Community Medicine and Research Methodology

MBBS Recap: high-yield notes for revision

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Revision notes for the MEC PG entrance: the measures, formulas, classifications and programme facts an examiner asks in Community Medicine and Research Methodology. Nepal-specific figures are labelled with their source; everything else is WHO or global practice.

Epidemiologic concepts and measures

Measures of disease frequency

Measure	Numerator / denominator	Note
Incidence rate	New cases in a period / population at risk (or person-time)	Measures the **risk of becoming ill**; needs follow-up
Point prevalence	All existing cases at one time / population	Includes old and new cases
Period prevalence	Cases existing at any time in a period / population	
Attack rate	Ill / exposed, in an outbreak over a limited time	A cumulative incidence; no time unit
Secondary attack rate	New cases among **susceptible contacts** of a primary case / susceptible contacts	Measures **infectivity** (communicability)
Case fatality rate	Deaths from a disease / cases of that disease, x 100	Measures **virulence or lethality**; strictly a **proportion**, not a rate (no time); rabies is the classic 100%
Proportional mortality	Deaths from one cause / all deaths	Not a risk

- **Prevalence = incidence x mean duration** (steady state, low prevalence). Any change in prevalence therefore comes from incidence, duration, or both.
- A treatment that prolongs life without curing leaves **incidence unchanged and raises prevalence**. A cure that shortens duration, or a fatal disease with rapid death, lowers prevalence.
- Attack rate in the exposed = ill exposed / all exposed. The common error is dividing by everybody at the event.
- Incidence density uses person-time (person-years) as the denominator, so it handles unequal follow-up.

Mortality and rates in general

- **Crude rate** covers the whole population; **specific rate** covers an age, sex or cause group; **standardised rate** removes the effect of age structure so populations can be compared.
- **Direct standardisation** applies the study populations' age-specific rates to a standard population; use it when age-specific rates are known. **Indirect standardisation** gives the **standardised mortality ratio (SMR)** = observed deaths / expected deaths, used for small populations or unstable rates (occupational groups).
- **Rate vs ratio vs proportion**: a rate measures occurrence over a period (incidence, crude birth and death rates, IMR); a ratio's numerator is not part of its denominator (sex ratio); a proportion has the numerator inside the denominator and ranges 0–1 (prevalence, case fatality).
- **Best indicators** (Park's answers): **IMR** is the most universally accepted indicator of a community's health status and of MCH services; **under-five mortality** is the best single indicator of a country's socio-economic development (UNICEF); **MMR** best reflects maternal care.

Epidemic terms

- **Endemic**: constant presence in an area. **Epidemic**: excess over the expected. **Pandemic**: across continents. **Sporadic**: scattered cases. **Hyperendemic**: persistently high in all age groups. **Holoendemic**: infection so intense from early life that most children are infected and adults, now immune, show little disease (malaria in parts of Africa).
- **Control**: incidence reduced to a locally acceptable level. **Elimination**: transmission (or the disease as a public health problem) ended in a defined area, the agent may persist; vigilance and vaccination continue because cases can still be imported. **Eradication**: transmission ended permanently worldwide, so intervention can stop (only smallpox, 1980, and rinderpest in animals, 2011). **Extinction**: the agent itself no longer exists in nature or the laboratory (not true of smallpox, whose virus is kept in two laboratories).
- **Primary case**: the case that introduced the infection into the population. **Index case**: the first case that **came to the investigator's attention**; they may be different people. **Secondary case**: infected by a primary case.
- **Incubation period**: infection to first symptoms; the **median incubation period** is the time for half the cases to appear. **Latent period**: in infectious-disease modelling, infection to infectiousness; in Park, the term is used for non-infectious diseases as the equivalent of incubation. **Generation time**: Park defines it as receipt of infection to **maximal infectivity** of the host; modern epidemiology uses infection in one person to infection in the next. **Serial interval**: symptom onset in one case to symptom onset in the next; easily observed in outbreaks. The **communicable period** is a different idea, not an estimate of incubation.
- Contacts are kept under **surveillance for twice the incubation period** in an epidemic; an outbreak is declared over after twice the longest incubation period with no new case.

Disease	Incubation	Communicable period
Chickenpox	14–16 days (10–21)	1–2 days before the rash to 5 days after (until crusted)

Disease	Incubation	Communicable period
Measles	10–14 days to the rash	4 days before to 4–5 days after the rash
Mumps	16–18 days (14–25)	Shortly before to about 5 days after parotitis
Pertussis	7–10 days	Catarrhal stage to about 3 weeks after paroxysms start
Diphtheria	2–5 days	Usually 2 weeks, rarely over 4
Typhoid	10–14 days (3–21)	While bacilli are shed
Hepatitis A / B	About 28 days / 30–180 days	
Japanese encephalitis	5–15 days	No person-to-person spread

- **Common-source outbreak**: sharp rise, then fall, with a single exposure (point source) or a plateau (continuous). **Propagated outbreak**: successive waves about one generation time apart (roughly one incubation period).
- **Epidemic curve**: cases against time of onset. The **modal incubation** of a point-source outbreak is read from the peak.
- **Types of epidemic** by curve: **common source** (point source: one exposure, cases within one incubation period; continuous or intermittent exposure gives a plateau or ragged curve), **propagated** (person to person; successive waves one generation time apart, a long tail) and **mixed**. **Time trends**: **short-term** (epidemic), **periodic or cyclical** (regular rises over years, as measles before vaccination every 2–3 years), **seasonal** (dengue after the monsoon, cholera in summer) and **secular** (long-term change over decades, such as the fall of TB in Europe).
- **Host, agent and environment terms**: **reservoir** (where the agent lives and multiplies; humans, animals, soil), **carrier** (infected, shows no disease: incubatory, convalescent, healthy), **infectivity** (ability to infect), **pathogenicity** (to cause disease in those infected), **virulence** (severity, measured by case fatality or the proportion with severe disease), **antigenicity** (to provoke immunity). **Active natural** immunity follows infection, **passive natural** is transplacental or breast-milk antibody, **active artificial** is a vaccine, **passive artificial** is immunoglobulin or antitoxin (immediate, short-lived).

Levels of prevention and iceberg

- **Primordial**: preventing risk factors from appearing (population habits, e.g. not adopting smoking). **Primary**: **health promotion and specific protection** (immunisation, chemoprophylaxis, chlorination, fluoridation, bed nets). **Secondary**: early diagnosis and treatment (screening, Pap smear, case finding). **Tertiary**: limiting disability and rehabilitation. **Quaternary**: protecting patients from over-medicalisation. Park's five modes of intervention map onto these: health promotion and specific protection (primary), early diagnosis and treatment (secondary), disability limitation and rehabilitation (tertiary).
- **Iceberg of disease**: the floating tip is clinical disease; submerged are subclinical, undiagnosed and carrier states. Hypertension, diabetes and tuberculosis are classic examples.
- **Natural history stages**: susceptibility, pre-symptomatic (subclinical), clinical, and recovery/disability/death.
- Spectrum of disease: **Subclinical infection** is the main reservoir of polio (about 1 in 200 infections paralytic).

Herd immunity and R

- **Basic reproduction number R0** = average secondary cases from one case in a wholly susceptible population. **Effective R** applies when some are immune. Outbreaks die out when **R < 1**.
- **Herd immunity threshold = 1 - 1/R0**. R0 5 gives 80%; measles (R0 12–18) needs about 92–95%.
- **Doubling time** (growth rate r%) is about 70 / r (rule of 70); a town at 2% a year doubles in 35 years.

Causation

- **Hill's criteria**: strength, consistency, specificity, **temporality (the only essential one)**, biological gradient, plausibility, coherence, experiment, analogy.
- **Epidemiological triad**: agent, host, environment. **Web of causation** suits multifactorial non-communicable diseases.
- **Sufficient vs necessary cause**: TB bacillus is necessary but not sufficient.
- John Snow (1854, Broad Street pump) is the **father of epidemiology**; Hippocrates the **father of medicine**. **"Father of public health"**: Park's answer is **cholera**, the disease whose epidemics forced the 19th-century sanitary reforms; if a person is wanted, Edwin Chadwick (the 1842 sanitary report) is the usual answer, and some texts name Hippocrates. Other attributions examiners ask: Jenner (vaccination, and the word), Pasteur (germ theory, rabies vaccine, the word "vaccine" for all such preparations), Pettenkofer (multifactorial causation), MacMahon and Pugh (web of causation), James Lind (scurvy trial), Ronald Ross (malaria in the mosquito), Walter Reed (yellow fever by mosquito), David Morley (road-to-health chart), Henri Dunant (Red Cross), Sackett (evidence-based medicine).

Sources of data and surveillance

- Census, vital registration, sample registration, health-service records, notifications, surveys.
- **Surveillance** = continuous collection, analysis and feedback. **Sentinel surveillance** uses selected sites; **active** surveillance seeks cases; **passive** relies on reports. **Syndromic** surveillance uses symptom clusters before diagnosis.
- **Nepal**: the **Early Warning and Reporting System (EWARS)**, run by the Epidemiology and Disease Control Division (EDCD) of the Department of Health Services, is a **hospital-based sentinel surveillance** system set up in the late 1990s to complement the routine HMIS: sentinel hospitals send immediate reports of single cases or outbreaks and **weekly reports (zero reports included)** of cases and deaths of six priority conditions: **malaria, kala-azar, dengue, acute gastroenteritis, cholera and severe acute respiratory infection** (MoHP Epidemic and Outbreak Surveillance programme; EWARS weekly bulletins, EDCD; the network was enlarged to 118 sites in 2019).

Screening and diagnostic tests

2 x 2 table and validity

	Disease present	Disease absent
Test positive	TP	FP

	Disease present	Disease absent
Test negative	FN	TN

- **Sensitivity** = TP / (TP + FN): proportion of the **diseased** who test positive. A highly sensitive test, when **negative, rules out** (SnNout).
- **Specificity** = TN / (TN + FP): proportion of the **healthy** who test negative. A highly specific test, when **positive, rules in** (SpPin).
- **PPV** = TP / (TP + FP); **NPV** = TN / (TN + FN). **Predictive values depend on prevalence**: as prevalence falls, PPV falls and NPV rises. Sensitivity and specificity are fixed properties of the test.
- Worked example: sensitivity 90%, specificity 80%, prevalence 10% in 1,000 people. TP 90, FN 10, FP 180, TN 720. PPV = 90/270 = 33%; NPV = 720/730 = 99%.
- **Likelihood ratios**: LR+ = sensitivity / (1 - specificity); LR- = (1 - sensitivity) / specificity. They do not depend on prevalence. Post-test odds = pre-test odds x LR (odds = p / (1 - p)). **LR+ above 10** strongly rules in; **LR- below 0.1** strongly rules out.
- **Accuracy** = (TP + TN) / total. **False positive rate** = 1 - specificity; **false negative rate** = 1 - sensitivity.
- **Youden index** = sensitivity + specificity - 1.

Cut-off and ROC

- Raise the cut-off for a disease marked by high values: **sensitivity and NPV fall, specificity and PPV rise**. Lowering does the reverse. For a disease marked by low values (anaemia, hyponatraemia), the directions are mirrored.
- **ROC curve**: sensitivity (y) against 1 - specificity (x). The **area under the curve** measures overall discrimination: 0.5 is useless, 1.0 perfect. The best cut-off is the point nearest the top left.
- Screen with a **sensitive** test, confirm with a **specific** one.

Combining tests

- **Series (sequential)**: positive only if all are positive: **specificity and PPV rise, sensitivity and NPV fall**. Used for confirming (HIV: WHO's testing strategy of three sequential reactive assays; Western blot is no longer recommended, WHO 2019).
- **Parallel (simultaneous)**: positive if **any** is positive: **sensitivity and NPV rise, specificity falls**. Used when missing a case is costly.

Reliability, validity, accuracy

- **Precision (reliability, repeatability)**: results agree on repetition; spoilt by **random error**; monitored in the laboratory by a range (R) chart. **Accuracy (validity)**: results agree with the truth; spoilt by **systematic error (bias)**; monitored by a mean or Levey-Jennings (Shewhart) control chart. A meter that reads 200 three times when the truth is 260 is **precise (reliable) but not accurate**.
- Observer agreement is measured by **kappa**: 0 means chance agreement, 1 perfect, over 0.8 very good, 0.4–0.6 moderate.

Screening programmes

- Wilson and Jungner criteria (WHO 1968): important condition, recognisable latent stage, accepted treatment, suitable test, facilities available, natural history understood, cost-balanced, continuing process.
- **Biases in screening evaluation**: **lead-time bias** (survival from diagnosis looks longer though death is not delayed), **length-time bias** (screening picks slow, less lethal disease), **selection (volunteer) bias**, overdiagnosis. The best measure of benefit is **disease-specific mortality** in a randomised trial, not survival time.
- **Screening vs diagnostic test**: screening is applied to the apparently healthy and is not diagnostic; positives need confirmation.
- Common screening tools: Pap smear, VIA and HPV DNA for cervix (**WHO 2021: HPV DNA testing as the primary test from age 30, every 5–10 years**; from 25, every 3–5 years, in women with HIV); mammography; faecal immunochemical test; PSA is not recommended for mass screening (USPSTF 2018: an individual decision at 55–69).
- **Nepal**: the National Guideline for Cervical Cancer Screening and Prevention (2010) chose **VIA for women aged 30–60, every 5 years**; HPV DNA testing is not yet widely available. Coverage is low: in the 2019 STEPS survey, about 6% of women aged 30–49 had been screened in the previous five years (peer-reviewed review, 2022).
- **Criterion validity** = agreement with a reference (gold) standard, quantified by sensitivity and specificity; **face validity** is only apparent appropriateness; repeatability and precision are about consistency. **Newborn screening**: heel-prick blood spot on filter paper, ideally 48–72 hours after birth (the normal TSH surge in the first day gives false positives earlier; cord blood is an alternative); **Guthrie test** for phenylketonuria; TSH for **congenital hypothyroidism**, to prevent irreversible intellectual disability.

Communicable disease epidemiology

Outbreak measures (also in Epidemiologic concepts)

- **Herd immunity threshold = 1 - 1/R0**: R0 5 needs 80% immune; measles (R0 12–18) about 92–95%.
- **Secondary attack rate** = new cases among exposed **susceptible** contacts within one incubation period / all susceptible contacts (the primary case and the immune left out): a measure of **infectivity**, not severity.
- **Epidemic curve**: a **single common-source (point) exposure** gives a curve that **rises quickly to one peak and falls within about one incubation period**, with no secondary waves; continuous exposure gives a plateau; a **propagated** (person-to-person) outbreak gives **successive waves about one generation time (roughly one incubation period) apart**; regular rises over years are **cyclical** trends.
- **Primary case** introduced the infection; **index case** is the first to reach the investigator's notice (often not the same person). **Serial interval**: symptom onset to symptom onset along a chain; **generation time**: infection to infection (Park: to maximal infectivity); **incubation period**: infection to symptoms in one person.

Vectors and diseases (the commonest question)

Disease	Agent	Vector / source
Malaria	Plasmodium	**Anopheles** female
Dengue, chikungunya, yellow fever, Zika	Flaviviruses/ alphavirus	**Aedes aegypti** (day biting)
Japanese encephalitis	Flavivirus	**Culex tritaeniorhynchus**; **pigs are amplifier hosts**, humans dead-end
Urban bancroftian filariasis	Wuchereria bancrofti	**Culex quinquefasciatus** (polluted water)

Disease	Agent	Vector / source
Rural filariasis (Brugia malayi)	Brugia	**Mansonia**
Kala-azar	Leishmania donovani	**Phlebotomus argentipes** (sandfly)
Plague	Yersinia pestis	**Xenopsylla cheopis** rat flea
Endemic (murine) typhus	Rickettsia typhi	Rat flea
Epidemic typhus	R. prowazekii	**Body louse** (faeces scratched in)
Scrub typhus	Orientia tsut-sugamushi	**Trombiculid mite (chigger)**
Indian tick typhus, Rocky Mountain spotted fever	R. conorii, R. rickettsii	**Hard tick** (also Lyme disease, tular-aemia, babesiosis, Kyasanur Forest disease)
Rickettsialpox	R. akari	Mite (mouse)
Trench fever	Bartonella quintana	Body louse
Q fever	Coxiella burnetii	**Inhalation** of dust from infected cattle, sheep, goats (ticks only among animals); no rash, Weil-Felix negative
Relapsing fever	Borrelia	Louse (epidemic), soft tick (endemic)
Sleeping sickness	Trypanosoma brucei	**Tsetse (Glossina)**
Chagas disease	Trypanosoma cruzi	Reduviid (triatomine) bug
Onchocerciasis	Onchocerca volvulus	**Simulium** (blackfly)
Loiasis	Loa loa	Chrysops
Guinea worm, fish tapeworm	Dracunculus, Diphyllo-bothrium	**Cyclops** (intermediate host, not a vector)

- **Rickettsiae**: obligate intracellular Gram-negative bacteria; doxycycline is the drug of choice at any age (chloramphenicol was the older answer in pregnancy). Spotted-fever rashes start on the wrists, ankles, palms and soles; typhus rashes start on the trunk. The **Neil-Mooser (tunica) reaction** in guinea pigs is positive with R. typhi (and spotted-fever rickettsiae) and negative with **R. prowazekii**, so it separates endemic from epidemic typhus. Scrub typhus shows an **eschar**.
- **Aedes** breeds in clean, stored, domestic water, bites by day and passes viruses **transovarially**; **Culex** in polluted water, eggs in rafts (also West Nile); **Anopheles** in clean, slow, sunlit water, eggs laid singly with floats (urban A. stephensi, rural A. culicifacies in South Asia). **Aedes aegypti house index** should be **below 1%** around ports and airports (no breeding within 400 m of an airport perimeter, IHR).
- The vector control triad: eliminate breeding, kill larvae (**temephos**, Gambusia fish, Bacillus thuringiensis israelensis), kill adults (indoor residual spray, insecticide-treated nets).

Malaria

- Falciparum: severe malaria, cerebral malaria, no hypnozoites (so no relapse; recrudescence only). **Vivax and ovale** form hypnozoites, so need **primaquine** radical cure (14 days, 0.25 mg/kg, after checking G6PD). **Malariae**: quartan fever, nephrotic syndrome.
- Stages: the **sporozoite** infects from the mosquito; transfusion malaria starts from **trophozoites** (no liver stage, so no relapse); the mosquito is infected by **gametocytes**. Thick film detects, thin film identifies the species.
- Indicators: **Annual Parasite Incidence (API)** = confirmed cases per 1,000 per year, the main measure of the **malaria situation in a control programme**; **Slide Positivity Rate (SPR)**; **Annual Blood Examination Rate (ABER)**, a measure of **operational efficiency** of surveillance (at least 10% expected); **Infant Parasite Rate** (positive films in infants, **the most sensitive index of recent transmission**); **spleen rate** in children 2–9 years (**endemicity**); **parasite rate**.
- Endemicity by spleen rate: hypoendemic <10%, mesoendemic 11–50%, hyperendemic 51–75% (children), holoendemic >75% (adults low).
- Treatment (WHO guidelines for malaria, 2022 onward): artemisinin-based combination therapy for uncomplicated falciparum; **severe malaria is IV artesunate** (quinine was the classic answer). **Exam answer**: chloroquine for vivax and in pregnancy. **Current practice**: WHO (2022) accepts artemether-lumefantrine in the first trimester; a **single low dose of primaquine (0.25 mg/kg)** is added to ACT for falciparum to block transmission in low-transmission areas. Chemoprophylaxis for travellers: doxycycline, atovaquone-proguanil or mefloquine.
- **Nepal** (National Malaria Treatment Protocol 2019, EDCD): **vivax and ovale**: chloroquine 3 days plus primaquine 14 days; **uncomplicated falciparum**: artemether-lumefantrine 3 days plus single-dose primaquine; severe malaria: artesunate.
- **G6PD deficiency** (X-linked, the commonest human enzyme deficiency): haemolysis with primaquine, dapsone, sulphonamides, nitrofurantoin, quinolones, fava beans and naphthalene.

Tuberculosis

- WHO 2022 guidelines: drug-sensitive TB, **2HRZE / 4HR** (6 months, the exam answer). Shorter options now recommended (WHO 2022): a **4-month 2HPZM/2HPM** regimen (rifapentine and moxifloxacin) from age 12, and **4 months (2HRZ(E)/2HR) for children with non-severe TB**. Rifampicin-resistant TB: a **6-month BPaLM** regimen (bedaquiline, pretomanid, linezolid, moxifloxacin), or all-oral 9-month regimens.
- Diagnosis: **Xpert MTB/RIF** (detects rifampicin resistance in two hours) is the initial test; smear microscopy remains a tool. Treatment by DOT / digital adherence.
- Infectious source: smear-positive pulmonary TB. **TB preventive treatment** (WHO 2024) for people with HIV, household contacts of any age (after excluding active TB; testing for infection optional in children under 5) and other risk groups (3HP, 1HP, 3HR, 4R or 6H).
- **HIV with TB**: TB treatment first, then **ART as soon as possible within 2 weeks, at any CD4 count** (WHO 2021; before 2021 the 2-week rule was for CD4 <50 cells/uL and others started within 8 weeks, the answer older books give). Never delay ART until TB treatment ends. Exception: **TB meningitis**, where early ART increases severe adverse events, so ART is delayed at least 4 weeks and started within 8.
- **Nepal**: the **National Tuberculosis Control Centre (NTCC)** runs the National TB Programme. Nepal's first **national TB prevalence survey (2018–19)** found about **416 per 100,000** (all forms, 2018; about 117,000 people with TB), nearly twice the earlier estimate, with an estimated incidence of 245 per 100,000 and about half of cases undiagnosed (NTCC/MoHP survey report, 2020).

HIV

- Transmission: sexual, blood, vertical. Vertical risk without intervention 15–45%; with ART and safe infant feeding <1–2%.
- Window period is shortened by 4th-generation (antigen/antibody) assays. WHO "treat all": ART for everyone with HIV regardless of CD4. First-line: **tenofovir + lamivudine/emtricitabine + dolutegravir**.
- PEP within 72 hours (best within 2 hours), 28 days; PrEP for high-risk groups (oral tenofovir-based; WHO 2025 also recommends twice-yearly injectable **lenacapavir**).

Enteric infections

- **Typhoid**: chronic carriers excrete for more than a year; the **gallbladder** is the site; shedding in faeces and urine (urinary carriers with schistosomiasis). Diagnosis: blood culture in week 1, Widal from week 2 (low specificity), bone marrow culture is most sensitive. Treatment: azithromycin or ceftriaxone, as quinolone resistance is common. Vi conjugate vaccine (TCV) is preferred.
- **Cholera**: rice-water stool, ORS, doxycycline/azithromycin; case fatality in untreated severe cholera 50%. **Oral cholera vaccine** for outbreaks and hotspots. **Cholera incubation** hours to 5 days.
- **Hepatitis A and E**: faeco-oral; E carries a maternal case fatality of **up to 20–25% in the third trimester** (WHO). **B and C**: blood-borne; B vertical transmission highest with HBeAg-positive mothers.
- **Poliomyelitis**: OPV and fIPV; global eradication; surveillance by acute flaccid paralysis (AFP) in children under 15, with two stool samples 24 hours apart within 14 days of onset. Wild types 2 and 3 are eradicated (2015, 2019); wild type 1 persists in Pakistan and Afghanistan; circulating vaccine-derived poliovirus (mostly type 2) is now the commoner cause of outbreaks, hence the 2016 switch from trivalent to **bivalent OPV** (types 1 and 3) plus IPV. The **WHO South-East Asia Region, Nepal included, was certified polio-free on 27 March 2014** (WHO SEARO).

Food poisoning (incubation clues)

Organism	Incubation	Clue
Staphylococcus aureus (preformed toxin)	**1–6 hours**	Vomiting, no fever; custard, cream, ham
Bacillus cereus (emetic)	1–6 hours	Reheated fried rice; the diarrhoeal toxin acts in 8–16 hours
Clostridium perfringens	8–16 hours	Diarrhoea, meat dishes
Salmonella	12–36 hours	Fever, eggs, poultry
Vibrio parahaemolyticus	12–24 hours	Seafood
Clostridium botulinum	12–36 hours	Descending paralysis; preformed neurotoxin

- The staphylococcal enterotoxin is **heat-stable**, so reheating does not make the food safe.

Zoonoses

- **Rabies** (WHO categories): I touching or feeding animal, intact skin: no treatment. II minor scratch or nibbling on skin without bleeding: wound washing and vaccine. **III bleeding bite, scratch with blood, licks on broken skin or mucosa, or bat exposure: wound washing, vaccine and rabies immunoglobulin** (infiltrated into and around the wound; the rest IM). Wash with soap and water 15 minutes; do not suture immediately (if suturing cannot wait, infiltrate RIG first and suture loosely hours later). Intradermal schedule (WHO 2018): 2 sites of 0.1 mL on days 0, 3, 7 ("one week, two sites"); intramuscular: days 0, 3, 7 and 14–28 (Essen) or 2-1-1 (Zagreb). Pre-exposure prophylaxis: days 0 and 7. **RIG** with the first vaccine dose, never after day 7 of the course; human RIG 20 IU/kg, equine 40 IU/kg. **Category II in an immunocompromised person also gets RIG.** A previously vaccinated person needs wound care and 2 booster doses (days 0, 3), **no RIG**. PEP is given whatever the animal's vaccination status; pregnancy is not a contraindication. Observe a pet dog or cat for 10 days; if it stays healthy the course can be stopped (if started).
- **Leptospirosis** (Leptospira interrogans, hooked spirochaete): rat urine, water-borne ("rats, rice fields and rainfall"; floods, sewer and farm workers); Weil's disease (jaundice, renal failure, haemorrhage). Diagnosis: **microscopic agglutination test (MAT) is the reference test** (Weil-Felix is for rickettsiae). Prophylaxis for heavy short-term exposure: **doxycycline 200 mg weekly**. Treatment: doxycycline for mild disease, IV penicillin or ceftriaxone for severe; a Jarisch-Herxheimer reaction may follow.
- **Japanese encephalitis** (flavivirus, Culex tritaeniorhynchus): pigs amplify, ardeid birds are reservoirs, humans and **horses** are dead-end hosts that show disease; most infections are inapparent. Nepal uses the **live attenuated SA 14-14-2 vaccine**, one dose at 12 months in the routine schedule.
- **Brucellosis, anthrax, plague, tularaemia**: occupational zoonoses; **anthrax** clues: woolsorter's disease (inhalation), malignant pustule (cutaneous). **CDC bioterrorism categories**: **A** (easily spread, high mortality, need special preparedness): variola, anthrax, plague, botulinum toxin, tularaemia and viral haemorrhagic fevers (Ebola, Marburg). **B** (moderately easy to spread, lower mortality): brucellosis, Q fever, glanders, typhus, ricin, staphylococcal enterotoxin B, food and water threats (Salmonella, Shigella, Vibrio cholerae). **C** (emerging, could be engineered): Nipah, hantavirus.
- **Snake bite**: first aid is reassure, immobilise the limb like a fracture, rapid transfer to hospital, tell the doctor the symptoms; **no tourniquet, cutting, suction, ice or herbal remedies** (WHO SEARO 2016 guideline). Antivenom is the treatment (polyvalent antivenom in South Asia); neurotoxic bites may also need **neostigmine with atropine** and ventilation. Snakebite envenoming has been a WHO NTD since 2017.

Respiratory infections

- **Measles** (paramyxovirus): R0 12–18; the secondary attack rate in susceptible household contacts is about 80–90%; **Koplik spots** (about day 2, before the rash); the rash starts behind the ears on about day 4; Warthin-Finkeldey giant cells; commonest complication otitis media (or diarrhoea), commonest cause of death pneumonia; SSPE years later; vitamin A given. **Rubella** (togavirus, the "third disease"): rash on day 1, posterior auricular nodes, Forchheimer spots on the palate; congenital rubella syndrome (**deafness, the commonest defect, cataract, PDA**, salt-and-pepper retinopathy, "blueberry muffin" skin) is greatest in the first trimester; diagnosed by IgM. Nepal was verified as having

controlled rubella in 2018 (WHO SEARO). **Mumps**: parotitis; **aseptic meningitis** the commonest extrasalivary complication; orchitis after puberty; pancreatitis. **Diphtheria**: antitoxin first, then penicillin. **Pertussis**: macrolides; Tdap in pregnancy. **Influenza**: antigenic drift (minor, annual) vs shift (major, pandemics). **COVID-19**: SARS-CoV-2, enveloped positive-sense RNA virus; incubation 1–14 days (median about 5); WHO declared a PHEIC on 30 January 2020, **a pandemic on 11 March 2020**, and ended the emergency on 5 May 2023. Hand rub needs **at least 60% alcohol** and does not replace washing for visibly soiled hands or spores. Biosafety: routine diagnostic work BSL-2, virus culture BSL-3; MDR-TB culture BSL-3; Ebola and Marburg BSL-4.

- **Quarantine** is restriction of **healthy** exposed contacts for the **longest incubation period** (incubation 4–18 days means 18 days); **isolation** separates the sick for the **maximum period of communicability**.

Nepal's disease-control institutions (curriculum)

- The **Epidemiology and Disease Control Division (EDCD)** of the Department of Health Services (under the Ministry of Health and Population) runs the surveillance and outbreak response and the malaria, kala-azar, dengue, rabies and zoonoses programmes; the **National Tuberculosis Control Centre (NTCC), Thimi, Bhaktapur**, runs the TB programme (with the Nepal Anti-Tuberculosis Association, a voluntary body); **Sukraraj Tropical and Infectious Disease Hospital**, Teku, is the national referral hospital for infectious diseases; the **National Public Health Laboratory**, Teku, is the national reference laboratory.
- **Leprosy**: Nepal declared elimination at national level on **19 January 2010** (prevalence below 1 per 10,000; sources give 0.77 to 0.89), but new cases have risen again since (about 1,850 in 2019/20 to about 2,500 in 2022/23; prevalence 0.85 per 10,000, with 14 districts, mostly in the Terai, above 1 per 10,000: DoHS leprosy factsheet); the **Khokana leprosy hospital** near Kathmandu is the old leprosarium. The WHO test for "elimination" is **prevalence below 1 per 10,000**, not zero cases.

Dengue (WHO 2009; 2012 revisions)

- Dengue without warning signs, with warning signs, and severe dengue (the 2009 classification replaced dengue haemorrhagic fever and dengue shock syndrome, the older exam terms). **Warning signs**: abdominal pain, persistent vomiting, fluid accumulation, mucosal bleed, lethargy, liver enlargement, rising haematocrit with falling platelets. **Critical phase** is days 3–7 around defervescence. Treatment is fluids; no antivirals; avoid NSAIDs. NS1 antigen in the first 5 days, IgM after. WHO's 2025 guideline on arboviral diseases (dengue, chikungunya, Zika, yellow fever) keeps the same approach.
- **Yellow fever** (flavivirus, Aedes aegypti; reservoir monkeys in the forest cycle, humans in the urban): intrinsic incubation 3–6 days, extrinsic 8–12; one attack gives lifelong immunity. **17D live vaccine**: the certificate is valid from 10 days after vaccination and, since the IHR change of July 2016, **for life** (the older answer, still in many books, is 10 years).

Neglected tropical diseases and elimination

- WHO's NTD list (21 conditions since noma was added in December 2023) includes lymphatic filariasis, visceral and cutaneous leishmaniasis, onchocerciasis, schistosomiasis, soil-transmitted helminths, trachoma, leprosy, **rabies**, dengue and chikungunya, **snakebite envenoming**, scabies, yaws, Chagas disease, echinococcosis, taeniasis/cysticercosis, mycetoma and other deep mycoses, and dracunculiasis. **Mass drug administration** for LF: **DEC + albendazole** (two-drug), or **IDA** (ivermectin + DEC + albendazole) where suitable; not given to children <2 years or pregnant women.
- **Leprosy**: elimination as a public health problem means registered prevalence <1 per 10,000; WHO 2018: the **three-drug MDT (rifampicin, dapsone, clofazimine) for both** paucibacillary (6 months) and multibacillary (12 months) leprosy, and **single-dose rifampicin** post-exposure prophylaxis for contacts.
- **Kala-azar**: the regional elimination target is **<1 case per 10,000 population a year at district level in Nepal** (sub-district, block or upazila, in India and Bangladesh) (WHO SEARO); Bangladesh was the first country validated (2023). Single-dose **liposomal amphotericin B** (10 mg/kg) is first-line in South Asia.
- **Nepal**: **trachoma** was the first in the South-East Asia Region to be validated as eliminated as a public health problem (**WHO, May 2018**). **Leprosy** was eliminated as a public health problem at national level in December 2009 and declared so in **2010** (MoHP Leprosy Control Programme). **Maternal and neonatal tetanus** elimination was validated in **2005** and confirmed sustained by a post-validation assessment in 2024 (WHO SEARO, WHO Nepal). **Lymphatic filariasis**: transmission interrupted in 56 of 64 endemic districts, MDA continuing in the rest (Banke, Kapilvastu and others), target 2030 (WHO Nepal, 2025–26). **Kala-azar**: cases fell by over 95% from 2007 to 2021, but new foci in hill districts have delayed validation.
- **Neurolathyrism**: from the grass pea (**Lathyrus sativus**, khesari dal), toxin **BOAA** (beta-N-oxalyl-amino-L-alanine), spastic paraplegia with a scissor ("crossed") gait; tendon reflexes are brisk, not absent. Prevention: steeping and parboiling the dal, low-toxin varieties, and **vitamin C** (Park's answer).
- **Pasteurisation of milk**: holder method 63 degrees C for 30 minutes; HTST (flash) 72 degrees C for 15 seconds then rapid cooling; UHT about 135–150 degrees C for 1–3 seconds. The most heat-resistant targets are the tubercle bacillus and Coxiella. Tests of pasteurised milk: **phosphatase test** (the enzyme is destroyed by adequate heating, so it checks pasteurisation), **standard plate count** and **coliform count** (post-pasteurisation contamination); the methylene blue reduction test grades raw milk quality. The **Nalgonda technique** is defluoridation of water, not a milk test.
- **Filariasis**: *Wuchereria bancrofti* microfilariae are **nocturnally periodic, peaking in blood between about 10 pm and 2 am** (Culex bites at night), so blood films are taken at night. **Hookworm**: *Necator americanus* and *Ancylostoma duodenale*; the **infective stage is the filariform (L3) larva** penetrating skin (ground itch); rhabditiform larvae hatch in soil and are not infective; **Chandler's index** = average hookworm eggs per gram of faeces across the community (above 300 an important public health problem). **Zoonosis direction** (Park's usage, the one the exam follows; some older texts swap the two words): **anthropozoonosis** animal to man; **zooanthroponosis** (reverse zoonosis) man to animal, as human tuberculosis in cattle; **amphixenosis** both ways.

Vaccines and cold chain

Vaccine types

- **Live attenuated**: BCG, OPV, measles, MR/MMR, rotavirus, varicella, live zoster (now largely replaced by the recombinant), yellow fever (17D), oral typhoid Ty21a, intranasal influenza, **Japanese encephalitis SA 14-14-2** (the one Nepal uses). Strong, long immunity; **contraindicated in pregnancy and severe immunosuppression**. Two live injectable vaccines are given the same day or 4 weeks apart; live oral vaccines at any interval. Live vaccines are deferred about 3 months after immunoglobulin or blood (longer after high doses).
- **Inactivated whole**: IPV (Salk), rabies, hepatitis A, whole-cell pertussis, Japanese encephalitis (inactivated Vero-cell types), injectable influenza. **Oral cholera vaccines** in use (Shanchol, Euvichol) are inactivated whole-cell.
- **Toxoid**: tetanus, diphtheria. **Subunit/recombinant**: hepatitis B (yeast), HPV (virus-like particles), acellular pertussis. **Polysaccharide**: pneumococcal PPSV23, Vi typhoid (T-independent; poor under 2 years). **Conjugate**: Hib, PCV, meningococcal, Vi-TCV (T-dependent; work in infants). **mRNA**: COVID-19. **Viral vector**: some COVID vaccines.

Cold chain

- **Vaccines damaged by freezing** (must never be frozen): those with aluminium adjuvant, that is **DPT, DT, Td, TT, hepatitis B, pentavalent, PCV, HPV**, and inactivated polio. Order of freeze sensitivity (Park): **hepatitis B most**, then DPT-containing vaccines, **TT least** among them. **Vaccines that tolerate freezing**: **OPV, measles, MR, BCG** (freeze-dried or live; OPV is stored frozen at -15 to -25 degrees C at the national and district stores; WHO no longer recommends freezing the freeze-dried ones).
- **Heat sensitivity** (Park): **reconstituted BCG and measles/MR are the most heat-sensitive of all**; of unopened vaccines, **OPV is the most heat-sensitive**, then measles; **hepatitis B and TT the least**.
- **Vaccines damaged by light**: **BCG, measles, MR, rubella** (stored in dark glass; once reconstituted, used within **6 hours or by the end of the session**, whichever is first).
- **Temperature for the vaccine fridge**: **+2 to +8 degrees C**. Deep freezer -15 to -25 degrees C for OPV and for making ice packs. In a **front-opening refrigerator**, the coldest shelf near the freezer takes OPV and measles/MR, the next BCG, and the lower shelves DPT, TT, hepatitis B and pentavalent. In a **top-opening ice-lined refrigerator** the **bottom is coldest**: OPV and measles may lie at the bottom, while freeze-sensitive vaccines are kept in the basket, never on the floor. **Never store in the door.**
- **Shake test** for suspected freezing (WHO): freeze a control vial of the same product and lot until solid, thaw it, then shake it beside the suspect vial. If the suspect vial **sediments more slowly** than the frozen control, it was not frozen and can be used; if it sediments **at the same rate or faster**, it was frozen and is discarded.
- **Vaccine vial monitor (VVM)**: a square inside a circle that darkens with heat. **Use if the square is lighter than the circle; discard if it is the same colour or darker** (stages 3 and 4), regardless of the expiry date. VVM does not detect freezing.
- **Open vial policy** (WHO 2014): opened multi-dose vials of liquid vaccines with a preservative (OPV, DPT, TT, Td, hepatitis B, pentavalent, and those IPV and PCV presentations WHO has prequalified for it) can be used in later sessions for up to **28 days** if unexpired, with the VVM not past its discard point, kept at 2–8 degrees C, drawn aseptically and the septum never submerged. Freeze-dried vaccines (BCG, measles, MR, JE, yellow fever) are **discarded 6 hours after reconstitution or at the end of the session**, whichever is first.
- **Cold chain equipment**: ice-lined refrigerator (ILR) and deep freezer, **cold box** (long-range transport, with ice packs), **vaccine carrier** (short-range, session use; 4 conditioned ice packs), **thermometers**, **data loggers**, **freeze tags**. Solar direct drive fridges for off-grid sites.
- **Cold chain levels**: national store, regional, district, health facility. The WHO **Effective Vaccine Management (EVM)** assessment audits it.

Contraindications

- **True contraindications**: **anaphylaxis to a prior dose or a component** (neomycin or streptomycin traces in IPV, MMR and varicella); live vaccines in pregnancy and in severe immunodeficiency (symptomatic HIV for BCG and yellow fever; MMR and varicella are still given when the CD4 is adequate); **encephalopathy within 7 days of a pertussis-containing dose** (stop the pertussis component); **intussusception history** (rotavirus); **severe combined immunodeficiency** (rotavirus).
- **Severe reaction after DPT** (fever over 40.5 degrees C, inconsolable crying for 3 hours or more, hypotonic-hyporesponsive episode, seizure): the **exam answer** is to give **DT** for the remaining doses (the pertussis component is blamed). Current US and WHO practice treats these, except encephalopathy, as precautions, so the next DTP dose may still be given after weighing the risk.
- **False contraindications**: mild illness with or without low-grade fever, mild diarrhoea, malnutrition, prematurity, current antibiotic use, a family history of adverse events, breastfeeding, a stable neurological condition.
- Egg allergy: **exam answer**: **influenza** and **yellow fever** vaccines are grown in embryonated eggs and need an allergist's assessment; measles and mumps are grown in chick-embryo fibroblast cultures and are safe. **Current practice**: influenza vaccine is given to people with any egg allergy with no extra precautions (ACIP 2023, the egg-protein content being negligible); yellow fever vaccine still needs caution.
- **Severe heat or reconstitution error**, not a contraindication but a reason to discard.

Schedule principles

- **BCG** at birth, 0.05 mL intradermal (0.1 mL after the newborn period) over the left deltoid insertion; scar after 4–6 weeks; protective against severe childhood forms of TB (miliary and meningitis), not against adult pulmonary TB.
- **Hepatitis B**: birth dose within 24 hours is recommended by WHO; 3 doses. Nepal's schedule has no birth dose; babies of HBsAg-positive mothers get vaccine and HBIG within 12–24 hours.
- **Rotavirus**: **exam answer**: first dose by **15 weeks, last by 32 weeks** (the intussusception concern; US practice: last dose by 8 months). WHO (2013) removed these upper age limits where rotavirus deaths are high, while still preferring early doses.

- **Measles**: 9 months in endemic countries (WHO) and a second dose at 15–18 months or older. **Minimum interval between doses of the same live injectable vaccine is 4 weeks.**
- **Tetanus** in pregnancy: for an unvaccinated woman, **Td 2 doses** at least 4 weeks apart in the first pregnancy (the second at least 2 weeks before delivery) and one booster in a subsequent one; WHO recommends 6 doses in childhood and adolescence (3 primary + 3 boosters) for lifelong protection, or 5 doses for a woman first vaccinated as an adult.
- Inactivated vaccines can be given at any interval; **live vaccines** are either given together or at least 4 weeks apart.
- **Adverse events following immunisation (AEFI)**, WHO cause-specific classification (2012, revised 2018): **vaccine product-related reaction, vaccine quality defect-related reaction, immunisation error-related reaction, immunisation anxiety-related reaction, and coincidental event** (the older terms were vaccine reaction, programme error, injection reaction, coincidental, unknown). Management of anaphylaxis: intramuscular **adrenaline 1:1,000, 0.01 mg/kg (maximum 0.5 mg)** into the anterolateral thigh.
- **Routes**: BCG intradermal; pentavalent and PCV intramuscular in the **anterolateral thigh**; OPV and rotavirus oral; MR and JE (SA 14-14-2) subcutaneous; **fIPV intradermal, 0.1 mL** (one-fifth of the full IM dose); TCV intramuscular.
- **Elderly and adults**: influenza yearly, pneumococcal (PCV20 or PCV21, or PCV15 then PPSV23), recombinant zoster vaccine (50 or older, two doses), Td/Tdap boosters, RSV vaccine at 75 (60–74 if at risk) (ACIP 2024), COVID-19. **HPV vaccine is not given to the elderly** (routine at 9–26, by shared decision to 45).
- **HPV** vaccine: WHO (2022) supports a **single dose for ages 9–20**, two doses from 21, and at least two (ideally three) for the immunocompromised; the primary target is girls 9–14. Bivalent covers types 16 and 18, quadrivalent adds 6 and 11, nonavalent adds 31, 33, 45, 52 and 58.

Nepal's schedule

The National Immunisation Programme (begun as EPI in 1977/78, 2034 BS, with BCG, DPT, OPV and measles) is run by the Child Health and Immunization Service Section of the Family Welfare Division, Department of Health Services (the Child Health Division until the 2018 restructuring; Gavi joint appraisal 2018). Schedule as presented by the Nepal Paediatric Society (NEPAS, 2024), consistent with the NDHS 2022 report's description:

Age	Vaccines
Birth	BCG
6 weeks	DPT-HepB-Hib 1, bOPV 1, PCV 1, rotavirus 1
10 weeks	DPT-HepB-Hib 2, bOPV 2, PCV 2, rotavirus 2
14 weeks	DPT-HepB-Hib 3, bOPV 3, **fIPV 1**
9 months	**MR 1, PCV 3 (booster), fIPV 2**
12 months	**JE** (live SA 14-14-2)
15 months	**MR 2, TCV**
Girls about 10 years (class 6)	**HPV**, one dose (routine after the 2025 campaign)
Pregnancy	Tetanus-diphtheria (Td) or TT, 2 doses

- PCV is given **2 + 1** (6 and 10 weeks, booster at 9 months); fIPV moved from 6 and 14 weeks to **14 weeks and 9 months** in 2022 (2079 BS). Nepal's rotavirus vaccine is the two-dose RV1.
- Introductions: hepatitis B 2002, Hib 2009, MR 2013, IPV 2014, PCV10 2015, bivalent OPV 2016, rotavirus 2020 (NEPAS 2024); **typhoid conjugate vaccine 2022** (a campaign reaching about 7.7 million children, then routine); **HPV 2025**, a single-dose school campaign for girls aged 10–14 from 4 February 2025 that reached about 1.46 million (94% administrative coverage), then routine (WHO Nepal 2025; WHO SEARO post-introduction evaluation, 2026).
- NDHS 2022: **80% of children 12–23 months fully vaccinated with the basic antigens** (BCG, 3 DPT, 3 polio, MR), but only **52% fully vaccinated by the national schedule** (adding fIPV, PCV, rotavirus and JE).
- Polio-free certification (with the WHO South-East Asia Region, **27 March 2014**) and maternal and neonatal tetanus elimination (**2005**): see the communicable diseases section.
- **Reconstituted BCG, measles, MR and yellow fever vaccines** carry no preservative: **discard within 6 hours or at the end of the session**; a vial reused later has caused **toxic shock (staphylococcal contamination)** clusters. **Reactions**: whole-cell pertussis (DPT, pentavalent) gives persistent crying and hypotonic-hyporesponsive episode; BCG local abscess or lymphadenitis; MMR rarely thrombocytopenia; rotavirus intussusception. **Immunity types**: infection or vaccine = active natural or artificial; transplacental IgG, milk = passive natural; immunoglobulin or antitoxin = **passive artificial**.

Non-communicable diseases

Risk factors and burden

- WHO's four main NCD groups: cardiovascular disease, cancer, chronic respiratory disease, diabetes. Four main shared risk factors: **tobacco, harmful alcohol, unhealthy diet, physical inactivity**. The WHO Global Action Plan target: a **25% relative reduction in premature NCD mortality by 2025** (the "25 by 25"); the SDG target is a one-third reduction by 2030.
- **WHO STEPS**: stepwise surveillance (Step 1 questionnaire, Step 2 physical measurements, Step 3 biochemical).
- **WHO "best buys"** for NCDs: tobacco taxes, smoke-free places, plain packaging, salt reduction, alcohol restrictions, and screening plus treatment for hypertension and cervical cancer.
- **WHO Framework Convention on Tobacco Control (FCTC)**, 2003 (in force 2005). **MPOWER**: Monitor, Protect from smoke, Offer help to quit, Warn about dangers, Enforce bans, Raise taxes.

Obesity

- **WHO BMI classes**: <18.5 underweight; 18.5–24.9 normal; **25–29.9 overweight**; **30 or more obese** (class I 30–34.9, II 35–39.9, III 40 or more).
- **Asian cut-offs**: the Asia-Pacific classification (WHO Western Pacific, IASO, 2000), the usual exam answer for South Asians: **overweight 23–24.9, obese 25 or more**. The WHO expert consultation (Lancet 2004) kept the international classes but added **public-health action points at 23 and 27.5** for Asian populations.
- **Waist circumference**: abdominal obesity when **>102 cm in men and >88 cm in women** (Western); in South Asians **>90 cm and >80 cm**. **Waist-hip ratio** abnormal >0.9 men, >0.85 women. BMI is computed as kg/m2.
- **Corpulence index** = **actual weight / desirable weight**; above 1.2 means obesity. **Ponderal index** is a different measure:

height / cube root of weight (in adults), or weight / length cubed (in newborns, to tell symmetric from asymmetric growth restriction). **Broca's index**: ideal weight (kg) = height (cm) - 100. **Lorentz's formula** also gives ideal weight. **Quetelet index** is BMI.

Hypertension

- **Rule of halves**: half of hypertensive patients are undetected; half of the detected are untreated; half of those treated are not controlled.
- **Classification**: **exam answer (JNC 7)**: normal <120/80; prehypertension 120–139/80–89; hypertension **140/90 or more** (stage 1 140–159/90–99, stage 2 160/100 or more). **Current guidelines**: ACC/AHA 2017 (kept in 2025) diagnose hypertension at **130/80**; ESH 2023 and WHO 2021 keep 140/90; ESC 2024 keeps 140/90 for hypertension, calls 120–139/70–89 "elevated", and aims treatment at a systolic of 120–129 where tolerated.
- Hypertension is the leading global risk factor for death. Salt target: **<5 g (2 g sodium) per day** (WHO).
- **Nepal**: Nepal's **STEPS survey 2019** (NHRC with WHO, adults 15–69) found **raised blood pressure in about one in four (24.5%)**, with only about one in five aware of it and few controlled. The WHO **Package of Essential NCD interventions (PEN)** is Nepal's primary-care approach to NCDs: piloted in Kailali and Ilam from October 2016 and extended to all 77 districts by 2021 (peer-reviewed reports; WHO Nepal 2022).

Diabetes

- **Diagnosis (WHO/ADA)**: fasting plasma glucose **126 mg/dL or more**, 2-hour OGTT **200 mg/dL or more**, **HbA1c 6.5% or more**, or random glucose 200 with symptoms. **Impaired fasting glucose 100–125** (WHO uses 110–125); impaired glucose tolerance 140–199 at 2 hours; HbA1c prediabetes 5.7–6.4%.
- **Type 2** accounts for over 90% of cases. Prevention (Diabetes Prevention Program): lifestyle change cuts incidence by about 58%; metformin about 31%. Current treatment beyond metformin favours **SGLT2 inhibitors and GLP-1 receptor agonists** where there is cardiovascular or kidney disease or heart failure, whatever the HbA1c (ADA Standards of Care 2025).
- The **South Asian phenotype** is lean and insulin-resistant with central obesity, so diabetes appears at lower BMI and younger age.

Cancer epidemiology

- **Cervical cancer**: persistent high-risk HPV 16 and 18 (about 70% of cases). WHO (2020) **90-70-90 strategy by 2030**: 90% of girls vaccinated by 15, 70% of women screened by 35 and again by 45 with a high-performance test, 90% of women with disease treated.
- **Breast cancer**: the commonest cancer in women globally (GLOBOCAN 2022; lung cancer is the commonest overall); clinical breast examination and mammography screening from 40–50 in suitable settings.
- **Oral cancer**: tobacco and betel quid with areca nut; **leukoplakia** and **oral submucous fibrosis** are premalignant. **Lung cancer**: smoking. **Liver cancer**: hepatitis B and C and aflatoxin. **Stomach**: Helicobacter pylori and salted foods. **Gall bladder**: gallstones and typhoid carriers. **Oesophageal**: tobacco, alcohol, hot beverages.
- **IARC Group 1** carcinogens include tobacco, alcohol, asbestos, aflatoxin, processed meat, **arsenic** and **benzene**.
- **Cancer screening in Nepal**: cervical screening by VIA under the 2010 national guideline (see Screening).

Cardiovascular and other

- **Coronary risk**: the **modifiable** are smoking, hypertension, dyslipidaemia, diabetes, obesity, inactivity; **non-modifiable** age, sex, family history. **Framingham** study is the classic cohort for coronary heart disease. **Rheumatic heart disease**: secondary prophylaxis with benzathine penicillin every 3–4 weeks.
- **Road traffic injuries** are the leading killer of those aged 5–29 (WHO). Injury prevention is a primary NCD-adjacent topic.
- **Mental health**: WHO mhGAP; depression is the leading cause of years lived with disability among mental disorders.
- **Disability-adjusted life years (DALY)** = years of life lost (YLL) + years lived with disability (YLD). **Quality-adjusted life year (QALY)** weights time by quality. **HALE** is healthy life expectancy.
- **Intellectual disability** (ICD-10, by IQ): **mild 50–69**, **moderate 35–49**, **severe 20–34**, **profound below 20**; moderate cases can learn basic self-care and simple communication with support. Current classifications: DSM-5-TR (2022) grades severity by adaptive functioning, not IQ, and ICD-11 (2022, "disorder of intellectual development") by how far intellectual and adaptive functioning fall below the mean (mild 2–3 SD, moderate 3–4 SD, severe and profound more than 4 SD).

Nutrition

Macronutrients and energy

- Energy values: carbohydrate **4 kcal/g**, protein **4**, fat **9**, alcohol **7**. Recommended proportions (WHO): carbohydrate 55–75% of energy, fat 15–30%, free sugars <10% (ideally <5%), **saturated fat <10%**, trans fat <1%, protein 10–15%.
- **Reference adults** (ICMR-NIN, the tables Park and South Asian exams use): the older reference man 60 kg and woman 50 kg (ICMR 2010), revised to **65 kg and 55 kg** (ICMR-NIN 2020). Energy for a man at sedentary, moderate and heavy work about 2,100–2,300, 2,700 and 3,500 kcal; women about 1,700–1,900, 2,100–2,200 and 2,700–2,900 kcal (the lower figures are ICMR 2020's).
- **Pregnancy**: **no extra energy in the first trimester**; about **+350 kcal a day** in the second and third (WHO/FAO: about 85, 285 and 475 kcal in the three trimesters). **Lactation**: about **+600 kcal** in the first six months and +520 in the next six. Extra protein is needed mainly in the second and third trimesters.
- **BMR** depends most on lean body mass; measured with the Benedict-Roth apparatus. The **thermic effect** of food is highest for protein. Respiratory quotient of a mixed diet about 0.8.
- **Protein quality**: **egg is the reference protein** (highest biological value, with breast milk); **net protein utilisation (NPU) is the commonest measure** of protein use; protein efficiency ratio. **Soybean has the most protein** of pulses (about 40%); pulses are the "poor man's meat". **Limiting amino acids**: lysine in cereals, methionine and cysteine in pulses. Mixed cereal-pulse diets complement each other. Recommended protein about 0.8–1 g/kg/day for adults.

- **Essential fatty acids**: linoleic (the most essential) and alpha-linolenic acid. Richest sources: linoleic acid safflower oil; alpha-linolenic acid flaxseed; monounsaturated olive oil; saturated fat coconut oil; EPA and DHA fish oils. **Dietary fibre**: 25–40 g/day.
- **Pregnancy nutrition** (WHO 2016): folic acid 400 microgram daily from before conception to the 12th week (5 mg after a previous neural tube defect), **daily iron 30–60 mg elemental with 400 microgram folic acid** through pregnancy, calcium 1.5–2 g where intake is low. Allowances in Park (ICMR 2010, revised in 2020): iron about 35 mg/day in pregnancy against 17 (men) and 21 (women); calcium about 1,000 mg in adults and 1,200 in pregnancy and lactation; iodine 250 microgram in pregnancy and lactation (WHO).

Vitamin A

- Deficiency: **night blindness (XN, the earliest)**, conjunctival xerosis (X1A), Bitot's spots (X1B), corneal xerosis (X2), corneal ulceration/keratomalacia (X3A, X3B), corneal scars (XS), xerophthalmic fundus (XF). **Bitot's spot** is a foamy triangular patch on the bulbar conjunctiva.
- **Prophylaxis** (WHO): **100,000 IU** for infants 6–11 months; **200,000 IU every 4–6 months** for children 12–59 months in deficient areas. **Treatment** of xerophthalmia: the age-appropriate dose (200,000 IU from 12 months; 100,000 at 6–11 months; 50,000 under 6 months) on **days 0, 1 and 14**.
- Sources: liver, egg, milk, **carrot, mango, papaya, green leafy vegetables (carotene)**, red palm oil. Richest fruit **ripe mango**, richest vegetable **carrot**; **best natural source overall: fish liver oils, halibut more than cod**. Richest vitamin C: **amla**, then guava.
- **Nepal**: the national programme gives **vitamin A capsules to children 6–59 months twice a year, in Baisakh and Kartik**, with **deworming (albendazole) for children 12–59 months** in the same two-day rounds, delivered mainly by **Female Community Health Volunteers**; it began in 8 districts in 1993 and has been national since 2002, with coverage over 80% for 25 years (peer-reviewed review, 2021; the April 2026 round reached about 2.3 million children).

Protein-energy malnutrition

- **Marasmus**: severe wasting, no oedema, hungry, "old man" face, low weight-for-height. **Kwashiorkor**: **pitting oedema**, flaky paint dermatosis, sparse hair (flag sign), fatty liver, apathy. **Marasmic kwashiorkor**: both.
- **Classification by weight-for-age (Gomez)**: 75–90% of the reference is grade I; 60–74% grade II; <60% grade III. **Wellcome**: kwashiorkor = underweight 60–80% with oedema; marasmus = <60% without oedema; marasmic kwashiorkor = <60% with oedema.
- **WHO 2006 growth standards**: moderate acute malnutrition is weight-for-height between -3 and -2 SD or **MUAC 11.5–12.5 cm**; **severe acute malnutrition** is weight-for-height below -3 SD, **MUAC below 11.5 cm** (6–59 months) or bilateral pitting oedema.
- **Waterlow**: stunting (height-for-age) = chronic malnutrition; wasting (weight-for-height) = acute malnutrition; underweight combines. **Shakir's tape** (the classic answer, children 1–5 years): green >13.5 cm normal, yellow 12.5–13.5 borderline, red <12.5 malnourished. The current WHO/UNICEF MUAC tape: **red <11.5 (SAM), yellow 11.5–12.5 (MAM), green 12.5 or more**.
- Treatment: ready-to-use therapeutic food (RUTF) for uncomplicated SAM at home; F-75 then F-100 in facility; rehydrate with **ReSoMal** (low sodium, high potassium).
- **Nepal (NDHS 2022, Key Indicators Report, MoHP/New ERA/ICF 2023)**: among children under 5, **stunting 25%, wasting 8%, underweight 19%** (stunting 57% in 1996, 36% in 2016); **exclusive breastfeeding 56%** of infants under 6 months; **anaemia 43% of children 6–59 months** (53% in 2016) and **34% of women 15–49** (41% in 2016).

Vitamins and minerals

Nutrient	Deficiency	Key fact
Thiamine (B1)	Beriberi (dry, wet), Wernicke	Polished rice; alcoholics
Riboflavin (B2)	Angular stomatitis, cheilosis	
Niacin (B3)	**Pellagra: dermatitis, diarrhoea, dementia**	Maize (bound niacin), trypto-phan
Pyridoxine (B6)	Neuropathy, sideroblastic anaemia	Isoniazid
Folate	Megaloblastic anaemia, neural tube defects	Pregnant women
Vitamin C	Scurvy	Citrus, amla
Vitamin D	Rickets, osteomalacia	Sun exposure
Vitamin K	Bleeding	Newborn prophylaxis
Iodine	Goitre, cretinism	Salt iodisation
Iron	Anaemia	Commonest micronutrient deficiency globally
Zinc	Growth failure, diarrhoea	ORS plus zinc

- **Iodine**: recommended **150 microgram a day** (200–250 in pregnancy and lactation); WHO (2014) advises salt iodisation at **20–40 ppm iodine**, depending on salt intake; the classic exam figures are **30 ppm at production and 15 ppm at the consumer level**. The indicator of iodine status in a population is **median urinary iodine** (100–199 microgram/L adequate in school-age children). Goitre grading (WHO). **Total goitre rate** of 5% or more in school-age children is a public health problem. **Nepal**: the **Iodized Salt (Production, Sale and Distribution) Act 2055 (1998)**, unenforced for 26 years, was set by the Cabinet to take effect on 17 July 2025 (Kathmandu Post, April 2025); Nepal's salt is iodised at about **50 ppm at production** (with about 30 ppm required at sale), above WHO's range, and lowering it is under review (Kathmandu Post 2023–24).
- **Iron-folic acid** and deworming: anaemia control uses weekly supplementation for adolescents, daily in pregnancy; WHO classes anaemia in a population as severe at a prevalence of 40% or more.
- **Zinc** with low-osmolarity ORS: 20 mg a day for 10–14 days (10 mg under 6 months).
- **Hunger index**: the **Global Hunger Index** combines **undernourishment, child stunting, child wasting and under-five mortality**; bands: under 10 low, **10–19.9 moderate**, 20–34.9 serious, 35–49.9 alarming, 50 or more extremely alarming. **Nepal**: 19.1 in 2022 (moderate); **14.8 in 2025, moderate, 72nd of 123** (GHI 2025).
- **Food toxicity**: **lathyrism** (khesari dal, BOAA), **epidemic dropsy** (argemone oil adulteration, sanguinarine), **endemic ascites** (pyrrolizidine alkaloids in Crotalaria), **aflatoxicosis** (Aspergillus flavus; groundnuts, hepatocellular carcinoma).

- **Breastfeeding**: start within 1 hour; **exclusive for 6 months**; continue with complementary feeding to 2 years or beyond. Colostrum is rich in IgA and protein. **Breast milk** has lower protein but more lactalbumin; the baby gets lactose, taurine and long-chain fatty acids.
- **Food fortification**: salt (iodine; double-fortified salt with iron), oil and vanaspati (vitamins A and D), rice and wheat flour (iron, folic acid, B12) are the usual vehicles.
- **WHO (2011) intermittent iron-folate**: weekly **60 mg elemental iron + 2.8 mg folic acid** for 3 months, then 3 months off, for menstruating women and adolescent girls where anaemia prevalence is 20% or more. Current WHO practice (2016): where anaemia prevalence in this group is 40% or more, **daily** iron (30–60 mg elemental) for 3 consecutive months a year.

Environmental and occupational health

Water

- **Sources and standards**: WHO drinking water guidelines (2022 edition). **Residual free chlorine**: **exam answer (Park): 0.5 mg/L after a contact period of 1 hour**; WHO: at least 0.5 mg/L after at least 30 minutes' contact at pH below 8, and 0.2–0.5 mg/L at the point of delivery. Swimming pools need at least 1 mg/L. Chlorine works best at **pH about 7**; the main disinfectant is **hypochlorous acid**. **Nepal's National Drinking Water Quality Standards 2062 (2005)**: arsenic **0.05 mg/L** (five times WHO's 0.01), fluoride 0.5–1.5 mg/L, and a residual chlorine range for chlorinated supplies.
- **Indicators of faecal pollution**: **E. coli** (the preferred indicator; it does not multiply in the environment), faecal coliforms, **Clostridium perfringens** spores (remote or past contamination), faecal streptococci. **Presumptive coliform count** by multiple-tube MPN; **drinking water should have zero E. coli per 100 mL**.
- **Hardness**: temporary (carbonates and bicarbonates; removed by boiling, Clarke's process) vs permanent (sulphates, chlorides, nitrates; needs sodium carbonate, base exchange); softening is advised above 150 mg/L (3 mEq/L). **Fluoride**: ideal 0.5–0.8 mg/L, **>1.5 mg/L causes fluorosis** (the WHO guideline value); removed by the **Nalgonda technique**. **Arsenic**: the WHO limit is **10 microgram/L**; chronic exposure causes hyperkeratosis, skin cancer and blackfoot disease; shallow tube wells in Nepal's **Terai** (Nawalparasi among the worst affected) are the recognised problem.
- **Purification**: storage, filtration and chlorination. **Slow sand filters** work by the biological **schmutzdecke (vital layer)** and remove about **99.9% of bacteria**; **rapid sand filters** need coagulation with alum and remove 98–99%. **Chlorine demand** = chlorine added (dose) minus residual: the chlorine needed to kill bacteria and oxidise organic matter and ammonia. **Break-point chlorination**: the dose at which combined chlorine is destroyed and free residual starts to rise. **Horrock's apparatus** finds the dose of bleaching powder needed; the **orthotolidine test** measures free and combined chlorine together, and the **orthotolidine-arsenite (OTA) test** separates them; the chloroscope reads residual chlorine. **Bleaching powder** has about **33% available chlorine**; 5% bleaching powder solution disinfects faeces and urine. Chlorine does not reliably kill spores, Cryptosporidium, Giardia cysts, hepatitis A or poliovirus at the usual doses.
- **Ozone, UV, solar disinfection (SODIS)** and boiling are household methods; household chlorine tablets are used in Nepal's emergency response.
- **Sanitation**: sanitary latrines (pour-flush, ventilated improved pit), septic tank, sewage treatment (primary, secondary, tertiary). **BOD** (biochemical oxygen demand) indicates organic load; **dissolved oxygen** is the opposite. Sewage treatment: activated sludge and trickling filters (secondary; the trickling filter's work is done by microorganisms). **Sullage** is waste water without human excreta. A pit latrine should be at least **15 m (50 feet)** from a water source. **Nepal was declared open defecation free on 30 September 2019**, the first in South Asia, after all 753 local levels had declared themselves ODF (Government of Nepal; UN-Habitat 2019); the next goal is total sanitation by 2030.

Mycotoxins and arthropods (curriculum additions)

- **Mycotoxins**: **aflatoxin B1** (Aspergillus flavus and parasiticus on damp stored groundnuts, maize and rice; **hepatocellular carcinoma**, multiplied by hepatitis B; acute aflatoxicosis is hepatic necrosis); prevent by drying grain below about 14% moisture and storing it dry. **Fusarium toxins**: **fumonisins** (maize; oesophageal cancer, neural tube defects), **zearalenone** (oestrogenic: hyperoestrogenism, early puberty), trichothecenes such as T-2 (alimentary toxic aleukia). **Ochratoxin A** (nephropathy, urothelial tumours); **ergot** (Claviceps on rye and millet: ergotism, gangrenous or convulsive); **patulin** (apple juice).
- **Food safety principles**: **HACCP** (hazard analysis and critical control points; seven principles) is the preventive system; adulteration examples are in Nutrition. Nepal's law is now the **Food Hygiene and Quality Act 2081 (2024)**, which **repealed the Food Act 2023 BS (1966)** (s. 60); it is enforced by the **Department of Food Technology and Quality Control**.
- **Medical entomology extras**: the **bed bug** (Cimex lectularius) bites and causes nuisance and anaemia but **has no proven role in transmitting disease**; the **cockroach** and **housefly** are **mechanical vectors** of enteric infections (the fly also of trachoma and eye infections); **mites** (Leptotrombidium chiggers) carry **scrub typhus**, a common cause of fever in Nepal's hills and Terai; **fleas** carry plague and murine typhus, **ticks** relapsing fever and spotted fevers, **lice** epidemic typhus, relapsing fever and trench fever.

Air and housing

- **Pollutants**: PM2.5 (particulate matter under 2.5 micrometre) penetrates alveoli, the health-damaging fraction; **WHO 2021 air quality guideline: annual PM2.5 5 microgram/m3, 24-hour 15 microgram/m3** (not to be exceeded on more than 3–4 days a year). SO2, NO2, ozone, CO, lead. Park's classic answers: **sulphur dioxide** is the best indicator of air pollution; the **soiling index** measures smoke. **Air Quality Index** (US EPA bands): 0–50 good, 51–100 moderate, 101–150 unhealthy for sensitive groups, 151–200 unhealthy, 201–300 very unhealthy, over 300 hazardous;
- **Where inhaled particles settle**: over 10 micrometre trapped in the nose; **5–10 in the upper airways (nasopharynx, larynx, trachea)**; about 1–5 (Park; some texts 0.5–3) reach the **alveoli**, the dangerous range for pneumoconiosis; under 0.5 move by Brownian motion and are largely breathed out.
- **Indoor air pollution** from biomass cooking is the leading source in South Asia; causes COPD, ARI in children, low birth weight. **Carbon monoxide** binds haemoglobin at 200–250 times oxygen's affinity (cherry-red skin).

- **Climate**: greenhouse gases (water vapour contributes most to the natural effect; **CO2** is the main one added by people; methane, nitrous oxide); **ozone layer** depletion by CFCs (Montreal Protocol 1987). **Global warming** and vector range changes (malaria and dengue moving into Nepal's hills).
- **Ventilation and comfort**: cross ventilation, air changes per hour; overcrowding standards (Park: floor space per person and persons per room); the **Kata thermometer** measures the **cooling power of air and low air velocities**; the **sling psychrometer** (wet and dry bulb) and hygrometer measure humidity.

Waste and radiation

- **Health-care waste colour code in Nepal** (MoHP/DoHS **National Health Care Waste Management Standards and Operating Procedures 2020**, Table 1): **green** non-risk biodegradable (food, garden waste); **blue** non-risk non-biodegradable and recyclable (plastic bottles, paper, glass, metal); **red** all risk waste: infectious, pathological, **sharps** (in a puncture-proof container), pharmaceutical and cytotoxic; **yellow** chemical waste (handled by authorised staff only); **black** radioactive waste. The 2014 national guideline it replaced used a more detailed scheme, and some older sources still give that one (with dark and light blue and brown bins); answer from the 2020 standard. India's colours (yellow for anatomical and infectious, red for recyclable plastics, white for sharps) **do not apply in Nepal**. WHO's own scheme: yellow infectious, yellow sharps box, brown chemical and pharmaceutical, black general.
- **Ionising radiation**: sievert is the unit of effective dose; the occupational limit is **20 mSv a year averaged over five years** (no single year over 50); the public limit 1 mSv a year (ICRP 2007).
- **Noise**: above **85 dB(A)** for 8 hours is hazardous; the **WHO limit** is 55 dB outdoors by day. **Noise-induced hearing loss** is first at **4 kHz** (the notch).
- **Heat**: heat stroke, heat cramps; effective temperature, wet-bulb globe temperature.

Occupational diseases

Disease	Exposure
Silicosis	Free silica: mining, stone cutting, glass, pottery; **eggshell calcification** of hilar nodes; predisposes to **tuberculosis**
Byssinosis	**Cotton, flax, hemp dust**; Monday morning chest tightness
Bagassosis	**Mouldy sugarcane** (Thermoactinomyces sacchari)
Anthracosis	Coal dust; coal workers' pneumoconiosis
Asbestosis	Asbestos; **pleural plaques the earliest and commonest sign**, **mesothelioma the most specific** association, **bronchogenic carcinoma the commonest cancer** (multiplied by smoking)
Farmer's lung	Mouldy hay (Saccharopolyspora rectivirgula, formerly Micropolyspora faeni)
Woolsorter's disease, brucellosis	Anthrax spores in wool and hides; abattoir and dairy workers
Siderosis, baritosis	Iron oxide; barium
Berylliosis	Beryllium (granulomas)
Lead poisoning	**Burton's blue line on gums**, colic, wrist drop, anaemia with basophilic stippling
Mercury	Stomatitis, tremor, erethism (mad hatter; mirror and felt-hat makers)
Cadmium	Itai-itai, renal damage, emphysema
Arsenic	Skin lesions; skin and lung cancer
Chromium	Skin ulcers ("chrome holes"), nasal septum perforation, lung cancer
Nickel	Nasal sinus and lung cancer
Hardwood dust	Adenocarcinoma of the nasal cavity and ethmoid sinus
Soot, tar, mineral oils	Scrotal and skin cancer (Pott's chimney sweeps); skin cancer is the commonest occupational cancer
Benzene	Leukaemia (AML)
Vinyl chloride	Hepatic angiosarcoma
Aniline dyes, beta-naphthylamine	**Bladder cancer**
Radiation	Leukaemia, bone cancer
Hand-arm vibration	Raynaud's phenomenon (vibration white finger)
Compressed air	Caisson disease (decompression sickness)

- **Prevention hierarchy**: eliminate, substitute, engineering control, administrative control, personal protective equipment.
- **Occupational legislation**: apply the principle (safe workplaces, compensation, notifiable diseases), but **Nepal's Labour Act and Contribution-based Social Security Act** apply, not India's Employees' State Insurance Act or Factories Act.
- **Workers' compensation** pays for **temporary disablement, permanent partial disablement, permanent total disablement and death**; in Nepal the **Labour Act 2074 (2017)** makes the employer buy **accident insurance of at least Rs 700,000** for every worker (premium wholly the employer's; **100% of it paid on death or total incapacity**, a share by the percentage of incapacity for partial; s. 55) and **medical insurance of at least Rs 100,000 a year** (premium shared; s. 54), and the enterprise pays the treatment of a prescribed **occupational disease**, and compensation if it is incurable, unless the Social Security Fund pays (s. 82); the **Contribution-Based Social Security Act 2074 (2017)** runs the accident, incapacity and medical schemes for contributors.
- **Agricultural hazards**: zoonoses (anthrax, brucellosis, bovine TB, rabies, leptospirosis, tetanus), pesticide poisoning (organophosphates), physical (heat, cold, noise, vibration) and mechanical injury. **Dermatoses** are primary irritant, allergic or carcinogenic.
- **Ergonomics** and **work-related** musculoskeletal disorders; **pneumoconiosis** is diagnosed by chest X-ray in the ILO classification.
- **Soiling index / coefficient of haze** = stain on filter paper, an indicator of **smoke and suspended particles**. **Occupational asthma**: isocyanates (spray painting, toluene diisocyanate), flour (baker's asthma), wood dust (western red cedar), laboratory animals and welding fumes; compare silica (silicosis) and coal dust (pneumoconiosis).

Maternal and child health, demography

Indicators (definitions are the usual question)

Indicator	Definition
Maternal mortality ratio (MMR)	Maternal deaths per **100,000 live births**
Maternal mortality rate	Maternal deaths per 100,000 women of reproductive age
Infant mortality rate (IMR)	Deaths under 1 year per **1,000 live births**
Neonatal mortality rate	Deaths in first 28 days per 1,000 live births (early neonatal first 7 days)
Perinatal mortality rate	Stillbirths (28 weeks or more in some, 22 weeks in WHO ICD) + early neonatal deaths per 1,000 total births
Under-five mortality rate	Deaths under 5 per 1,000 live births
Stillbirth rate	Per 1,000 total births
Crude birth rate	Live births per 1,000 mid-year population
General fertility rate	Births per 1,000 women aged 15–49
Total fertility rate (TFR)	Average children a woman would have through her reproductive life
Gross reproduction rate	Daughters a woman would have
Net reproduction rate (NRR)	Daughters, allowing for mortality; **NRR = 1 is replacement**
Couple protection rate	Percent of eligible couples effectively protected
Pearl index	Pregnancies per 100 woman-years = (accidental pregnancies x 1,200) / (women x months of use)

- **Replacement-level fertility** is a TFR of about **2.1**; an NRR of 1 needs a **couple protection rate over 60%** (Park). A population keeps growing for a time after reaching it (**population momentum**).
- **Demographic cycle**: stage 1 high stationary, 2 early expanding, 3 late expanding, 4 low stationary, 5 declining. **Doubling time** = 70 / growth rate.
- **Dependency ratio** = (population under 15 + 65 and over) / working age 15–64. **Sex ratio**: Nepal's census gives **males per 100 females: 95.6 in the 2021 census** (population 29,164,578; National Statistics Office); India's census gives females per 1,000 males.
- **Life expectancy**, **HDI** (a long healthy life, knowledge, and income as GNI per head at PPP), **PQLI** (infant mortality, life expectancy at age one, literacy; **per capita income is not in it**) are composite indicators.
- **Direct causes of maternal death** (global): **haemorrhage (the leading)**, hypertensive disorders, sepsis, unsafe abortion, obstructed labour. **Three delays**: in deciding to seek care, in reaching it, in receiving it.
- **Nepal's maternal mortality ratio**: **151 per 100,000 live births** in the census-based **Nepal Maternal Mortality Study 2021** (MoHP, NSO, NHRC; down from 239 in NDHS 2016), highest in Lumbini (207) and Karnali, lowest in Bagmati (98). The **SDG target is 70** by 2030; Nepal's SDG targets for neonatal and under-five mortality are **12 and 20** (the global SDG figures are 12 and 25).
- **Leading causes of neonatal death**: prematurity, birth asphyxia, sepsis. **Child deaths after the neonatal period**: pneumonia, diarrhoea, malaria, malnutrition.

Demography (curriculum additions)

- **Total fertility rate** = the sum of the **age-specific fertility rates** multiplied by the width of each age group (usually 5 years); with 5-year groups and rates per 1,000, TFR = 5 x (sum of ASFR) / 1,000. General fertility rate has women 15–49 as the denominator and crude birth rate the whole mid-year population.
- **Dependency ratio worked**: young (0–14) 300, old (65+) 100, working age 600: **total 400/600 = 67 per 100**, young dependency 50, old dependency about 17. The denominator is always the **working-age group** (dividing by the total population gives 40, the usual trap). **Child-woman ratio** = children 0–4 per 1,000 women 15–49. **Sex ratio** and **masculinity ratio** compare males and females.
- **Population pyramid**: broad base and narrow top is **expanding** (young, high birth rate, the shape of Nepal's past); a base **narrower than the middle** (births falling) is **constrictive**; near-vertical sides (births and deaths low and balanced) is **stationary**; a bulge at working ages gives the **demographic dividend**. **Baby boom** is a sudden sustained rise in births (post-war), **baby bust** a sharp fall.
- **Demographic transition**: stage 1 high birth and high death rates (stationary), **stage 2 death rate falls while the birth rate stays high: the fastest growth** (early expanding), stage 3 birth rate falls (late expanding), stage 4 both low (stationary), stage 5 births below deaths (declining). **Malthus (1798)**: population grows geometrically, food only arithmetically, checked by famine, war and disease (positive) or by restraint (preventive).
- **Natural increase** = crude birth rate minus crude death rate (per 1,000; divide by 10 for a percentage). **Balancing equation**: P1 = P0 + births - deaths + in-migrants - out-migrants. **Net migration rate** = in-migration minus out-migration rate; **gross migration** is their sum. Projection models: **arithmetic** (equal numbers each period), **geometric** (equal percentage each period) and **exponential** (continuous growth); doubling time = 70 / growth rate (%).
- **Standardisation**: **direct** applies each population's age-specific rates to one standard population; **indirect** applies standard rates to the study population's age structure and gives the **SMR = observed / expected deaths x 100**, used when age-specific rates are unstable or unknown. **Contraceptive prevalence rate** = percentage of married women of reproductive age using a method.
- **Human Development Index** combines life expectancy at birth, years of schooling (mean and expected) and gross national income per head (a geometric mean of the three indices; UNDP).

Antenatal, intrapartum and postnatal care

- **WHO 2016 antenatal guideline**: a **minimum of eight contacts** (replacing the four-visit focused model) for a positive pregnancy experience: **one in the first trimester (by 12 weeks), two in the second (20 and 26 weeks), five in the third (30, 34, 36, 38, 40 weeks)**. **Risk approach**: high-risk mothers are identified (age <18 or >35, short stature <145 cm, grand multiparity, previous caesarean, hypertension).

- **Essential components**: tetanus toxoid, iron-folic acid, blood pressure, urine protein, haemoglobin, ultrasound before 24 weeks, HIV, syphilis, hepatitis B screening.
- **Safe motherhood**: skilled attendance at birth, emergency obstetric care. **Basic EmOC** has 7 signal functions (parenteral antibiotics, uterotonics, anticonvulsants, manual removal of the placenta, removal of retained products, assisted vaginal delivery, newborn resuscitation); **comprehensive EmOC** adds caesarean section and blood transfusion. The UN rule: 5 emergency units (4 basic and 1 comprehensive) per 500,000 population.
- **Partograph**: alert and action lines (4 hours apart in the WHO 2000 version; WHO 2020 replaces it with the Labour Care Guide).
- **Postnatal** (WHO 2022): stay at least 24 hours after a normal facility birth, then **at least four postnatal contacts**: within 24 hours, day 3 (48–72 hours), days 7–14, and week 6. **Newborn care**: the **WHO "essential newborn care"**: dry, skin-to-skin contact, delayed cord clamping at 1–3 minutes, early breastfeeding, **kangaroo mother care** for small babies (WHO 2022 recommends it immediately after birth).
- **Low birth weight**: below **2,500 g**; very low <1,500 g; extremely low <1,000 g. **Preterm**: <37 weeks.
- **IMNCI** (integrated management of neonatal and childhood illness; in Nepal the community-based **CB-IMNCI**, whose childhood conditions are pneumonia, diarrhoea, malaria, measles and malnutrition, plus newborn problems) classifies by colour: pink (urgent referral), yellow (treat), green (home care). **Fast breathing**: ≥60/min under 2 months, ≥50 at 2–11 months, ≥40 at 1–5 years. **Chest indrawing** is severe pneumonia in older rules (WHO 2014 manages chest indrawing pneumonia as pneumonia with amoxicillin; **danger signs** need referral).
- **Diarrhoea**: plan A, B and C; **low-osmolarity ORS** and zinc. **Dehydration**: some (restless, thirsty, sunken eyes, skin pinch slow), severe (lethargic, unable to drink, skin pinch very slow).
- **Growth monitoring**: the road-to-health card.
- **Contraception**: **LAM** (lactational amenorrhoea method) is more than 98% effective in the first six months with exclusive breastfeeding and no menses. **Pearl index** examples: combined pill 0.1–0.3 (perfect use); IUD copper under 1; condom 2–15 (typical); injectable DMPA 0.3 (perfect), every **3 months**. **Emergency contraception**: levonorgestrel 1.5 mg within 72 hours (works to 120 hours with lower effectiveness), copper IUD within 5 days (most effective), ulipristal 30 mg. **Implants** last 3–5 years. **Postpartum IUD** within 48 hours or after 4 weeks.
- **Nepal figures (NDHS 2022, Key Indicators Report, MoHP/ New ERA/ICF 2023)**: **neonatal mortality 21, infant 28 and under-five 33 per 1,000 live births** (5 years before the survey); **total fertility rate 2.1**; ANC from a skilled provider 94%, **four or more antenatal visits 81%**; **institutional delivery 79%** and **skilled birth attendance 80%**; **modern contraceptive use 43%** of currently married women (57% any method; female sterilisation, injectables and implants the commonest modern methods, withdrawal the commonest traditional one); **fully vaccinated children 12–23 months 80%** (basic antigens). **Neonatal mortality did not change between NDHS 2016 and 2022** (Nepal's own target was 16 by 2022).
- **Abortion law in Nepal** (Indian MTP limits do not apply). The **Muluki Criminal Code 2074, s. 189**, allows abortion by a licensed provider with the woman's consent **up to 12 weeks on request**, **up to 18 weeks after rape or incest**, and **at any stage** when a licensed doctor finds a risk to her life or physical or mental health, a fetal disability, or that she has HIV or another incurable disease. The later **Right to Safe Motherhood and Reproductive Health Act 2075 (2018), s. 15**, keeps 12 weeks on request and allows **up to 28 weeks** on the health, disability, rape or incest, HIV or incurable-disease and fetal-defect grounds. Know both.
- **Aama programme** (the Aama and Newborn Programme, MoHP): it began in **2005** as the Safe Delivery Incentive Programme (a cash payment towards transport for a facility birth), added **free delivery care in all public facilities in 2009** (named Aama), merged the **incentive for four ANC visits in 2012** (Aama Surakshya Karyakram), and took in **free newborn care in 2016/17**. The cash amounts differ by ecological zone (more for mountain, then hill, then Terai districts) and have been revised over time (NHSSP review of the programme, 2020).
- **Female Community Health Volunteers (FCHVs)**: begun in **1988/89 (2045/46 BS) in 27 districts** and extended to every district; about **52,000** women volunteers today (press reports, 2024–26), who give health education, distribute condoms, pills, ORS and zinc, iron and vitamin A, identify sick newborns and children under CB-IMNCI, and refer (MoHP Female Community Health Programme). They are the backbone of the vitamin A and deworming rounds.
- **No-scalpel vasectomy** (puncture and blunt dissection of the scrotal skin, same vas occlusion): fewer haematomas, infections and less pain than the conventional incision, quicker recovery; efficacy and the need for a semen check three months later are unchanged.

Health education

Communication and education

- **Communication** has sender, message, channel and receiver, with feedback. **Barriers**: language, noise, cultural beliefs, differences in status. In a community clinic, use the people's own words, involve local leaders and respect their beliefs about illness; treating "regardless of their cultural perceptions" is the classic wrong option.
- **Methods**: **individual** (counselling, interview); **group** (lecture, demonstration, role play, panel, symposium, workshop, group discussion, brainstorming, **buzz session**); **mass media** (radio, television, newspapers, posters; wide reach, poor feedback).
- **Teaching aids**: **Edgar Dale's cone of experience**: direct, purposeful experiences retain the most; verbal symbols the least. **Demonstration** is the best way to teach a skill. **Role play** teaches attitudes.
- **Health education principles**: credibility, interest, participation, motivation, comprehension, reinforcement, learning by doing, known to unknown, setting an example, good human relations, feedback, leaders, **small groups work better than lectures for behaviour change**.
- **Social marketing**, **IEC** (information, education, communication) and **BCC** (behaviour change communication).

Models of behaviour change

- **Transtheoretical (stages of change, Prochaska and DiClemente)**: **precontemplation** (no intention in the next 6

months), **contemplation** (intends within 6 months), **preparation** (within 30 days; small steps taken), **action** (changed for under 6 months), **maintenance** (over 6 months), with possible relapse. A smoker who plans to quit within six months but has not acted is in **contemplation**.

- **Health belief model**: perceived susceptibility, severity, benefits, barriers, cues to action, self-efficacy.
- **Theory of planned behaviour**: attitude, subjective norms, perceived control. **Social learning theory** (Bandura): learning through observation, self-efficacy.
- **Diffusion of innovations** (Rogers): innovators, early adopters, early majority, late majority, laggards.

Health promotion, counselling and the social sciences (curriculum additions)

- **Ottawa Charter 1986** gives five action areas (see below) and three strategies: **advocate, enable, mediate**. **Jakarta Declaration 1997** was the first to bring in the private sector; its five priorities: promote social responsibility for health, increase investment in health development, consolidate and expand partnerships, increase community capacity and empower the individual, secure a health-promotion infrastructure. Later charters: Bangkok 2005, Shanghai 2016.
- **PRECEDE-PROCEED (Green)**: planning works backwards from the quality of life through health problems and behaviour to the **predisposing** (knowledge, beliefs), **enabling** (skills, resources, services) and **reinforcing** (family, peers, providers) factors; PROCEED is implementation and evaluation.
- **Participatory learning and action (PLA)** and **focus group discussion** (6–12 people, a facilitator and a note-taker, one topic) find a community's needs in its own words; they are qualitative, not representative. **Counselling** is two-way, helps the patient decide and improves compliance; good providers are empathic, listen and use plain language. Barriers to communication: noise, distortion of the message, cultural difference, the patient's mistaken perception of the problem.
- **Parsons' sick role**: the sick person is **exempt from normal duties**, **not blamed for the illness**, **obliged to want to get well** and **obliged to seek competent help**. **Szasz and Hollender's three models** of doctor-patient relationship: **activity-passivity** (emergency, unconscious patient), **guidance-cooperation** (acute illness) and **mutual participation** (chronic illness, patient manages with the doctor).
- **Foster and Anderson's medical systems**: **personalistic** (illness caused by an agent such as a god, ghost or sorcerer) and **naturalistic** (an imbalance of natural forces, as in humoral hot-cold and Ayurvedic ideas). **Ethnocentrism** judges other cultures by one's own; **cultural relativism** judges them by their own standards; **cultural lag** (Ogburn) is the delay of customs behind material change.

Primary health care

- **Alma-Ata 1978**: "Health for All by 2000"; **primary health care** is essential care, universally accessible, community-involved, at a cost the country can afford. **Eight elements**: education on health problems; food supply and nutrition; water and sanitation; maternal and child health including family planning; immunisation; prevention of endemic diseases; treatment of common diseases and injuries; essential drugs. **Principles**: equitable distribution, community participation, intersectoral coordination, appropriate technology.
- **Ottawa Charter 1986** defined health promotion (build healthy public policy, create supportive environments, strengthen community action, develop personal skills, reorient health services). **Health promotion** 'enabling people to increase control over their health'.
- **WHO's definition of health** (1948, unchanged): a state of complete physical, mental and social well-being, not merely the absence of disease; a spiritual dimension was proposed later.
- **Levels of health care**: primary, secondary, tertiary.
- **Alma-Ata's four As** of access: availability, accessibility, acceptability, affordability; Park gives **five principles**: equitable distribution, community participation, intersectoral coordination, appropriate technology, and a focus on prevention and promotion. A high-cost super-specialty unit as a priority runs against equity and appropriate technology. **Jakarta 1997** carried health promotion into the 21st century; **Astana 2018** (WHO, UNICEF) renewed primary health care as the route to universal health coverage and added NCDs and mental health.
- **Nepal**: the **Constitution of Nepal 2015 (Article 35)** makes **free basic health services** a fundamental right, set out in the **Public Health Service Act 2075 (2018)** and its basic health services package; under the federal structure (7 provinces, 753 local levels) local governments run health posts and basic hospitals. The government's plan for the sector is the **Nepal Health Sector Strategic Plan 2023–2030** (endorsed 2023; aimed at universal health coverage).
- **Culture terms**: **enculturation** = learning one's own culture from childhood; **acculturation** = change in a culture after continuous contact with another; **accommodation** = adjustment between cultures in contact, each adopting some ways of the other without giving up its own (as a traditional healer taking up some modern practices); **diffusion** = spread of traits between societies; **cultural lag** = material change outpacing customs.

Study designs

Classification

- **Observational**: descriptive (case report, case series, cross-sectional, ecological, correlational) and analytical (**case-control, cohort**). **Experimental**: randomised controlled trial (RCT), community trial, field trial, quasi-experimental.
- **Descriptive** studies generate hypotheses (person, place, time); **analytical** studies test them.
- **Ecological study**: the unit is a group; risk of the **ecological fallacy** (an association in groups need not hold in individuals).
- **Cross-sectional** (prevalence) study: exposure and outcome measured at one time; cannot show temporality; good for prevalence, poor for rare diseases or short-lived ones. **Case series** has no comparison group.

Case-control study

- Starts with **outcome**: cases and controls, looking back for **exposure** (retrospective). **Best for rare diseases and for many exposures**; quick and cheap; needs small samples.
- Measures the **odds ratio**; cannot give incidence or relative risk directly (unless the disease is rare, where OR approximates RR).
- Weak points: **recall bias**, selection bias (**Berkson's** in hospital controls), temporality unclear, **not suited to rare exposures**.

- **Matching** controls controls confounding; over-matching reduces efficiency. **Nested case-control**: cases and controls drawn from a cohort, reducing recall bias.

Cohort study

- Starts with **exposure**: exposed and unexposed groups followed for the outcome. May be prospective, retrospective (historical) or ambispective.
- **Best for rare exposures and many outcomes**; gives **incidence, relative risk and attributable risk**; establishes temporality.
- Weak points: costly, long, **loss to follow-up (attrition bias)**, not suited to rare disease; **Framingham heart study**, the British doctors' study (smoking and lung cancer, Doll and Hill), and Nurses' Health Study are classic cohorts.
- **Prospective cohort** is the strongest observational design for causation.

Randomised controlled trial

- **Randomisation** balances known and unknown confounders. **Allocation concealment** prevents selection bias in assignment; **blinding** prevents bias in assessment and participant behaviour. **Single blind**: participant unaware. **Double blind**: participant and investigator/assessor unaware. **Triple blind**: also the analyst or monitoring committee.
- **Intention-to-treat** analysis analyses participants in the groups to which they were assigned and preserves randomisation; **per-protocol** analysis includes only those who followed the protocol. ITT is the standard for efficacy in practice (effectiveness).
- **Phases**: **phase 0** microdose, **phase I** safety in a few healthy volunteers (dose, toxicity, pharmacokinetics), **phase II** efficacy and dose in patients, **phase III** large randomised comparison with the standard, **phase IV** post-marketing surveillance.
- **Crossover trial**: each person receives both treatments in turn, with a **washout** period; each is their own control, so fewer participants are needed; suits **chronic, stable** conditions; not for curable disease, surgery or treatments with lasting effects (carry-over). **Factorial** designs test two interventions in four groups. **Cluster RCT** randomises groups.
- **Non-inferiority** trials show a new treatment is no worse than the standard by a margin. **Pragmatic** trials test effectiveness in real practice; **explanatory** trials test efficacy in ideal conditions.
- **Placebo** is ethical only where no proven treatment exists, or for compelling methodological reasons with no risk of serious harm (Declaration of Helsinki).
- **Random allocation** in a parallel trial (each person stays in one arm) protects **internal validity**; **random sampling** from the population protects **external validity** (generalisability). Stratified (or block) randomisation balances chosen prognostic factors.
- **CONSORT** reports RCTs, **STROBE** observational studies, **PRISMA** systematic reviews, **STARD** diagnostic accuracy, **CARE** case reports, **ARRIVE** animal studies.

Hierarchy of evidence and reviews

- From the top: **systematic reviews and meta-analyses of RCTs**, individual RCT, cohort, case-control, cross-sectional, case series and reports, then expert opinion and animal or laboratory studies.
- **Meta-analysis** pools results statistically; **heterogeneity** is checked by the I-squared statistic and Cochran's Q; shown as a **forest plot**; **publication bias** by a **funnel plot** (asymmetry). **Cochrane** produces systematic reviews.
- **Number needed to harm**: 1 / absolute risk increase (the attributable risk of the harmful exposure).
- For the **effectiveness of an intervention** the single best study is the **RCT**, and the highest level of evidence a **systematic review and meta-analysis of RCTs**; for causes of a rare disease, the case-control study; for prognosis, the cohort.

Other design points

- **Internal validity** is whether results are true for the study sample; **external validity (generalisability)** is whether they apply beyond it.
- **Pilot study** tests feasibility; **qualitative methods**: focus group discussions, in-depth interviews, **saturation** (no new themes), **triangulation**.
- **Natural experiment**, **before-and-after** and **historical controls** are quasi-experimental and weaker.
- **Research question** quality criteria: **FINER** (feasible, interesting, novel, ethical, relevant). **PICO** structures a clinical question (population, intervention, comparison, outcome).
- **Cohort types**: **concurrent (prospective)** enrols now and follows forward; **historical (retrospective)** uses past records of exposure and outcome already occurred; **ambispective** combines both. A case-control study is nicknamed *trohoc* (cohort reversed); **up to about four controls per case** is useful, beyond that power gains are negligible. **Maximum attrition of candidate drugs is in phase II** (efficacy).

Biostatistics

Types of data and scales

- **Nominal** (names, no order: sex, blood group), **ordinal** (ranked, unequal intervals: pain scores, Likert, cancer stage), **interval** (equal intervals, no true zero: temperature in Celsius), **ratio** (true zero: height, weight, blood pressure). **Discrete** (counts) vs **continuous**.
- **Nominal** is the least informative scale (religion, marital status); IQ is treated as interval.
- Presentation: **histogram** (continuous data; **no gaps between bars**; area shows frequency; bars cannot be reordered), **frequency polygon** (mid-points of the bars joined by straight lines), **bar chart** (discrete or categorical; gaps between bars; may be reordered), **pie chart** (parts of a whole), **line diagram** (trends), **scatter diagram** (two variables), **box-and-whisker plot** (median, quartiles), **ogive** (cumulative frequency, read for the median and quartiles), **pictogram**, **stem-and-leaf**.

Central tendency and spread

- **Mean** uses all values and is pulled by outliers; **median** is the middle value, **best for skewed data** (hospital stay, incomes); **mode** is the commonest. **Geometric mean** suits ratios and titres; **harmonic mean** rates.
- In a **positively skewed** distribution: **mean > median > mode** (tail to the right); in **negatively skewed**: mean < median < mode. In the normal distribution all three are equal. In a moderately skewed distribution, **mode = 3 median - 2 mean** (Pearson's empirical rule).

- Worked: for 2, 4, 4, 6, 4 the mean is 20/5 = 4, the median (middle of 2, 4, 4, 4, 6) is 4, and the mode is 4. With an even count, the median is the mean of the middle two.
- **Range**; **interquartile range** (Q3 - Q1); **variance** = SD squared; **standard deviation**; **coefficient of variation** = SD / mean x 100, **unit-free, used to compare variation between variables** (height and weight).
- **Spread least affected by outliers**: interquartile range (and the median for centre). Of all the usual measures, the **mode** is the most resistant: adding one extreme value leaves it unchanged, while the mean, SD, variance and range all move (the mean is the most sensitive measure of centre). Range, SD, variance and mean deviation are **absolute** measures of dispersion; the **coefficient of variation is relative**.
- **Standard error of the mean** = **SD / square root of n**; it measures the variation of sample means, shrinks as n rises. **SD** describes variation of observations; **SE** describes precision of an estimate.
- **Precision against accuracy**: repeated readings that agree (200, 200, 200) but miss the true value (260) are **precise (reliable) but not accurate (valid)**; random error spoils precision, systematic error accuracy.

Normal distribution

- Symmetrical, bell-shaped, continuous, asymptotic to the x-axis, total area 1; **mean = median = mode**. **68% within mean ± 1 SD; 95% within ± 1.96 SD (about 2); 99.7% within ± 3 SD**. Two-tailed critical values: **90% 1.645, 95% 1.96, 99% 2.58**. **Standard normal (z)**: mean 0, SD 1; z = (x - mean) / SD. For any distribution, **Chebyshev's inequality** guarantees at least 1 - $1/k^2$ of values within k SD (75% within 2 SD).
- **Kurtosis**: leptokurtic (sharp peak, heavy tails), mesokurtic (normal), platykurtic (flat).
- **Normality tests**: **Shapiro-Wilk** (preferred, especially for small samples; often given as n under about 50–100), **Kolmogorov-Smirnov** for larger samples; also a Q-Q plot.
- **Confidence interval (95%)** = estimate ± 1.96 x SE. If a 95% CI for a **ratio (RR, OR) includes 1**, or for a **difference includes 0**, the result is not significant at 5%. The CI narrows with a **larger sample, less variability and a lower confidence level**.
- **Skewness** and **kurtosis** describe shape. **Skewed data** can be log-transformed.

Hypothesis tests

- **Null hypothesis (H0)**: no difference. **p-value**: probability of getting a result at least as extreme **if H0 is true**; it is not the probability that H0 is true. The conventional threshold is p < 0.05. A small p says nothing about the size or clinical importance.
- **Type I error (alpha)**: rejecting a true H0 (false positive; alpha, the significance level, is its maximum probability); **type II (beta)**: failing to reject a false H0 (false negative). **Power = 1 - beta** (usually 80–90%). Power rises with **larger sample, bigger effect size, higher alpha and lower variability**. The sample size is increased when alpha and beta are both reduced.
- **Choosing the test**:

Data	Test
Two means, independent, normal	**Unpaired (independent) t-test**
Two means, same people before and after	**Paired t-test**
Three or more means	**ANOVA** (F-test)
Two categorical proportions	**Chi-square test**; **Fisher's exact** if expected count <5
Paired categorical	**McNemar's test**
Two groups, non-normal or ordinal, independent	**Mann-Whitney U (Wilcoxon rank sum)**
Paired, non-normal	**Wilcoxon signed-rank**
Three or more groups, non-normal	**Kruskal-Wallis**
Correlation, normal	**Pearson's r**; non-normal **Spearman's rho**
Time to event	**Kaplan-Meier** curves compared by **log-rank test**; **Cox regression** gives hazard ratios
One sample mean against a known value	One-sample **t-test**; z-test if n >30 and variance known
Binary outcome, several predictors	**Logistic regression** (odds ratio)

- **Parametric** tests (t-tests, z-test, ANOVA, Pearson's r) assume interval or ratio data from a normal distribution, compare means and are **more powerful**; **non-parametric** tests are distribution-free, compare medians or ranks, suit nominal, ordinal or skewed small samples, and include **chi-square, Fisher's exact, McNemar, sign, Mann-Whitney U, Wilcoxon signed-rank, Kruskal-Wallis and Friedman** (the last for three or more related groups; repeated-measures ANOVA is its parametric partner).
- **Degrees of freedom** for a contingency table = (rows - 1) x (columns - 1): **1 for a 2 x 2 table**. Chi-square tests significance, not the strength of association.
- **Correlation coefficient r** ranges from -1 to +1 (above about 0.7 is strong; 0 means no linear correlation); **r squared, the coefficient of determination**, gives the proportion of variation explained. To **predict** one variable from another, use **regression** (the regression coefficient), not correlation. Correlation is not causation. **Linear regression** predicts a continuous outcome (y = a + bx); the slope b is the regression coefficient.
- **Multiple testing** raises the type I error; the **Bonferroni** correction divides alpha by the number of tests.
- **Curriculum extras**: **chi-square** tests proportions, goodness of fit and independence in an r x c table (observed against expected counts, expected = row total x column total / grand total). **Z-test** for a proportion or for means when n >30. **Regression**: y = a + bx, where **b** is the change in y per unit x (not the same as r) and **r squared** is the share of variation in y explained by x; correlation and regression show association, **not causation**, and r has no units. **Binomial distribution**: two outcomes, fixed number of trials n, constant probability p (mean np, SD square root of npq); **Poisson**: rare events in a fixed interval, **mean equals variance**.

Measures of association and effect

Measure	Formula	Used in
Relative risk (risk ratio)	Ie / Io = [a/(a+b)] / [c/(c+d)]	Cohort, trials
Odds ratio	ad / bc (the **cross-product ratio**)	Case-control; also cross-sectional

Measure	Formula	Used in
Attributable risk (risk difference)	Ie - Io	The excess risk in the exposed (smokers minus non-smokers)
Attributable risk percent	(Ie - Io) / Ie x 100	Share of disease in the exposed due to exposure
Population attributable risk	It - Io	Excess in the whole population
PAR percent	(It - Io) / It x 100	Share of disease in the population preventable
Absolute risk reduction	Control event rate - experimental event rate	Trials
Relative risk reduction	ARR / control event rate = 1 - RR	Trials
Number needed to treat	1 / ARR	20 for ARR 5%
Hazard ratio	Ratio of instantaneous event rates	Survival
Efficacy of a vaccine	(ARU - ARV) / ARU x 100	Trials

- Worked: 40/100 cases and 20/100 controls exposed. Cases: 40 exposed, 60 unexposed; controls: 20 exposed, 80 unexposed. **OR = (40 x 80) / (60 x 20) = 2.67**.
- Relative risk 1 means no association; >1 risk factor; <1 protective. In a case-control study **OR approximates RR when the disease is rare**.
- **Mortality ratio**, **proportional mortality** and **SMR** (see epidemiologic concepts).
- **Life table**: shows the probability of dying at each age; **survival analysis** handles censored data. **Kaplan-Meier**: step curve; **median survival** is where the curve falls to 50%.
- **Regression to the mean**: extreme values on first measurement tend to be closer to the mean on retest.

Other practical formulas

- **Pearl index** = accidental pregnancies x 1,200 / (women x months of use), per 100 woman-years; for 200 women using a method 6 months with 6 pregnancies: 6 x 1,200 / 1,200 = **6**. **Sample size** for a prevalence: n = Z^2 p q / d^2 (Z 1.96, p expected prevalence, q = 1 - p, d absolute precision).
- **Health indices**: DALY, QALY, HALE. **Crude death rate** = deaths per 1,000 mid-year population.
- A **line diagram** shows a **time trend** of one measure; a scatter diagram shows two continuous variables on each subject; a histogram the distribution of one continuous variable; a pie chart proportions of a whole.

Sampling

Probability (random) methods

- **Simple random sampling**: every unit has the same chance; needs a complete list (**sampling frame**); use random number tables or computer generation. **Lottery method**.
- **Systematic sampling**: every kth unit (**k = N / n**, the sampling interval) after a random start; easy to do; risk if the list has a periodic pattern. Simple random sampling suits small, homogeneous populations.
- **Stratified random sampling**: divide into homogeneous strata (age, sex, ethnic group) and sample each; reduces variance and ensures representation of small groups. **Proportionate** (in proportion to stratum size) or disproportionate (equal numbers, for comparison).
- **Cluster sampling**: the **clusters (groups such as villages or wards) are chosen at random, not individuals**, then all members are included (single stage) or a sample of members (multistage). Needs no complete list of individuals, cheaper for dispersed populations; but **greater sampling error than simple random sampling for the same size** (members of a cluster resemble each other), measured by the **design effect** (usually 1.5–2; so the sample is multiplied by it).
- **WHO 30 x 7 cluster survey (EPI)**: 30 clusters of 7 children aged 12–23 months to estimate immunisation coverage (210 children); with a precision of about ±10%. Modern WHO coverage surveys use **probability-proportional-to-size (PPS)** to choose clusters.
- **Multistage sampling**: used in large surveys such as DHS (stage 1 ward or enumeration area chosen with probability proportional to size; stage 2 households). **Multiphase sampling**: all units at the first phase, a subsample in the second. **LQAS** (lot quality assurance sampling) classifies small areas using small samples (19 in a lot).

Non-probability methods

- **Convenience (accidental)**: whoever is available. **Purposive (judgement)**: chosen by the researcher. **Quota**: fixed numbers from subgroups, but not randomly selected. **Snowball**: participants recruit others, for hidden populations (people who inject drugs). **Volunteer** samples select themselves. **Consecutive sampling**: all eligible cases in a period.
- **Sampling error** is due to chance: a larger sample reduces it and raises precision, but only a complete census removes it. **Sampling bias** is systematic and is reduced by proper random methods, not by size.
- Non-probability samples cannot estimate sampling error and are prone to selection bias.

Sample size and error

- **Sampling error** falls as sample size rises (as the **square root of n**): quadrupling the sample halves the standard error. **Non-sampling errors** (measurement, response, recording) are not reduced by larger sample.
- Sample size depends on **expected prevalence, precision (margin of error), confidence level, power, effect size and variability**. A higher required precision or power needs a larger sample. **Finite population correction** reduces the sample for a small population.
- **Sampling distribution**: the distribution of sample means; the **central limit theorem** says it is approximately normal whatever the population when n is large.
- **Randomisation** (allocation of subjects to groups) differs from **random sampling** (selection from a population): sampling gives external validity; randomisation gives internal validity.
- Response rate and **non-response bias**.

Bias and confounding

Bias (systematic error)

- **Selection bias**: how participants were chosen or retained.
  - **Berkson's bias (admission rate bias)**: hospital-based case-control studies, as the chance of admission depends on both the disease and the exposure.

    - **Neyman (prevalence-incidence) bias**: studying only survivors or prevalent cases misses fatal cases.
    - **Healthy worker effect**: workers appear healthier than the general population used as the unexposed comparison (the sick are less often employed); biases occupational cohorts toward no effect.
    - **Volunteer bias, non-response bias, loss to follow-up (attrition bias)**, **diagnostic (detection) bias**, **lead-time and length-time bias** (screening).
    - **Selection bias in a cohort**: exposed and unexposed differ in more than exposure.
- **Information (measurement) bias**: errors in measuring exposure or outcome.
    - **Recall bias**: cases remember exposure better than controls, **a problem in case-control studies**. **Reporting bias** (social desirability, stigma). **Interviewer (observer) bias**: knowledge of status changes questioning (leading questions); countered by blinding and standard interview times. **Surveillance (detection) bias**: the more one looks, the more one finds. **Misclassification**: **non-differential** (same in both groups; biases toward the null) and **differential** (can go either way). **Hawthorne effect**: participants change their behaviour because they are being studied, a **subject (participant) bias**, not a selection bias.
    - **Instrument bias** (uncalibrated devices); **Pygmalion (observer-expectancy) effect**: the researcher's belief raises the response; the **Golem effect** is its opposite.
- **Controlling bias**: careful design, clear case definitions, **blinding**, standardised measurement, objective data sources, high follow-up, **random selection**, and for recall bias use records or controls with another disease.
- **Publication bias**: positive studies are published more often; the **funnel plot** detects it.

Confounding

- A **confounder** is associated with the exposure, is an independent risk factor for the outcome, and **is not on the causal pathway** between them. Coffee and lung cancer, confounded by smoking. Age and sex are the commonest confounders.
- **Control at design**: **randomisation** (controls known and unknown), **restriction** (limit to one stratum, e.g. only non-smokers), **matching** (case-control and cohort).
- **Control at analysis**: **stratification** (Mantel-Haenszel adjusted estimate), **standardisation**, **multivariable regression** (logistic, Cox, linear). Only **randomisation** deals with unmeasured confounders.
- A larger sample, blinding and more careful measurement do not remove confounding.
- **Effect modification (interaction)** differs from confounding: the effect really differs between strata (e.g. the effect of oral contraceptives on stroke is greater in smokers); it is reported, not removed. If the stratum-specific estimates differ, do not pool them.
- **Mediator** (on the pathway) should not be adjusted for in estimating the total effect. **Collider** adjustment introduces bias.
- **Reverse causation**: the disease changes the exposure (weight loss before cancer diagnosis).
- **Residual confounding** persists after adjustment because of imperfect measurement.

Validity and reliability

- **Internal validity** can be threatened by bias, confounding and chance. **Reliability** is repeatability (kappa for categorical, intraclass correlation for continuous measures).
- **Confounding vs bias**: bias is a flaw in design or measurement that cannot be fixed afterwards; confounding can be adjusted in analysis if the factor was measured.
- **Apprehension bias**: a subject's anxiety changes a reading (pulse, blood pressure), a measurement bias; compare Berkson's (hospital-based selection), lead-time (earlier detection) and Neyman (prevalent cases) biases.

Research ethics

Historical codes

- **Nuremberg Code (1947)**: from the trial of Nazi physicians; **voluntary informed consent is absolutely essential**, the first international research code.
- **Declaration of Helsinki (1964)** of the World Medical Association; repeatedly revised, **most recently in October 2024** (Helsinki; the 2013 version is the one older books quote). It gives **ethics committee review** before the study, **informed consent**, risk-benefit assessment, special protection of **vulnerable groups**, **registration of trials** and publication of results, and strict use of **placebo** only when no proven treatment exists or compelling methodological reasons.
- **Belmont Report (1979)**, USA: **respect for persons (autonomy)**, **beneficence** (including non-maleficence) and **justice**. It followed the **Tuskegee syphilis study** (1932–72) scandal.
- **CIOMS guidelines** (2016, international ethical guidelines for health-related research involving humans) with the WHO. **ICH-GCP** (Good Clinical Practice, E6; R2 2016, **R3 adopted January 2025**) is the standard for trials. **Declaration of Geneva** and the Hippocratic oath are about clinical ethics, not research.
- **Willowbrook** (hepatitis in children), **Thalidomide** and the **Nazi experiments** also prompted regulation.

Principles

- **Autonomy**: informed consent and the right to withdraw at any time without penalty. **Beneficence**: maximise benefit. **Non-maleficence**: avoid harm. **Justice**: fair selection and sharing of burdens and benefits; vulnerable groups neither exploited nor excluded.
- **Informed consent** needs **information** (aim, procedures, risks and benefits, alternatives, confidentiality, voluntary nature), **comprehension**, **voluntariness** and capacity. It is **written** (or witnessed oral where participants are illiterate); a **legally authorised representative** consents for those who lack capacity; **assent** from children old enough, with a parent's consent. **Waiver of consent** is possible for minimal-risk research with the ethics committee's approval (record reviews).
- **Confidentiality and privacy**: anonymised or de-identified data; secure storage.
- **Vulnerable groups**: children, pregnant women, prisoners, the mentally ill, the poor and illiterate, students and employees of the investigator.

- **Equipoise** (genuine uncertainty about which arm is better) justifies randomisation.
- **Conflict of interest** is declared; authorship follows **ICMJE** criteria (substantial contribution, drafting, final approval, accountability for all aspects).
- **Scientific misconduct**: fabrication, falsification, plagiarism (FFP).

Oversight

- **Ethics committee** (institutional review board): multidisciplinary, of both sexes, including a non-scientific member and a lay person from the community (CIOMS 2016); it reviews the protocol before starting and monitors afterwards; it is independent of the investigator and sponsor.
- **Data and safety monitoring board (DSMB)**: an **independent** group that reviews **unblinded interim data** and recommends stopping a trial for harm, clear benefit or futility. The sponsor and investigators do not decide on stopping, as they have conflicts of interest.
- **Serious adverse event (SAE)** reporting: death, hospitalisation, disability, life-threatening; reported promptly to the ethics committee and regulator. **Compensation** for research-related injury is expected.
- **Clinical trial registration** (before enrolment of the first participant; registries such as ClinicalTrials.gov and WHO ICTRP) is required by ICMJE journals.
- **Nepal**: health research on human participants needs ethical approval from the **Ethical Review Board (ERB) of the Nepal Health Research Council (NHRC)**, the statutory body under the **Nepal Health Research Council Act 2047 (1991)**, or from an **Institutional Review Committee (IRC)** accredited by NHRC (Guidelines for IRCs, 2016). The standard is the **National Ethical Guidelines for Health Research in Nepal** (first 2001; current edition 2022). Proposals now go through NHRC's online review platform; the ERB is recognised by FERCAP (2019).
- **Animal research** follows the **3 Rs**: replacement, reduction, refinement.

Primary health care and health economics

Primary health care and its history

- **Primary health care (PHC)** is essential care made universally accessible, with the full participation of the community, at a cost the community and country can afford (**Alma-Ata Declaration, WHO and UNICEF, September 1978**). Its slogan was **"Health for All by 2000"**; the declaration calls health a human right and a social goal.
- **Principles (Park)**: **equitable distribution**, **community participation**, **intersectoral coordination**, **appropriate technology** (scientifically sound, acceptable, affordable) and a focus on **prevention and promotion**. Equity argues against payment at the point of use; a high-cost specialist unit is not a PHC priority. Primary **care** (the first level of contact) is narrower than primary health **care** (an approach for the whole system).
- **Eight elements** (Alma-Ata): health education, food supply and nutrition, safe water and sanitation, maternal and child health with family planning, immunisation, prevention and control of endemic diseases, treatment of common diseases and injuries, and essential drugs.
- **Comprehensive vs selective PHC**: the Alma-Ata approach is **comprehensive** (rights, equity, social causes). **Selective PHC** (Walsh and Warren, 1979) picks a few cost-effective interventions, the origin of UNICEF's **GOBI** (growth monitoring, oral rehydration, breastfeeding, immunisation); critics said it ignored community participation and the social roots of ill health.
- **Later milestones**: **Ottawa 1986** (health promotion), **Jakarta 1997**, the **Millennium Development Goals** (2000–15) and **Sustainable Development Goals** (2015–30; **SDG 3.8 universal health coverage**), the **WHO World Health Report 2008** ("Primary Health Care: Now More Than Ever"), and the **Astana Declaration 2018**, which renewed PHC as the base of universal health coverage and added mental health and NCDs.
- **Levels of care**: primary (health post, community), secondary (district hospital), tertiary (specialist and teaching hospitals); **referral** runs upwards, feedback back down. **Universal health coverage** has three dimensions: who is covered, which services, and how much of the cost is covered (**financial protection**).

The health system

- **WHO's six building blocks (2007)**: service delivery, health workforce, health information, access to essential medicines, vaccines and technology, financing, and leadership and governance.
- **Health system** = all actors and resources whose main aim is health; **health service delivery** is only one part. A system is judged by its goals: **health, responsiveness and fair financing**. **Reform** is changing financing, organisation or delivery to improve equity, efficiency or quality.
- **Models of financing**: **general taxation** (Beveridge; the state pays and often provides), **social health insurance** (Bismarck; contributions from workers and employers into a fund), **private insurance**, **out-of-pocket payment** (the least equitable; catastrophic spending drives families into poverty), **community-based financing** and **donor funds**. Pooling risk and **strategic purchasing** improve fairness.
- **Management basics**: planning cycle (situation analysis, priority setting, target, resource allocation, implementation, monitoring and evaluation); **monitoring** is continuous tracking of activities, **evaluation** a judgement of effect and value.

Health economics

- **Cost-minimisation analysis**: outcomes are equal, so compare costs only. **Cost-effectiveness analysis**: cost per **natural unit** of outcome (cost per case detected, per life year gained). **Cost-utility analysis**: cost per **QALY** (or DALY averted), so unlike programmes can be compared. **Cost-benefit analysis**: costs and outcomes both **in money** (benefit-cost ratio, net benefit). **Cost-of-illness** studies only measure what a disease costs society.
- **QALY** = years of life multiplied by a quality weight from 1 (full health) to 0 (death); it counts a **gain**. **DALY = YLL + YLD**: years of life lost to premature death plus years lived with disability; it counts a **loss**, so one DALY is one lost year of healthy life. Both are used in **burden of disease** estimates (the Global Burden of Disease study). **Healthy life expectancy (HALE)** is a summary measure of population health, not a component of the DALY.
- **Economic indicators**: **GDP** is the value of goods and services produced inside a country in a year; **GNP** adds income earned abroad by its citizens and subtracts that earned by foreigners

inside; **per capita** divides by the population; **economic growth rate** is the yearly percentage change in real GDP. **Health spending** is judged as a share of GDP and as **out-of-pocket** share. The old WHO-CHOICE rule called an intervention **very cost-effective** under one GDP per capita per DALY averted and **cost-effective** under three; it is now considered a poor basis for decisions.

- **Opportunity cost** is the benefit of the next best use of the resources. **Marginal cost** is the cost of one more unit.

Nepal's health system and programmes (verified 2026)

- **Constitution of Nepal 2015, Article 35**: every citizen has the right to **free basic health services** and emergency care; the **Public Health Service Act 2075 (2018)** and its **Regulation 2077 (2020)** set out the basic services free of charge (**Basic Health Service Package**) and the state's duty to pay for emergency services.
- **Structure**: the **Ministry of Health and Population (MoHP)** with the **Department of Health Services** (central), **provincial health ministries and directorates**, and the **local levels** (753 municipalities and rural municipalities), which run **health posts and basic hospitals**; this federal arrangement replaced the district-centred system of the old Local Self-Governance Act, and the **Local Government Operation Act 2074 (2017)** lists the local governments' functions, **basic health and sanitation** among them (Constitution, Schedule 8). Providers: **public**, private for profit, private not for profit (NGOs, missions) and **informal** (traditional healers, self care).
- **Planning**: the **Nepal Health Sector Strategy 2015–2020** (extended past 2020) was followed by the **Nepal Health Sector Strategic Plan 2023–2030**, a roadmap towards universal health coverage and the SDGs; the **National Health Policy 2076 (2019)** (MoHP) is the policy base for the federal health system. The Millennium Development Goals the old curriculum names ended in 2015.
- **Social health insurance**: the **Health Insurance Act 2074 (2017)** created the **Health Insurance Board** and the national scheme, which now reaches **all 77 districts** (nearly 10 million enrolled by 2026 but only about 6 million active, with a funding gap of tens of billions of rupees: press reports of Board figures). Workers in formal employment contribute to the **Social Security Fund** (Contribution-Based Social Security Act 2074 (2017), s. 10: medical treatment and health, maternity, accident, incapacity, old age, dependent family and unemployment protection schemes).
- **Programmes seen in questions**: the **Aama programme** and the **Female Community Health Volunteers** (see Maternal and child health), **CB-IMNCI**, the national immunisation programme, the **Community Drug Programme** (a community-managed **revolving drug fund** begun in 1996/97, 2053/54 BS, with UNICEF support, in which user fees restocked health-post medicines; the old curriculum names it; in **October 2007** the government made essential care and medicines **free at health posts and sub-health posts**, and the Public Health Service Act 2075 now makes basic health services free; the programme's present status was not confirmed, so know it as history) and the **Safe Motherhood and Reproductive Health Rights Act 2075 (2018)**.
- **Regulation**: the **Drug Act 2035 (1978)**, which set up the **Department of Drug Administration** (drug registration, manufacture, sale, import and export), the **Food Hygiene and Quality Act 2081 (2024)** (replacing the Food Act 2023), the **Consumer Protection Act 2075 (2018)**, the **Nepal Medical Council Act 2020 (1964)** (registration and the Council's code of ethics) and the **Nepal Health Research Council Act 2047 (1991)** (ethical review). On abortion see the maternal health section: **the Criminal Code and the 2075 Act apply, not India's MTP Act**.
- **Efficacy** = effect under ideal (trial) conditions; **effectiveness** = effect in routine practice; **efficiency** = result per unit of resources (same output for less cost); **equity** = fair distribution.

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