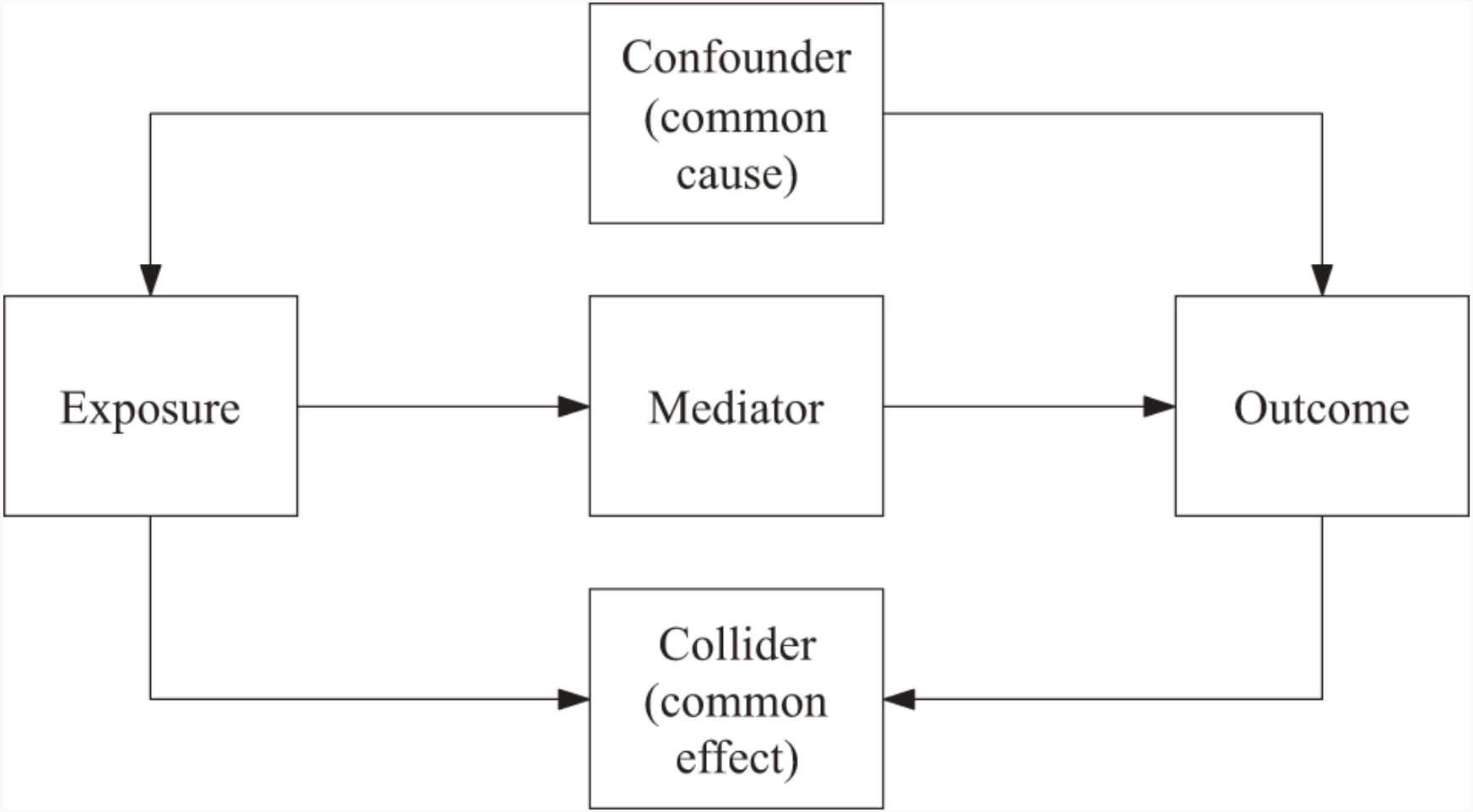
Causality — Concept

- Causality refers to the relationship in which a cause is responsible for producing the observed effect, established through rigorous scientific inquiry and adherence to specific criteria.
- Establishing causality in medicine requires: convergence of evidence across multiple study designs, explicit causal criteria, and ruling out bias, confounding, and chance.
- Temporal relationship — cause must **always** precede the effect — is the **only obligatory** criterion.

Bradford Hill Criteria (1965)

1. Strength of association — stronger statistical association → more likely causal
2. Consistency — reproducible across researchers, times, places, and methods; with explanations for discrepancies
3. Specificity — more precisely disease and exposure can be defined, the stronger the observed association
4. Temporal relationship — the presumed cause must always precede the effect **(only obligatory criterion)**
5. Biological gradient — dose-response: changes in exposure intensity lead to corresponding changes in disease occurrence
6. Plausibility — logical explanation consistent with medical knowledge and science
7. Coherence — all observations and results consistent with the hypothetical model
8. Experimental evidence — in experimental conditions, changes in the cause lead to changes in the outcome
9. Analogy — association resembles similar described phenomena and events

Causal Diagrams (DAGs)



DAGs — Key Concepts

- A directed acyclic graph (DAG) represents hypothesised causal relationships as nodes (variables) and directed arrows (causal effects); no variable can cause itself through circular pathways.
- Causal paths — directed from exposure to outcome following the temporal sequence of causation.
- Confounding paths — a common cause influences both exposure and outcome, creating spurious association.
- Collider paths — a common effect of exposure and outcome; conditioning on a collider **opens** a spurious association between otherwise independent variables.

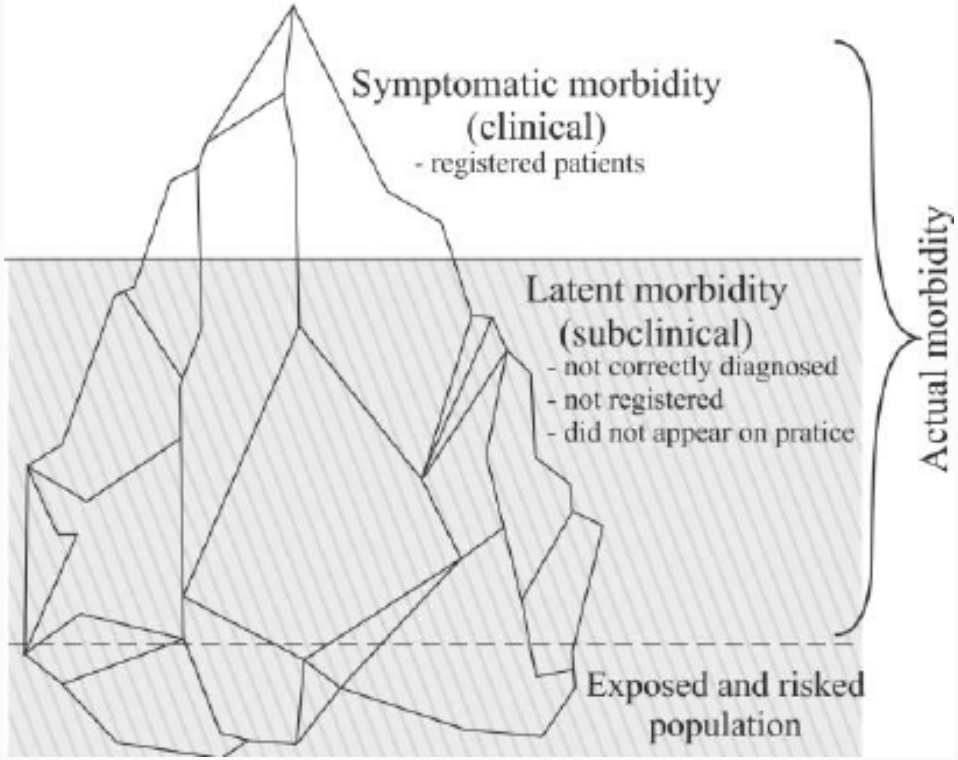
Measurement of Disease & Exposure

Core Concepts: Illness, Disease, Sickness

- Illness — the **subjective** experience of being unwell; symptoms as perceived by the patient, prompting healthcare seeking.
- Disease — an **objective** pathological condition identified by clinical examination, laboratory testing, or imaging; the medical construct used for diagnosis.
- Sickness — a broader social and administrative term encompassing physical and mental aspects of poor health, used interchangeably in common discourse.

Surveillance systems capture **diagnosed disease**, not the subjective experience of illness — a distinction critical for interpreting morbidity data.

The Morbidity Iceberg



Visible portion — reported and diagnosed cases known to health services.

Hidden portion — undetected cases due to:

- Mild or absent symptoms
- Lack of healthcare access
- Underdiagnosis by providers
- Asymptomatic infection
- Stigma and under-reporting

Prevalence estimates from diagnosed cases alone **substantially underestimate** true disease burden.

Incidence (Incident Cases)

- Incidence refers to the rate at which **new events** occur in a population, taking into account the variable time periods during which individuals are disease-free and thus "at risk."
- The numerator is the number of new events in a defined time period the denominator is the population at risk during this period.

$$I = \frac{\text{Number of new events}}{\text{Population at risk}} \times \text{Time} \times 10^n$$

Incidence Rate vs. Cumulative Incidence

- Incidence rate (incidence density) — divides new cases by total **person-time** at risk; expressed per 1 000 person-years; no upper bound; has dimension of inverse time.

$$I_{\text{rate}} = \frac{\text{New cases}}{\text{Total person-time at risk}} \times 10^{n}$$

- Cumulative incidence (risk / attack rate) — proportion of initially disease-free individuals who develop disease over a defined period; dimensionless, ranges 0–1.

$$\text{CI} = \frac{\text{New cases during period}}{\text{Population at risk at start of period}}$$

Cumulative Risk — Further Distinctions

- Cumulative risk accumulates age-specific rates over an age span (typically 0–64 or 0–74 years) — the probability of developing disease in the absence of competing causes of death.
- For rare diseases (cumulative risk < 10%), approximated by the cumulative rate — the simple sum of age-specific incidence rates.
- General conversion between rate and risk over interval Δt:

$$\text{Risk} = 1 - e^{-I_{\text{rate}} \times \Delta t}$$

What Changes in Incidence Signal

- Rising incidence — emergence of new or potent risk factors, environmental exposures, epidemics, inadequate vaccination, or low levels of prevention.
- Falling incidence — effective primary prevention, improved vaccination coverage, better sanitation, or targeted health policy.
- Incidence rate and cumulative incidence converge when follow-up is complete and uniform; the incidence rate is preferred when substantial variation in observation time exists.

Prevalence (Prevalent Cases)

Prevalence is the number of persons in a defined population who have a specified disease or condition at a given point in time (or time period) — regardless of when disease onset occurred.

- Point prevalence:

$$P_{\text{point}} = \frac{\text{All cases at a specific point in time}}{\text{Total population at that point}} \times 10^n$$

- Period prevalence:

$$P_{\text{period}} = \frac{\text{Cases at any time during a period}}{\text{Total population during the period}} \times 10^n$$

Prevalence — Governing Factors & Relationships

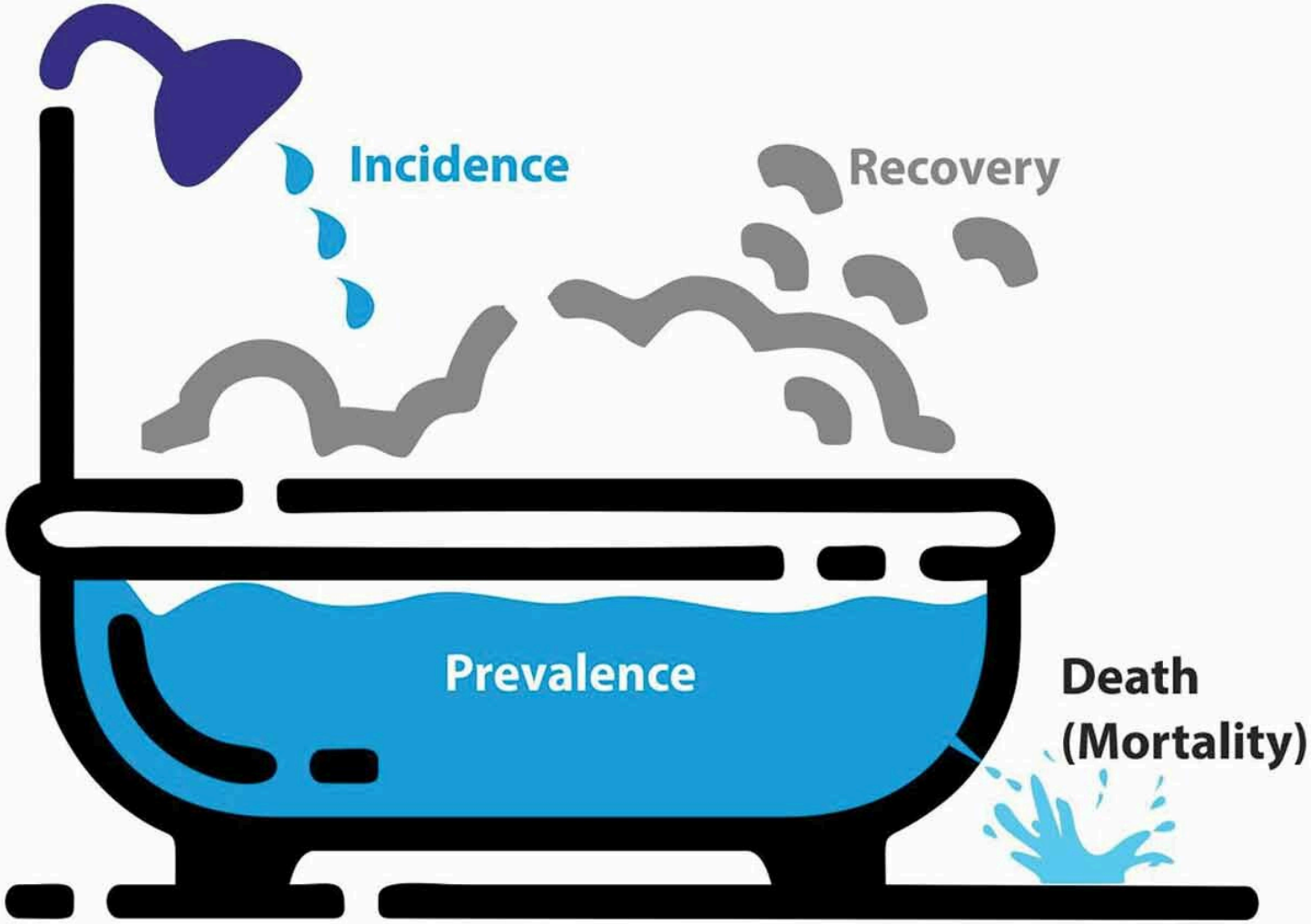
- Prevalence increases with longer disease duration, lower case-fatality, improved survival without cure, higher incidence, or better diagnostic detection.
- Prevalence decreases with shorter disease duration, higher case-fatality, or effective curative treatment.
- Under steady-state conditions (stable population, constant incidence and prevalence):

$$P \approx I \times D$$

where D = average disease duration.

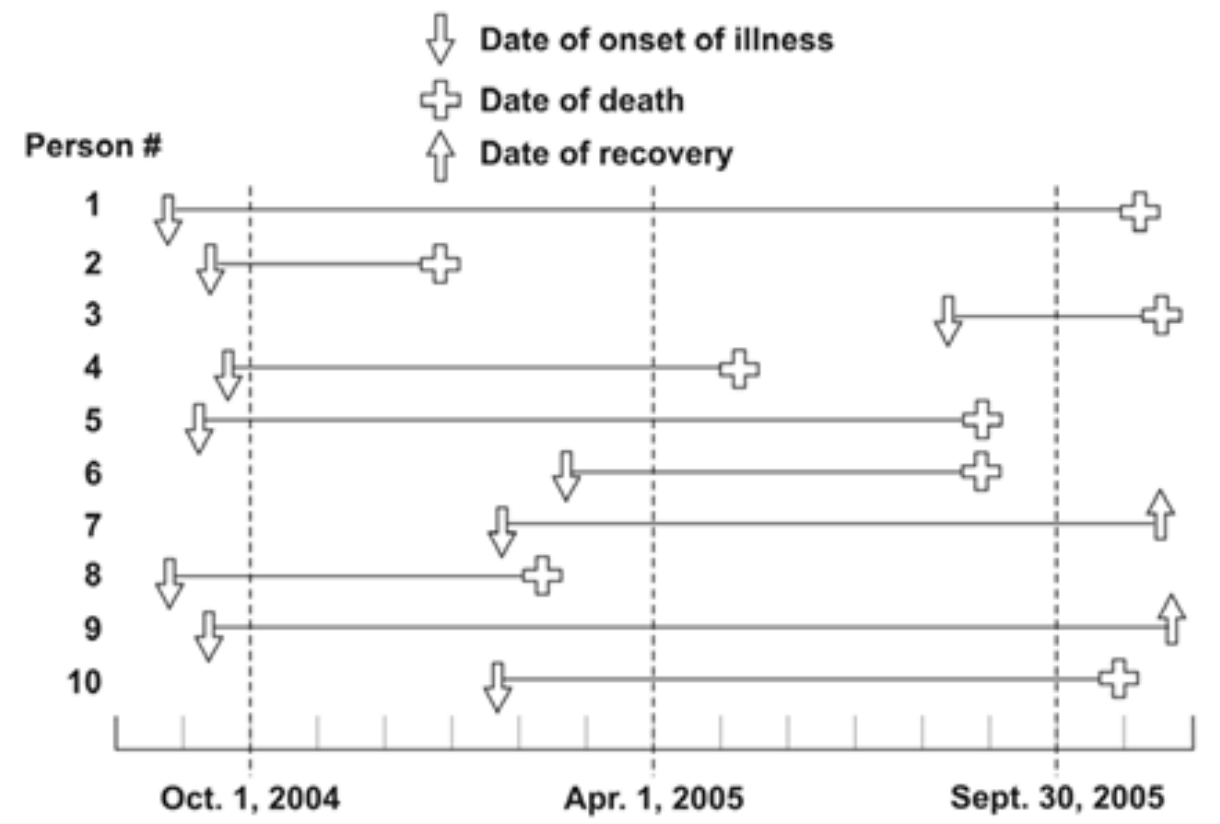
- Prevalence odds (ratio of diseased to non-diseased) exactly equals $I_{\text{rate}} \times D$.

Incidence vs. Prevalence



Incidence vs. Prevalence — Calculations

In a closed population with no migration, susceptible population is 100 individuals:



Measurement of Exposure

- The measurement of exposure involves quantification of **intensity**, **frequency**, and **duration** of contact with a particular factor or agent.
- Requires at least two groups: the exposed and the unexposed to the factor under investigation.
- Key exposure metrics: Relative Risk (RR), Odds Ratio (OR), Risk Difference (RD), and the attributable measures AF%, PAR, PAR%.

Relative Risk (RR)

- Relative risk is the ratio of disease incidence in the **exposed** to disease incidence in the **unexposed**; measures the strength of association. Range: $[0, +\infty)$.

$$\text{RR} = \frac{\text{Incidence of disease in the exposed}}{\text{Incidence of disease in the unexposed}}$$

- RR = 1 → no association between exposure and disease
- RR > 1 → exposure increases disease likelihood (risk factor)
- RR < 1 → exposure decreases disease likelihood (protective factor)

Odds Ratio (OR)

- The odds ratio is the ratio of the **odds** of disease in the exposed to the **odds** in the unexposed — the preferred measure in **case-control studies** where incidence cannot be directly calculated.

$$\text{OR} = \frac{\text{Odds of disease in the exposed}}{\text{Odds of disease in the unexposed}}$$

- OR = 1 → equal probability in both groups
- OR > 1 → event more likely in the exposed group
- OR < 1 → event less likely in the exposed group

Risk Difference (Attributable Risk)

- The attributable risk (risk difference) is the absolute excess incidence in the exposed group attributable to the studied risk factor.

$$\text{RD} = \text{Incidence (exposed)} - \text{Incidence (unexposed)}$$

- If RD = 0.05 → 5 per 100 exposed individuals developed disease as a result of the exposure.
- Number Needed to Harm (NNH) — number of exposed individuals required to produce one additional case:

$$\text{NNH} = \frac{1}{\text{RD}}$$

Attributable Fraction in the Exposed (AF%)

- The attributable fraction is the relative proportion of cases in the **exposed group** that are attributable to the exposure.

$$\text{AF\%} = \frac{\textbf{Incidence in the exposed} - \textbf{Incidence in the unexposed}}{\textbf{Incidence in the exposed}} \times 100\%$$

Answers: *"What proportion of disease in exposed individuals would be prevented by eliminating the exposure?"*

Population Attributable Risk (PAR) & PAR%

- PAR — the absolute excess incidence in the **entire population** (exposed + unexposed) attributable to the exposure.

$$\text{PAR} = \text{Incidence in the entire population} - \text{Incidence in the unexposed}$$

- PAR% (Population Etiologic Fraction) — the relative proportion of all disease in the entire population attributable to the exposure.

$$\text{PAR\%} = \frac{\text{Incidence (entire population)} - \text{Incidence (unexposed)}}{\text{Incidence (entire population)}} \times 100\%$$

PAR% guides public health priority-setting: it accounts for both association strength and exposure prevalence.

Summary: Exposure Measures

Measure	What it quantifies	Study design	Scale
RR	Relative incidence ratio	Cohort	$[0, +\infty)$
OR	Relative odds ratio	Case-control	$[0, +\infty)$
RD / AR	Absolute excess risk	Cohort / RCT	$[-1, 1]$
NNH	Exposed per extra case	Clinical	$[1, +\infty)$
AF%	Excess fraction — exposed	Cohort	0–100%
PAR	Excess cases — population	Population	Absolute
PAR%	Attributable fraction — population	Population	0–100%

Case Finding & Case Reporting

Case Finding

Case finding is the process of identifying individuals who meet a specific case definition for a disease — a critical step in outbreak investigation and ongoing programme management.

- Passive case finding — patients present at healthcare facilities on their own initiative due to symptoms (e.g., TB at primary health centres).
- Active case finding — public health officials proactively search for cases rather than waiting for spontaneous presentation.

Active Case Finding — Methods

- Searching through existing surveillance and laboratory data for unreported cases.
- Surveying physicians and clinical laboratories for diagnoses typical of a current outbreak.
- Contact tracing — interviewing known cases to identify secondary cases.
- Public announcements via mass media encouraging individuals with specific symptoms to come forward.

Approaches: population-based (entire community; avoids healthcare-access bias) vs. healthcare provider-based (individuals already in contact with health services).

Case Definitions in Outbreak Investigation

- A case definition combines clinical criteria (signs, symptoms), laboratory results, and orientations regarding time, place, and person.
- Early stages → broad (sensitive) definition to capture as many cases as possible; refined later to high specificity.
- Three levels of certainty:
  - Possible — compatible clinical presentation alone
  - Probable — clinical + epidemiological link or preliminary laboratory result
  - Confirmed — definitive laboratory evidence or specific diagnostic criteria

Case Reporting Systems

Case reporting (notification) systems are the structured mechanisms by which information about identified cases is transmitted to public health authorities.

- Passive reporting — most common; mandated by law; providers and laboratories report "notifiable" diseases; fewer resources required but prone to underreporting.
- Active reporting — health officials regularly contact providers to collect data; more complete and timely but resource-intensive.
- Mandatory (statutory) reporting — legally required for specific communicable diseases (cholera, plague, smallpox).
- Voluntary reporting — used for less severe or emerging conditions without legal obligation.

Identification, Privacy & Global Systems

- Nominative notifications — include patient identifying details; enable contact tracing and individual follow-up.
- Non-nominative notifications — anonymous; used primarily for statistical trend monitoring.
- Modern systems use electronic and web-based platforms (e.g., CATI) to accelerate data collection and analysis.
- International networks: WHO FLUNET (influenza); ECDC TESSy (Europe); CDC MMWR (USA).
- Systems are evaluated by sensitivity (ability to detect true cases) and timeliness in triggering a public health response.

Barriers to Reporting

- Reporting may be delayed or suppressed due to:
  - Fear of social stigma associated with diagnosis
  - Concerns about travel restrictions or economic sanctions
  - Poor provider compliance or inadequate documentation practices
  - Incomplete access to healthcare or diagnostic services

Morbidity Data Sources

Disease Registration — Purposes

1. Control of infectious diseases — timely detection enables isolation, contact tracing, targeted vaccination.
2. Planning and evaluation of preventive programmes.
3. Assessment of necessary healthcare services.
4. Evaluation of the economic burden of diseases.
5. Research into etiology and pathogenesis.
6. National and international studies on disease prevalence and disability.

ICD — International Classification of Diseases

- Developed and maintained by WHO since 1948; provides standardised nomenclature and coding for diseases, injuries, and causes of death.
- Uses a hierarchical alphanumeric structure enabling systematic electronic processing and international comparability.
- Three major cause groups:
  - Group I — communicable, maternal, perinatal, and nutritional conditions
  - Group II — non-communicable and degenerative diseases
  - Group III — injuries

N48.2 Other inflammatory disorders of penis

Abscess
Boil
Carbuncle
Cellulitis
of corpus cavernosum and penis

Cavernitis (penis)

Use additional code (B95-B98), if desired, to identify infectious agent.

N48.3 Priapism

Painful erection

N48.4 Impotence of organic origin

Use additional code, if desired, to identify cause.

Excl.: psychogenic impotence (F52.2)

ICD-10 and ICD-11

- ICD-10 — adopted 1990; implemented from 1994; 22 chapters; alphanumeric codes; over 70 000 coded units. Mandatory in Bulgaria since **Regulation 42 (2004)**.
- ICD-11 — 28 chapters; digital-first design; adopted by WHO May 2019; in force January 2022. Structural innovations include harmonisation with DSM-5, genomic extensions, and new chapters for traditional medicine and sleep-wake disorders.
- Clinical modifications (e.g., ICD-10-CM in the USA with > 69 000 codes) introduce national variations that can undermine international comparability.

Legal Framework

Regulation 42 of December 8, 2004, on the Introduction of Classification Statistical Systems for Coding Diseases and Health-related Problems and Medical Procedures:

> Healthcare institutions, regional health inspectorates, physicians, dentists, pharmacists, and other medical and non-medical professionals handling health and medical statistical information shall apply in medical and medical-statistical documentation the International Statistical Classification of Diseases and Related Health Problems – Tenth Revision (ICD-10).

Legal Framework

Regulation on the Procedure for Reporting, Registration, Confirmation, Appeal, and Reporting of Occupational Diseases:

Practicing physicians and dentists, when suspecting an occupational disease, promptly send a notification to the territorial division of the National Social Security Institute (NSSI) at the permanent address of the individual and to the insurer with acknowledgment of receipt within 5 working days of clinical diagnosis.

Legal Framework

Regulation 21 of July 18, 2005, on the Procedure for Registration, Reporting, and Reporting of Infectious Diseases:

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Cases of infectious diseases are classified into the following categories
during registration, reporting, and reporting:
1. Possible case of infectious disease.
2. Probable case of infectious disease.
3. Confirmed case of infectious disease.
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Legal Framework

Registration of infectious diseases is carried out by healthcare institutions, health cabinets in schools, childcare facilities, specialised institutions for social services, and regional health inspectorates (RHI).

- The Ministry of Health (MoH) establishes and maintains:
  1. A specialised electronic information system for registering patients with HIV.
  2. A specialised electronic information system for registering patients with tuberculosis, suspects, and contacts.

Legal Framework

- The National Centre for Infectious and Parasitic Diseases administers and maintains:
  1. An information system for collecting and analysing data on morbidity from measles, rubella, and epidemic mumps.
  2. An information system for collecting and analysing data on morbidity from influenza and acute respiratory diseases, including a module for case-based surveillance of severe acute respiratory diseases.
  3. A surveillance information system for acute flaccid paralysis.

Legal Framework

Regulation 24 of July 7, 2004, on the Approval of the Medical Standard Psychiatry:

`Patients with risk behaviour in the disease are subject to registration, and the treating psychiatrist is obliged to send patient data to the district information centre.`

Legal Framework

Regulation 3 of April 27, 2000, on Health Cabinets in Childcare Facilities and Schools:

Medical specialists from health cabinets in childcare facilities and schools perform mandatory registration of the health and immunisation status of children and students in the health-preventive card, based on data received from the child's or student's personal (family) physician.

Legal Framework

Regulation 8 of November 3, 2016, on Preventive Examinations and Dispensary Care:

The state establishes and maintains a system for organised screening of the population. The system ensures monitoring, control, analysis, and reporting of screening activity indicators. Healthcare institutions conducting dispensary observation maintain a register (in electronic and paper form) of all individuals under dispensary care.

National Health Information System (NHIS)

Bulgarian National Health Information System (NHIS)

- The National Health Information System (NHIS) collects, processes, and stores information about the health status of the population by creating and maintaining an electronic health record for each citizen.
- The information system includes electronic health records of citizens and all registers, databases, and systems managed by the Ministry of Health and secondary distributors with a budget to the Minister of Health, healthcare institutions, the National Health Insurance Fund (NHIF), and insurance companies.
- Rather than isolated databases per provider, the NHIS creates a federated system where authorised users access relevant information regardless of its origin — balancing care coordination with privacy and data security.

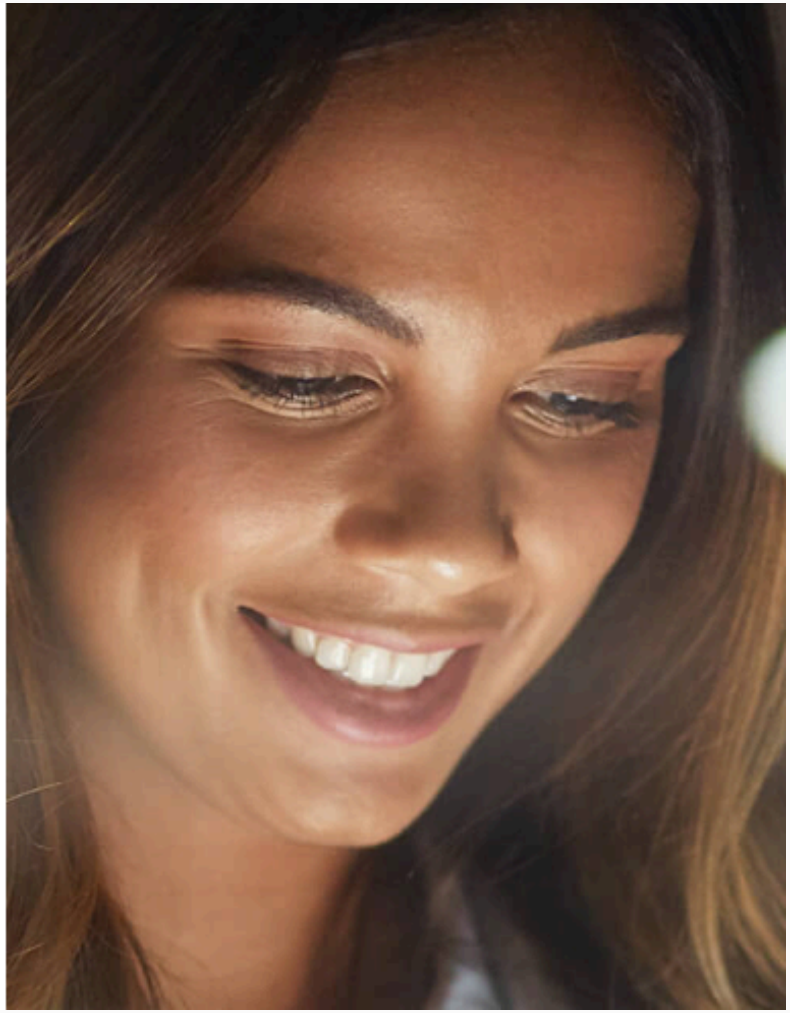
Bulgarian National Health Information System (NHIS)

НАЦИОНАЛНА
ЗДРАВНОИНФОРМАЦИОННА
СИСТЕМА

Електронно
пациентско досие

Вашето пациентско досие е личен електронен архив на здравна информация, защитен с най-високо ниво на информационна сигурност.

Вход с еАвтентикация ›



NHIS — Strategic Objectives

1. Improving medical care quality — EHR-based clinical decision support and systematic quality monitoring.
2. Enhanced diagnosis and error reduction — drug interaction alerts, abnormal result flagging, protocol adherence prompts.
3. Rational pharmacotherapy — real-time prescribing checks; prescription drug monitoring.
4. Facilitating patient–clinician communication — patient portals, secure messaging, telemedicine integration.

NHIS — Strategic Objectives

5. Increased healthcare system efficiency — eliminate redundant testing; streamlined insurance claims.
6. Quick access to data in emergency situations — allergy, medication, and diagnosis data immediately available.
7. Improving screening and preventive activities — systematic identification of eligible populations; proactive outreach.
8. Reducing storage costs — electronic storage replaces costly paper record infrastructure.

Thank you for your attention!