

# Introduction à la statistique médicale : description du cours

1<sup>ère</sup> année, 2<sup>ème</sup> semestre, 10 heures de cours + 3 x 2 heures de travaux pratiques, examen obligatoire

L'objectif de ce cours est d'initier l'étudiant aux concepts et aux méthodes de la statistique médicale. Le cours est planifié pour une durée de 10 périodes en 5 séances. L'enseignement proposé intègre une partie des objectifs du « Catalogue des buts d'enseignement de la médecine sociale et préventive au niveau prégradué (14 avril 2003) » mais il aborde la « méthode statistique médicale » d'un point de vue plus général. Les concepts et les méthodes statistiques sont introduits à l'aide de problèmes quantitatifs fondamentaux dans la médecine tels que:

- L'établissement et utilisation de « normes »
- La décision médicale basée sur un test de diagnostic
- Les problèmes d'hérédité génétique
- Le rôle de l'échantillonnage dans les études d'observation.

Chaque thème est traité de façon relativement complète; toutefois, cette introduction n'est pas conçue comme un cours exhaustif de méthodes statistiques. Pour chaque thème, une série d'exercices pratiques est mise à disposition sur Myunil (voir : lien au Site du cours de [www.iumsp.ch](http://www.iumsp.ch)) avec leurs solutions. Les exercices et les solutions sont discutés dans les séances de travaux pratiques. Les thèmes de ces exercices sont en partie tirés des cours de physiologie, radiophysique et de génétique du module B1.3 (« développement ») en coordination avec les enseignants. Un polycopié du cours est téléchargeable de Myunil ou de [www.iumsp.ch](http://www.iumsp.ch). L'étudiant-e est encouragé-e à compléter son étude à l'aide de BOMS (Basics of Medical Statistics, projet du Campus virtuel suisse ; [www.boms.ch](http://www.boms.ch)) et à l'approfondir à l'aide du « Polycopié de biostatistique » téléchargeable sur [www.iumsp.ch](http://www.iumsp.ch).

A la fin du cours l'étudiant-e sera capable de reconnaître les mérites et les faiblesses de la méthode statistique dans la médecine contemporaine (« evidence based medicine »). Il sera capable de réaliser des opérations quantitatives simples de la pratique médicale, comme l'interprétation d'une valeur « anormale » ou le calcul de la probabilité qu'un sujet testé positif soit réellement malade. Il interprétera correctement le concept de test statistique.

## Objectifs détaillés

1. Introduire l'étudiant aux mesures statistiques principales (moyenne, écart type, médiane, percentiles) et à l'examen, l'interprétation, et l'utilisation de distributions de données. Introduire l'étudiant au concept de « modèle mathématique » comme description d'une distribution réelle (exemple de la distribution normale).

Durée : 4 périodes en 2 séances

Application : Détermination et utilisation de courbes de croissance et de normes en pédiatrie.

Références :

BOMS, Chapitres 1, 2, 3, 6

Polycopié de biostatistique, Chapitres 1, 2, 7

[www.who.int/childgrowth/standards/en/](http://www.who.int/childgrowth/standards/en/)

2. Introduire les concepts de probabilité, probabilité conjointe, probabilité conditionnelle et leurs relations. Introduire le concept d'indépendance entre deux caractères. Etude d'un tableau de fréquences à deux voies (fréquences marginales ; fréquences conditionnelles).

Durée : 2 périodes en 1 séance

Application 1: décision médicale basée sur un test de diagnostic (sensibilité, spécificité, taux de faux négatifs, valeur prédictive)

Application 2 : problèmes simples d'hérédité génétique

Références :

BOMS, Chapitre 5

Polycopié de biostatistique, Chapitres 4, 5

3. Introduire le concept d'étude d'observation, d'échantillonnage et d'inférence statistique de l'échantillon à la population. Apprendre à comparer des proportions : le risque relatif, le test du chi-carré.  
Durée : 2 périodes en 1 séance  
Application : étude épidémiologique de la relation entre un facteur antécédent et la survenue d'une maladie ; échantillonnage prospectif, rétrospectif, transversal.  
Références :  
BOMS, Chapitres 4, 5, 9, 12  
Polycopié de biostatistique, Chapitres 10, 11
4. Apprendre à comparer les moyennes de deux populations à l'aide d'échantillons ; le test de Student.  
Durée : 2 périodes en 1 séance  
Application : à définir.  
Références :  
BOMS, Chapitre 11  
Polycopié de biostatistique, Chapitre 12

## Plan du cours

Des variations du plan pourraient être nécessaires pour assurer la coordination avec les autres cours du B1.3.

### Séance de cours no 1: Distributions, Mesures, Normes

#### Exemples introductifs

Courbes de croissance, âge modale au décès, distribution des durées et des coûts de séjour hospitalier

#### Concepts et techniques

Population, échantillon  
Variables, observations  
Concept et représentation de distribution univariée  
histogrammes, diagramme en secteurs, fonction cumulative, box-plot  
courbe de survie  
Caractéristiques principales d'une distribution univariée: symétrie (centre de symétrie), asymétrie, position, étalement  
Concept de distribution bivariée  
pour variables binaires (qualitatives) : table 2 x 2  
pour variables continues (diagramme de dispersion)

### Séance de cours no 2: Distributions, Mesures, Normes

#### Concepts et techniques

Mesures numériques de position : moyenne, médiane, percentiles  
Mesures numériques d'étalement : variance, écart type, écart interquartile  
Mesures d'association : risque relatif, coefficient de corrélation  
Concept de modèle d'une distribution  
Modèle de Gauss

#### Exemples d'application

Box-plots de la mortalité infantile des cantons suisses  
Lecture et interprétation des courbes de croissance (poids, taille, circonférence crânienne) utilisées en pédiatrie. Que signifie « être dans la norme » ?

## **Séance de cours no 3: Eléments de calcul des probabilités**

### **Concepts et techniques**

Probabilité conjointe  
Probabilité conditionnelle  
Règles fondamentales du calcul des probabilités

### **Exemples d'applications**

Décision médicale à l'aide d'un test de diagnostique : sensibilité, spécificité, valeurs prédictives,  
Combinaison de tests  
Génétique : problèmes d'hérédité simples

## **Séance de cours no 4: Inférence, partie I**

### **Concepts et techniques**

Comparaison de proportions : formulation du problème, population, échantillon, inférence  
Cadre théorique du test : hypothèses, statistique de test, règle de décision, distribution d'échantillonnage  
Tester l'indépendance de deux caractères : test du chi carré  
Risque relatif, intervalle de confiance pour le risque relatif

### **Exemples d'applications**

Etudes d'observation en épidémiologie : étude transversale, étude prospective, étude rétrospective

## **Séance de cours no 5: Inférence, partie II**

### **Concepts et techniques**

Comparaison d'une moyenne empirique à une valeur théorique : formulation du problème  
Comparaison de deux moyennes : formulation du problème  
Cadre théorique du test de Student  
Intervalle de confiance pour une moyenne  
Intervalle de confiance pour la différence entre deux moyennes  
Relation entre test et intervalle de confiance

### **Exemple d'applications**

Analyse d'une expérience de radiophysique

## **Travaux pratiques no 1**

Lecture de courbes de croissance (interprétation de percentiles; que signifie « être dans la norme »)

## **Travaux pratiques no 2**

Sensibilité, la spécificité et la valeur prédictive d'un test de diagnostic  
Problèmes d'hérédité simples

## **Travaux pratiques no**

Problèmes sur la comparaison de proportions : test d'adéquation pour un problème de dihybridisme  
Problèmes sur la comparaison de moyennes : analyse d'une expérience de radiophysique

<b>Item catalogue SPM 2006</b>		
<b>English version, November 2007</b>		
<b>1 Social- and Preventive Medicine (52 items)</b>		
<b>1.1 Basic terms and concepts</b>		
1	Important definitions and concepts: health and disease, salutogenesis and pathogenesis, the individual, the population, public health, epidemiology, clinical epidemiology, social medicine, preventive medicine, environmental medicine, health services, health economics, public health policy, health care, health promotion, health behavior.	2
2	Approaches and strategies of prevention: primary, secondary and tertiary prevention; structural and individual-level prevention strategies; population approach and high-risk approach.	2
3	Concepts in social medicine and social epidemiology: social class, socio-economic status, social mobility, gender, ethnicity, social networks, cultural changes.	2
4	Explanations for differences in health and utilization of health care services of population groups, according to age, sex, social status, ethnicity.	1
<b>1.2 Methods and basic principles</b>		
<b>1.2.1 Epidemiology</b>		
1	Applications of epidemiology: descriptive and analytical approaches.	1
2	Measures of disease frequency: prevalence, incidence, incidence rate, cumulative incidence (risk).	2
3	Measures of association: relative measures (risk ratio, rate ratio, odds ratio); absolute measures (risk difference, number needed to treat/harm, attributable risk).	2
4	Observational and experimental study designs, their advantages and disadvantages and areas of application: case series, cross-sectional studies, case-control studies, cohort studies, randomized controlled trials, systematic reviews, meta-analysis.	2
5	Critical appraisal of study methodology, internal and external validity of results: systematic error (selection bias, information bias); confounding and how to deal with it (age standardization, stratification, multivariable analysis).	2
6	Diagnostic and screening tests: sensitivity, specificity, positive and negative predictive values, likelihood-ratio, pre-test probability, post-test probability.	2
7	Types of bias in the evaluation of diagnostic and screening tests (partial verification bias, differential verification bias); influence of the patient spectrum and pre-test probability on the interpretation of test results.	1
8	Types of bias in the evaluation of screening programs (lead time bias, length bias, overdiagnosis bias).	1
<b>1.2.2 Biostatistics</b>		
1	Type of variables: categorical (binary, nominal, ordinal) and numerical (discrete, continuous).	2
2	Describing data and their variability: frequency, proportion, mean, standard deviation, median; histogram, box-plot, scatter plot, survival curve.	2
3	Estimation: standard errors (of a mean, difference between two means, proportion, difference between two proportions), confidence intervals.	2
4	Hypothesis testing: null and alternative hypotheses; interpretation of P values; relation between P values and confidence intervals.	2
<b>1.2.3 Demography, health indicators and data sources</b>		
1	Important indicators: birth rate, various death rates, life expectancy, years of life lost, health related quality of life, DALY (disability adjusted life year), QALY (quality adjusted life year).	2
2	Trends in health indicators in Switzerland, demographic predictions, comparison with other countries.	1
3	Major causes of death, according to age, sex, social status, ethnicity; importance of different causes in relation to years of life lost.	2
4	Important data sources in Switzerland: population census, birth- and death-registers, health surveys, hospital statistics, Swiss household panel, linkage studies (for example Swiss National Cohort).	1

<b>1.3. Interventions</b>		
<b>1.3.1 The Swiss healthcare system</b>		
<b>1.3.1.1 Organization and responsibilities</b>		
1	Definition of the term healthcare system.	1
2	Responsibilities of the state at federal, cantonal and municipal levels: surveillance, health promotion, and disease prevention; education, occupations and research. Role of non-governmental organizations (self-help groups, disease-specific organizations, Red Cross).	1
3	Responsibilities and organization of health care providers: out-patient care (doctors, midwives and nurses in private practice, managed care group practices, pharmacists, Spitex services); providers of care in public and private hospitals, hospital out-patient clinics and nursing homes.	1
<b>1.3.1.2 Costs, benefits and financing of the health service</b>		
1	International comparisons of different types of healthcare systems.	1
2	Funding of healthcare in Switzerland: funders (the state, social insurance, out of pocket payments); sources of costs (out-patient and in-patient health care providers, medicines). Trends and determinants of health care spending.	2
3	Models of reimbursement for health care provision: fee-for-service, fee-per-case, prospective or retrospective lump sum payments, HMO model (principle of capitation). Fundamentals of the Tarmed system.	1
4	Costs and benefits of interventions: direct, indirect and intangible costs.	1
<b>1.3.2 Prevention and health promotion</b>		
<b>1.3.2.1 Intervention strategies</b>		
1	Population-based public health strategies: general principles, appropriate setting of priorities, feasibility, evaluation.	1
2	Population-based primary prevention: general principles, mass campaigns and targeted interventions, structural and individual-based strategies.	1
3	Secondary prevention: general principles, screening programs, criteria for assessing the appropriateness of screening, current recommendations for screening.	1
4	Principles of primary and secondary prevention in primary health care, opportunistic screening.	1
5	Ethical issues related to public health interventions (for example screening), prioritization and equity in health care.	1
<b>1.3.2.2 Risk factors, resources and primary prevention</b>		
1	Salutogenesis: important behavior-related (exercise, nutrition, relaxation, safer sex) and psychosocial resources (health competence, coping, sense of coherence, social support).	1
2	Pathogenesis: important behavior-related risk factors (smoking, alcohol, obesity) and psychosocial burdens (stress, critical life events).	1
3	Lifestyle and health behavior: role of cultural influences and the social environment.	1
4	Counseling of individuals: model of behavior change; stages of change, stage-appropriate advice.	2
5	Epidemiology, preventive recommendations and approaches to intervention regarding exercise, nutrition, alcohol consumption, smoking and sexual behavior.	2
6	Health promotion: Ottawa Charta (levels of action, strategies), health promotion in defined settings (for example schools, communities, workplaces, hospitals).	1
7	Prevention and health promotion: important institutions and programs in Switzerland (national health goals, plans of action of Federal Office of Public Health, national campaigns); opportunities and barriers; considerations at the political level.	1
<b>1.3.3 Chronic and degenerative diseases, accidents</b>		
1	Epidemiology (prevalence, incidence, mortality, years of life lost) in Switzerland, international comparisons, and strategies for the prevention of: cardiovascular diseases, diabetes, cancer (lung, breast, colon, prostate, melanoma), musculoskeletal diseases, respiratory diseases and allergies, mental health problems, addiction, accidents.	1
2	Life course approach to health: specific risks, health problems and preventive measures for children, adolescents and young adults, middle-aged adults and the elderly.	1

<b>1.3.4 Environmental medicine</b>		
<b>1.3.4.1 Methodological aspects</b>		
1	Estimating human exposure to environmental pollution (methods of measuring, semiquantitative procedures, indicators, dosage and safety limits).	1
2	Evaluating health risks due to environmental factors from the point of view of the individual and of society as a whole.	1
<b>1.3.4.2 Physical, chemical and radiological hazards</b>		
1	Sources, trends, distribution and health consequences of: outdoor air pollutants (particulate matter, ozone, nitrogen dioxide); indoor air pollutants (passive smoking, radon, asbestos, formaldehyde, solvents and mould); non-ionizing and ultraviolet radiation; ionizing radiation; noise pollution; water- and soil-pollutants (nitrates, heavy metals, production and quality of drinking water in Switzerland).	1
2	Sources, trends, distribution and health consequences of greenhouse gases and climate change.	1
<b>1.3.5 International health</b>		
1	International priorities for health and health care: UN Millennium Development Goals; strengthening health systems; Global Fund to fight for AIDS, TB and Malaria; essential health interventions; primary health care for all.	1
2	Major causes of disease and death in infancy and the neonatal period, under-5s, adults in different parts of the world.	1
3	Determinants of international differences in health: poverty, hunger, population growth, education, differences in income, gender differences, environment, conflicts, access to medical resources.	1
<b>2 Infectious diseases (10 Items)</b>		
<b>2.1 Basic terms and concepts</b>		
1	Important definitions and concepts: virulence, resistance, pathogenicity, transmissibility; contamination, colonization, infection, carrier; incubation period, latent period, infectious period; exposure, primary and secondary attack rate, reproductive number ( $R_0$ ), herd immunity; endemic, epidemic, pandemic, sporadic case, outbreak; surveillance, notification; zoonosis, reservoir, vector, vehicle; chemoprophylaxis, immunization, vaccination, active immunization, passive immunization; emerging and re-emerging infections.	2
2	Laws: international health regulations; paragraphs in the Swiss constitution (Article 69, 69bis); law on epidemic diseases (Epidemiengesetz/Loi sur les épidémies), notification regulations (Meldeverordnung/Ordonnance sur la déclaration).	1
3	Epidemiological surveillance: national and international notification requirements (who reports what, when, and to whom); the Sentinella network; advantages and disadvantages of different surveillance systems.	1
4	Steps in the recognition, investigation and control of outbreaks.	1
<b>2.2 Epidemiology and prevention</b>		
1	Epidemiology (incidence, prevalence, mortality and years of life lost, route of transmission, risk factors) in Switzerland, international comparison, and strategies for the prevention of major infectious diseases: food-borne infections; vaccine preventable infections; nosocomial infections; HIV and sexually transmitted infections; zoonoses; travel-related infections (travelers' diarrhea, malaria, amebiasis, hepatitis, yellow fever, rabies, Dengue fever, typhoid fever, tuberculosis, legionnaire's disease, cholera, HIV and sexually transmitted infections); healthcare-related infections (hepatitis, HIV, tuberculosis, influenza, varicella, parvoviruses).	1
<b>2.3 Preventive strategies</b>		
1	Vaccination (characteristics, indications, contraindications, side-effects, storage, means of delivery and usage of vaccines for routine administration and specific indications): viral: poliomyelitis, MMR, hepatitis A, hepatitis B, influenza, varicella, tick-borne encephalitis; bacterial: tetanus, diphtheria, pertussis, hemophilus influenzae B, meningococcus C, BCG, typhoid fever, pneumococcal infection.	2
2	Benefits and risks of vaccination: vaccine efficacy, vaccination coverage, vaccination campaigns, vaccination failure, adverse events, cost-effectiveness.	1

3	Chemoprophylaxis (recommended medications, contraindications and indications) for: meningococcal meningitis, tuberculosis, endocarditis, malaria, toxoplasmosis, pneumocystis jiroveci (carinii)-pneumonia in the immune-suppressed, pre- and post-exposure prophylaxis of HIV infection; principles and indications for chemoprophylaxis in individuals and during epidemics.	1
4	General preventive measures in hospitals: hand washing, asepsis, sterilization, disinfection, isolation; specific precautions for specific risk procedures (surgical interventions, urinary catheters, intravascular catheters, endoscopy).	2
5	Other measures: border medical examinations and mass screening, needle exchange programs, testing of drinking water, prohibition to work in an occupation (for example handling food).	1
<b>3 Occupational medicine (11 Items)</b>		
<b>3.1 Basic terms and concepts</b>		
1	Important definitions and concepts: occupational medicine, occupational disease, occupation-related illnesses. Occupational safety limits of the Swiss Accident Insurance Fund (SUVA).	1
2	Steps in the investigation of a suspected occupation-related health problem in an individual or a group.	2
3	Regulations for health protection and promotion in the occupational and accident insurance law (UVG/LAA).	2
4	Principles of primary, secondary and tertiary prevention in the workplace.	1
<b>3.2 Occupational diseases</b>		
1	Occupational workplace history-taking, and important work-place hazards (noise, electromagnetic fields, vibration, lead, mercury, solvents, carbon monoxide, aromatic amines, asbestos, wood dust, benzene).	2
<b>3.3 Work and health</b>		
1	Ergonomics: workplace layout and environmental influences, including working at a computer terminal, in an open-plan office, person-machine interactions.	2
2	Psychosocial factors and stress, including conditions of work, new work forms, bullying, burnout, unemployment, stress-associated diseases.	1
3	Health-promoting organization of the workplace: work tasks and organization, including working in groups, working time, regulation of coffee and lunch breaks.	1
4	Company health management: absence (determining and maintaining the ability to work), addiction, health promotion.	1
5	Epidemiology of: accidents in the place of work for specific occupations in Switzerland; major work-related diseases, recognized by the accident insurance law (UVG/LAA), in different occupations.	1
6	Epidemiology and health and social consequences of Shift- and night-work, work during pregnancy, part-time work.	1
<b>4. Insurance medicine (21 Items)</b>		
<b>4.1. Basic terms and concepts</b>		
1	Insurance medicine-related duties of treating physicians; independent medical examiners, training opportunities.	2
2	Liability principles: finality principle, causality principle.	1
<b>4.2 Social insurance</b>		
1	General aims and characteristics of social insurance.	2
2	Overview of the Swiss social insurance system.	2
3	Funding sources in the Swiss social insurance system: insurance payments, salary deductions, franchises, costs carried by the patient, subventions.	2
4	Definitions in the general section of the social insurance regulations (ATSG/LPGA): sickness, accidents, inability to work, incapacity to work, disability, helplessness, subsidiarity principle.	2
5	Definitions of the Swiss accident insurance law (UVG/LAA): accident-like bodily damage, occupational disease.	2
6	Health insurance law (KVG/LAMal): insured persons, benefits (including positive list of preventive measures).	2
7	Accident insurance law (UVG/LAA): insured persons, SUVA and other insurance providers, benefits, including integrity benefits.	1

8	Occupational diseases: insured persons, list of occupational diseases recognized by UVG / LAA	1
9	Disability insurance (IVG/LAI): insured persons, benefits, including re-integration measures, special training and auxiliary equipment.	1
10	Prevention, medical checkups and health promotion (KVG/LAMal).	1
11	Criteria of effectiveness, appropriateness and efficiency of medical measures (WZW/EAE) as required by KVG/LAMal.	1
12	Managed care: forms of provision and insurance products (HMO systems, general practitioner networks, gatekeeping).	1
13	Instruments for treatment management: case management, disease management, demand management.	1
<b>4.3 Legal aspects of working as a physician</b>		
1	Physicians' obligations: to treat, to protect confidential data, to report and to give information (if appropriate).	1
2	Determination of the degree of incapacity to work.	2
3	Administration of justice in the area of social insurance (ATSG/LPGA).	1
4	Requirements for informed consent of patients.	2
5	Principles of physicians' liability (malpractice).	1