Universidade de São Paulo
Faculdade de Saúde Pública
Departamento de Epidemiologia

Método Epidemiológico

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Introdução

Epidemiology

“The study of the occurrence and distribution of health-related events, states, and processes in specified populations, including the study of the determinants influencing such processes, and the application of this knowledge to control relevant health problems.”

Dictionary of epidemiology 6ed.

Introdução

Epidemiology

“The **study** of the occurrence and distribution of health-related events, states, and processes in specified populations, including the study of the determinants influencing such processes, and the application of this knowledge to control relevant health problems.”

→ observação, elaboração e teste de hipótese

Estudos Epidemiológicos

Dictionary of epidemiology 6ed.

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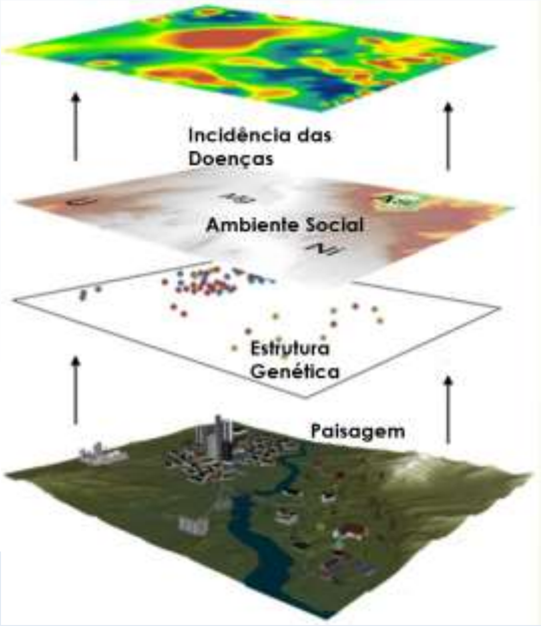
Epidemiology

“The study of the occurrence and **distribution** of health-related events, states, and processes in specified populations, including the study of the determinants influencing such processes, and the application of this knowledge to control relevant health problems.”

→ Tempo, espaço e pessoa



Introdução

Epidemiology

"The study of the occurrence and distribution of **health-related events**, states, and processes in specified populations, including the study of the determinants influencing such processes, and the application of this knowledge to control relevant health problems."

→ doenças, óbitos, comportamento, adesão a condutas preventivas e uso de serviços de saúde

Dictionary of epidemiology 6ed.

Introdução

Epidemiology

“The study of the occurrence and distribution of health-related events, states, and processes in specified populations, including the study of the determinants influencing such processes, and the **application of this knowledge to control relevant health problems**.”

↓

Prevenção e controle de problemas de saúde

Dictionary of epidemiology 6ed.

Principais pressupostos dos estudos epidemiológicos

- ✓ A doença humana não ocorre aleatoriamente na população

- ✓ A doença humana tem fatores causais, prognósticos e preventivos que podem ser identificados por meio de investigações sistemáticas de diferentes populações ou subgrupos de populações em diferentes pontos no tempo e/ou no espaço

(Hennekens & Burning, 1987).

Objetivos da epidemiologia

1. Identificar a causa e fatores de risco da doença
2. Conhecer a extensão da doença na população
3. Estudar a história natural da doença
4. Avaliar medidas de prevenção e tratamento
5. Prover fundamentos para o desenvolvimento de políticas de prevenção de doenças e promoção da saúde

Evidências

Fatores e mecanismos causais

→

Prevenção, controle e tratamento

Gordis, 2009.

Etapas do Raciocínio Epidemiológico

1) A partir da observação clínica, de pesquisas de laboratório ou mesmo de especulações teóricas pode surgir uma hipótese a respeito de uma possível associação entre um fator e a ocorrência da doença

2) O teste dessa hipótese é efetuado mediante estudos epidemiológicos que incluem um grupo apropriado de comparação

3) O estudo é efetuado mediante a coleta sistemática de dados e a análise correspondente com o objetivo de determinar a existência ou não de associação entre a exposição e o desfecho de interesse

(Hennekens & Burning, 1987).

Etapas do Raciocínio Epidemiológico

4) Em seguida é necessário avaliar a validade das possíveis associações estatísticas observadas, excluindo o acaso, o erro sistemático na coleta ou interpretação dos dados (viés) ou o efeito de outras variáveis que podem ser responsáveis pela associação observada, efeito conhecido como fator de confusão

5) Finalmente, o julgamento focaliza a existência de uma associação de causa e efeito levando-se em consideração critérios de avaliação da associação causal, entre eles: força da associação, consistência dos resultados obtidos, efeito dose resposta, plausibilidade biológica, entre outros

(Hennekens & Burning, 1987).

Raciocínio Epidemiológico

- **Validade Interna:** é o grau em que as conclusões do pesquisador descrevem corretamente o que realmente ocorreu no estudo

- **Validade Externa:** o grau em que essas conclusões apresentadas são apropriadas quando aplicadas para o universo externo ao estudo

No desenvolvimento de um estudo necessitamos ter em mente tanto a validade interna como a externa, com o principal objetivo de maximizar esses atributos no final do estudo

Raciocínio Epidemiológico

- Determinar se existe associação estatística entre um fator de risco presumido e a doença

- Elaborar inferências considerando como possível associação causal as associações estatísticas encontradas

Tomada de decisões

Estudos Epidemiológicos

↓

Associação entre exposição e desfecho

↓

Se a associação foi observada, ela reflete uma **relação causal**?

Gordis, 2009

Tipos de associação

A associação encontrada poderia ser decorrente de:

- ✓ Acaso (erro aleatório)?
- ✓ Fator de confusão?
- ✓ Viés (erro sistemático)?
- ✓ Causal?

Causalidade em Epidemiologia

- Aspectos filosóficos
- Aspectos operacionais (critérios de julgamento de causalidade)
- Limites e possibilidades de sua aproximação por meio do método científico

Causalidade em Epidemiologia

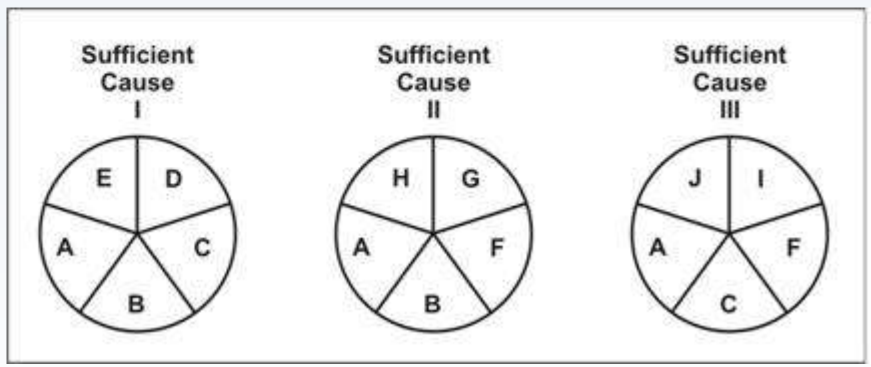
Modelos explicativos da ocorrência das doenças

- Unicausalidade miasmática
- Unicausalidade biológica
- Modelo ecológico (tríade)
- Multicausalidade
  - Redes causais
  - Modelos sistêmicos

Causalidade em Epidemiologia

Modelos causais em Epidemiologia

Causas componentes e suficientes - Rothman



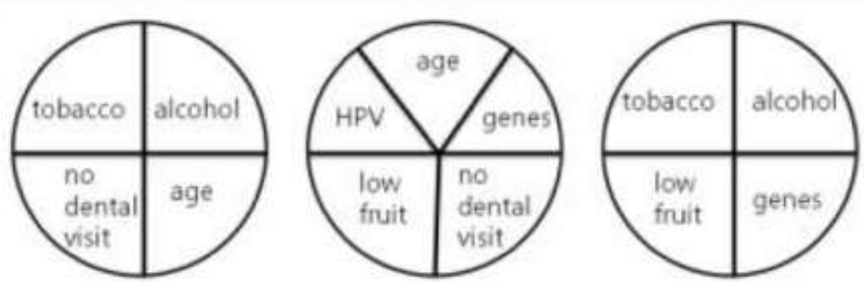


Fig. 4.
A causal pie model for the oral cancer.

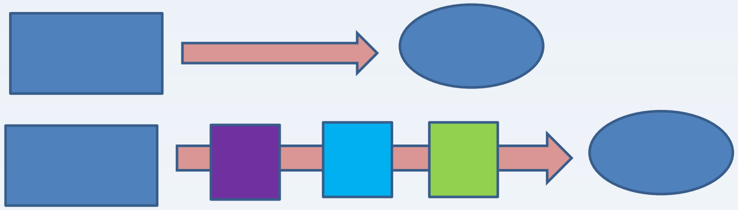
Kosin Med J. 2013 Dec;28(2):87-97.

Tipos de relações causais

Caminho causal:

Direto: Sem passo intermediário

Indireto: *Passo intermediário* **



Se a relação é causal, há 4 tipos possíveis:

- Causa necessária e suficiente
- Causa necessária, mas não suficiente
- Causa suficiente, mas não necessária
- Causa nem suficiente, nem necessária

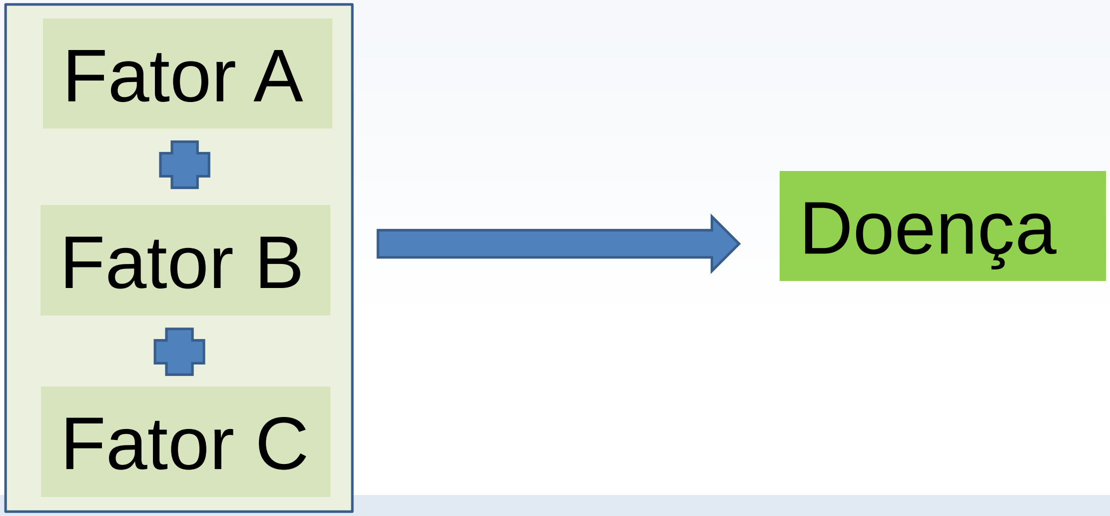
Causa Necessária e Suficiente

- Sem o fator a doença nunca se desenvolve (necessário)
- Na presença do fator a doença sempre se desenvolve (suficiente)
- Situação que raramente ocorre
- Diferença na imunidade, suscetibilidade genética, ...

Gordis, 2009

Causa Necessária e não Suficiente

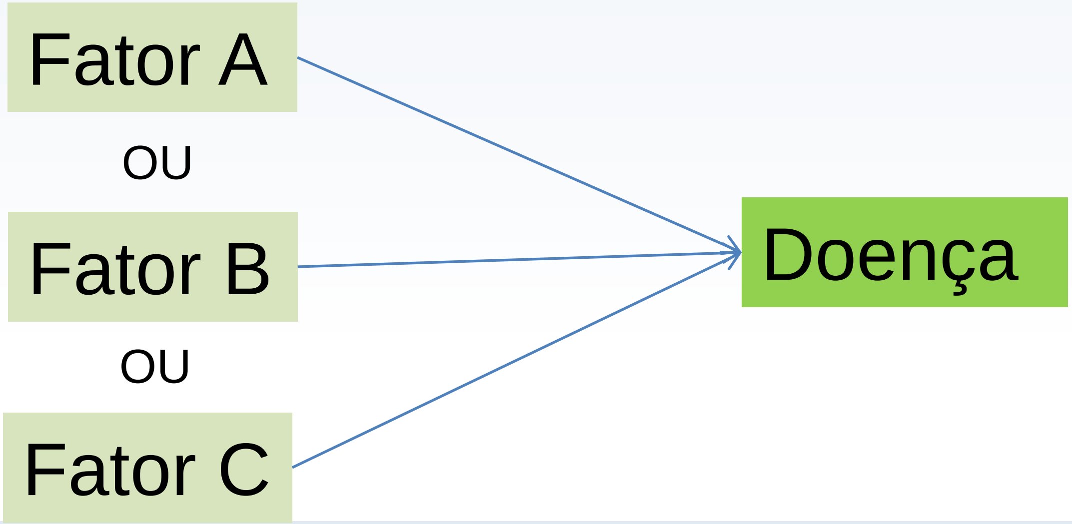
- Cada fator é necessário, mas não é por si só, suficiente para causar a doença
- Múltiplos fatores são requeridos, em geral, em uma sequencia temporal específica
- Exemplo: Tuberculose



Gordis, 2009

Causa Suficiente e não Necessária

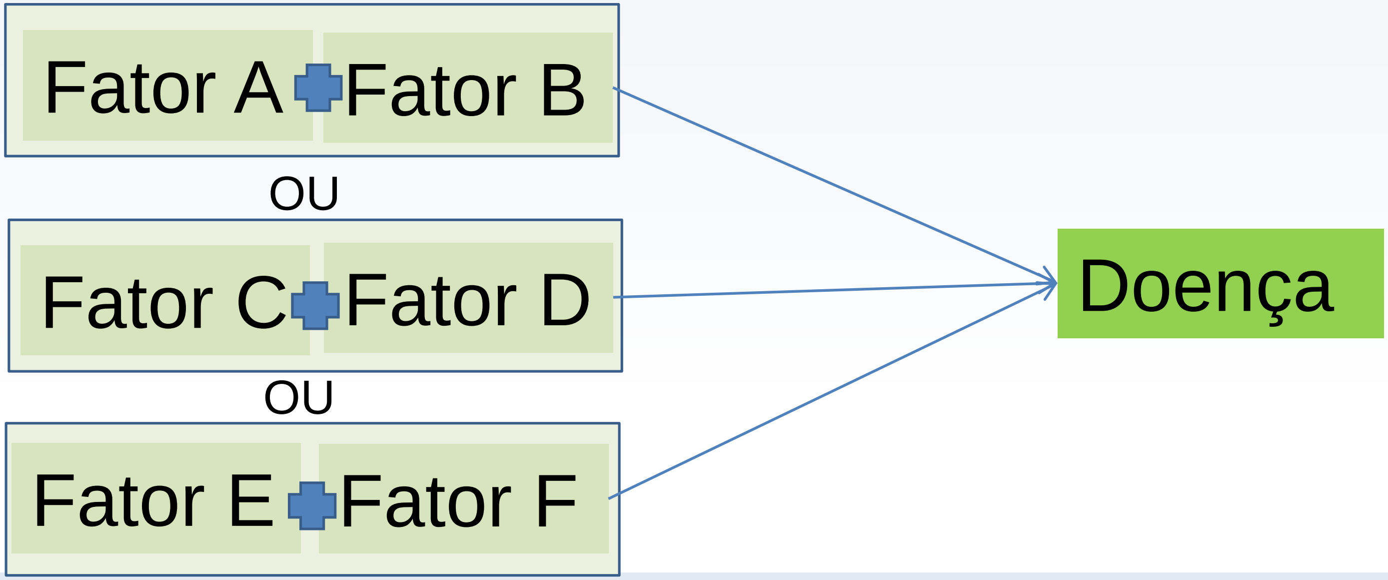
- Nesse modelo, o fator sozinho pode causar a doença, assim como outros fatores atuando isoladamente
- Ex: Exposição à radiação ou benzeno podem levar à leucemia,



Gordis, 2009

Causa nem Suficiente e nem Necessária

- O fator, por si só, é nem suficiente, nem necessário para produzir doença.
- Modelos mais complexos de causalidade
- Ex: Doenças crônicas



Gordis, 2009

Causalidade em Epidemiologia

TABLE 1—Eras in the Evolution of Modern Epidemiology and an Emergent Era

Era	Paradigm	Analytic Approach	Preventive Approach
Sanitary statistics (first half of 19th century)	Miasma: poisoning by foul emanations from soil, air, and water	Demonstrate clustering of morbidity and mortality	Introduce drainage, sewage, sanitation
Infectious disease (late 19th century through first half of 20th century)	Germ theory: single agents relate one to one to specific diseases	Laboratory isolation and culture from disease sites, experimental transmission and reproduction of lesions	Interrupt transmission (vaccines, isolation of the affected through quarantine and fever hospitals, and ultimately antibiotics)
Chronic disease epidemiology (latter half of 20th century)	Black box: exposure related to outcome, without necessity for intervening factors or pathogenesis	Risk ratio of exposure to outcome at individual level in populations	Control risk factors by modifying lifestyle (diet, exercise, etc), agent (guns, food, etc), or environment (pollution, passive smoking, etc)
Eco-epidemiology (emerging)	Chinese boxes: relations within and between localized structures organized in a hierarchy of levels	Analysis of determinants and outcomes at different levels of organization: within and across contexts (using new information systems) and in depth (using new biomedical techniques)	Apply both information and biomedical technology to find leverage at efficacious levels, from contextual to molecular

Susser, 2001

Causalidade em Epidemiologia

Aspectos operacionais (critérios de julgamento de causalidade)

- Postulados de Koch
- Postulados de Evans
- Critérios de causalidade de Bradford Hill
  - Força de associação
  - Consistência
  - Temporalidade
  - Gradiente Biológico
  - Plausibilidade biológica
  - Especificidade
  - Coerência, analogia, evidencia experimental, cessação....

Table 2. Bradford Hill Criteria for Evidence of Causation as Applied to the Relationship between Zika Virus Infection and Microcephaly and Other Brain Anomalies*

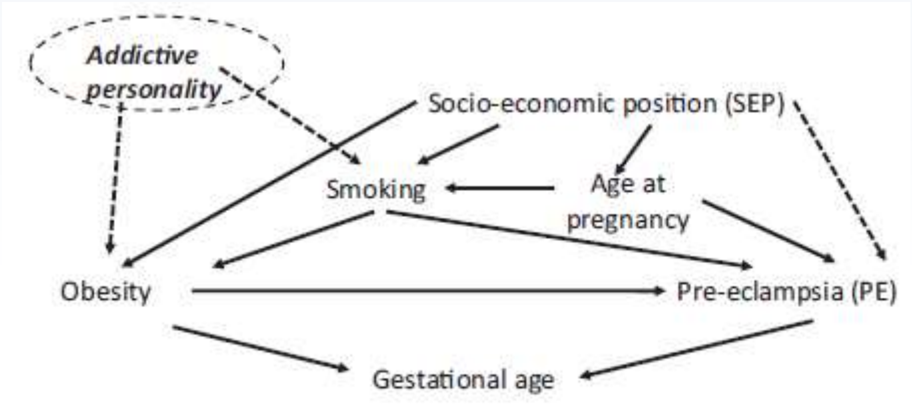
Criterion	Evidence	Criterion Met?
Strength of association	A recent epidemiologic study from French Polynesia suggests a strong association between prenatal Zika virus infection and microcephaly (estimated risk ratio, approximately 50).[2] The substantial increase in the number of cases of microcephaly and other brain anomalies that have been associated with the Zika virus outbreak in Brazil suggests a strong association.[1,2]	Yes
Consistency	Two epidemiologic studies, one from Brazil and one from French Polynesia,[2,14] support the association between prenatal Zika virus infection and microcephaly and other serious brain anomalies. The observed increase in the number of cases of microcephaly after outbreaks of Zika virus infection in Brazil and French Polynesia, as well as preliminary reports of cases in Colombia, support consistency.[1,2,42] Case reports of Zika virus infection in fetuses or infants with microcephaly or other brain anomalies who were born to mothers who traveled to areas of active Zika virus transmission support consistency.[16,18,19]	Yes
Specificity	Other causes of microcephaly exist; however, on the basis of clinical descriptions that are available for a small number of infants with presumed congenital Zika virus infection,[20] the clinical phenotype linked to the Zika virus appears to be an unusual form of microcephaly that is consistent with the fetal brain disruption sequence.	Yes
Temporality	Zika virus infection in mothers during pregnancy precedes the finding of microcephaly or other brain anomalies in fetuses or infants.[14-20] Zika virus outbreaks in Brazil and French Polynesia preceded the increase in the number of cases of microcephaly.[1,2]	Yes
Biologic gradient	Infection is a phenomenon that is either present or absent; there is no dose–response relationship. No data are available regarding whether women with an increased viral load have a higher risk of adverse pregnancy or birth outcomes.	NA
Plausibility	Findings are similar to those seen after prenatal infection with some other viral teratogens (e.g., cytomegalovirus and rubella virus).[26] Evidence that Zika virus infects neural progenitor cells and produces cell death and abnormal growth,[29] along with evidence of Zika virus in brains of fetuses and infants with microcephaly, on the basis of on immunohistochemical staining and identification of Zika virus RNA and live virus,[16,17,19] provides strong biologic plausibility.	Yes
Coherence	No results in an animal model of effects of Zika virus on pregnancy have yet been published, but animal models have shown that Zika virus is neurotropic,[27,28] a finding that is consistent with prenatal Zika virus infection causing microcephaly and other brain anomalies. Zika virus infects neural progenitor cells and produces cell death and abnormal growth,[29] a finding that is consistent with a causal relationship between Zika virus infection and microcephaly.	Yes
Experiment	No experimental animal model of Zika virus teratogenicity is available.	No
Analogy	No other flavivirus has been shown to definitively cause birth defects in humans,[4] but flaviviruses, Wesselsbron and Japanese encephalitis viruses, have been shown to cause stillbirth and brain anomalies in animals.[43] Findings are similar to those seen after prenatal infection with other viral teratogens (e.g., cytomegalovirus, rubella virus).[26]	Yes

* The criteria listed here were proposed by Hill.[40] We have updated a recent analysis by Frank et al.[41]

Causalidade em Epidemiologia

Limites e possibilidades de sua aproximação por meio do método estatístico

- Modelos de respostas potenciais (contrafactual) (Rubin)
- Modelos de equações estruturais (Pearl)
- Modelos gráficos / diagramas causais / DAGs
- Críticas



Pearce, 2016

EDITORIAL

OPEN

Epidemiology is a science of high importance

Epidemiology dates back to the Age of Pericles in 5th Century B.C., but its standing as a 'true' science in 21st century is often questioned. This is unexpected, given that epidemiology directly impacts lives and our reliance on it will only increase in a changing world.

Epidemiology identifies the distribution of diseases, factors underlying their source and cause, and methods for their control; this requires an understanding of how political, social and scientific factors intersect to exacerbate disease risk, which makes epidemiology a unique science. Nevertheless, its definition as a science is debated; among the criticisms of the field are that epidemiology is an inexact science that it is simply a set of tools used by other disciplines, and that its dependence on observational data makes it a form of journalism rather than a science[1,2]. *Nature Communications* editors have visited established epidemiologists and also found, to our surprise, that their impression from the rest of the scientific community is often that epidemiology is not viewed as a 'true' science.

Among the many reasons why its scientific significance is sometimes trivialised is its intersection with the so-called 'soft'

While the exact number of people whose lives have been saved by epidemiological research may not be possible to calculate, its importance in enhancing life quality and longevity cannot be overlooked. Even more significantly, despite the uncertainty, the incompleteness of models and the imperfections of data, epidemiology continues to be at the forefront of saving lives today through forecasting epidemics and pandemics, and identifying diseases likely to cause outbreaks in the future and implementing forward-planning, targeted and collaborative interventions to minimise fatalities[7,8].

Increasingly, epidemiology is the key to understanding the impact of climate change on disease burden through the effect of temperature, humidity and seasonality on infectious disease dynamics, and the expansion of the ranges of disease vectors. Unlikely to be an isolated case, the State of Texas has reported transmission or

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So, epidemiology is important but is it a science?

- Yes, it is.
- it is a bona fide multidisciplinary approach to the study of human health and disease that follows the scientific method of systematic observation, and the formulation, testing, and modification of hypotheses.
- If anything, epidemiology is a highly complex science because it needs to consider multiple variables associated with human diseases, such as pathogens, human social or travel dynamics, and the climate.

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