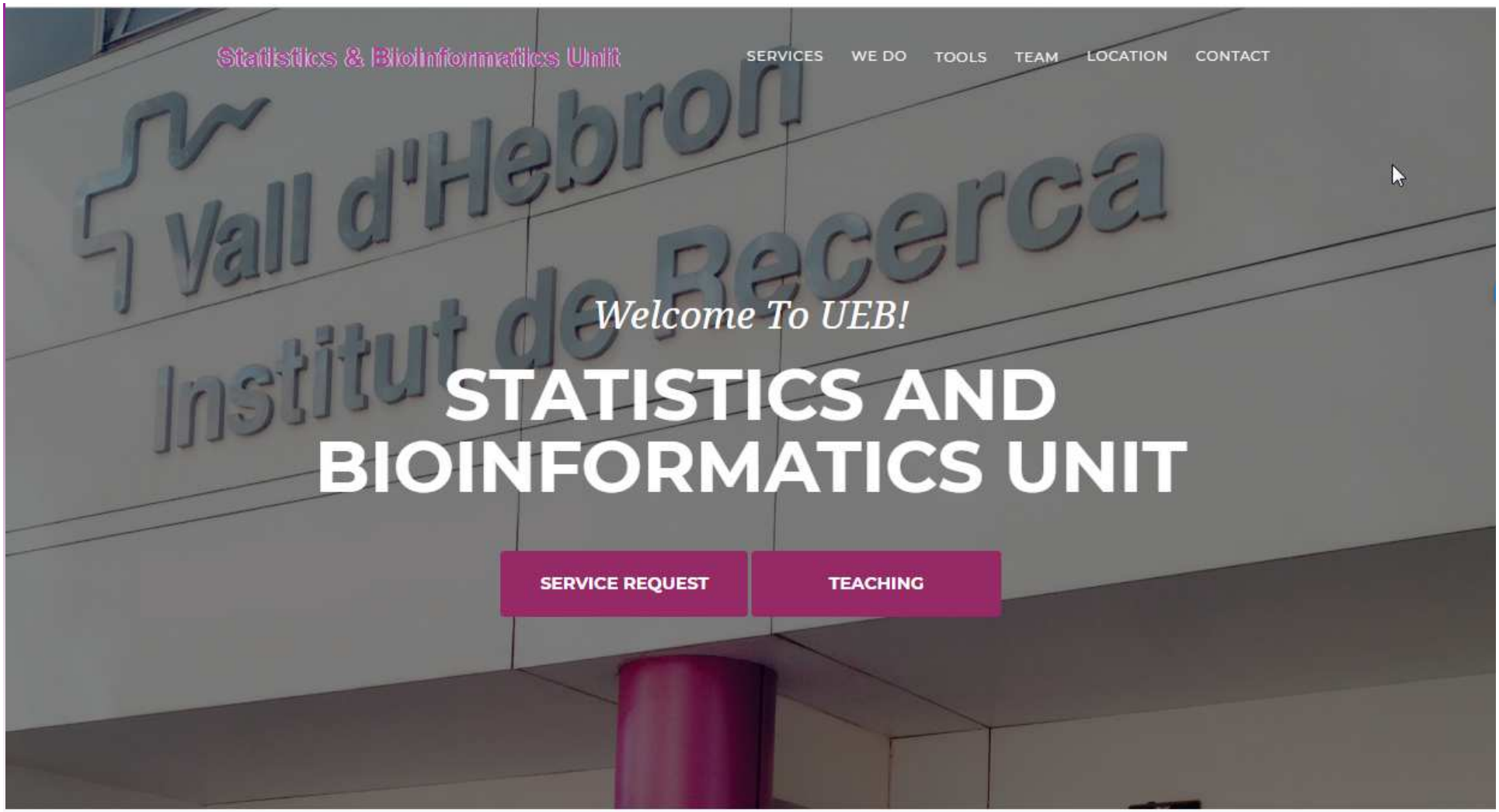
Píndoles estadístiques UEB-VHIR

Odds-ratio, riscos relatius, riscos absoluts....Endreçant les idees

Santiago Pérez-Hoyos
Unitat d'Estadística i Bioinformàtica

Divendres 27 de setembre de 12:30 a 13:30
Sala d'Actes de Traumatologia i Rehabilitació

Les píndoles estadístiques son sessions divulgatives, organitzades per la Unitat d'Estadística i Bioinformàtica (UEB) del VHIR, on es presenten problemes i solucions estadístiques dirigides als professionals interessats del Campus Vall d'Hebron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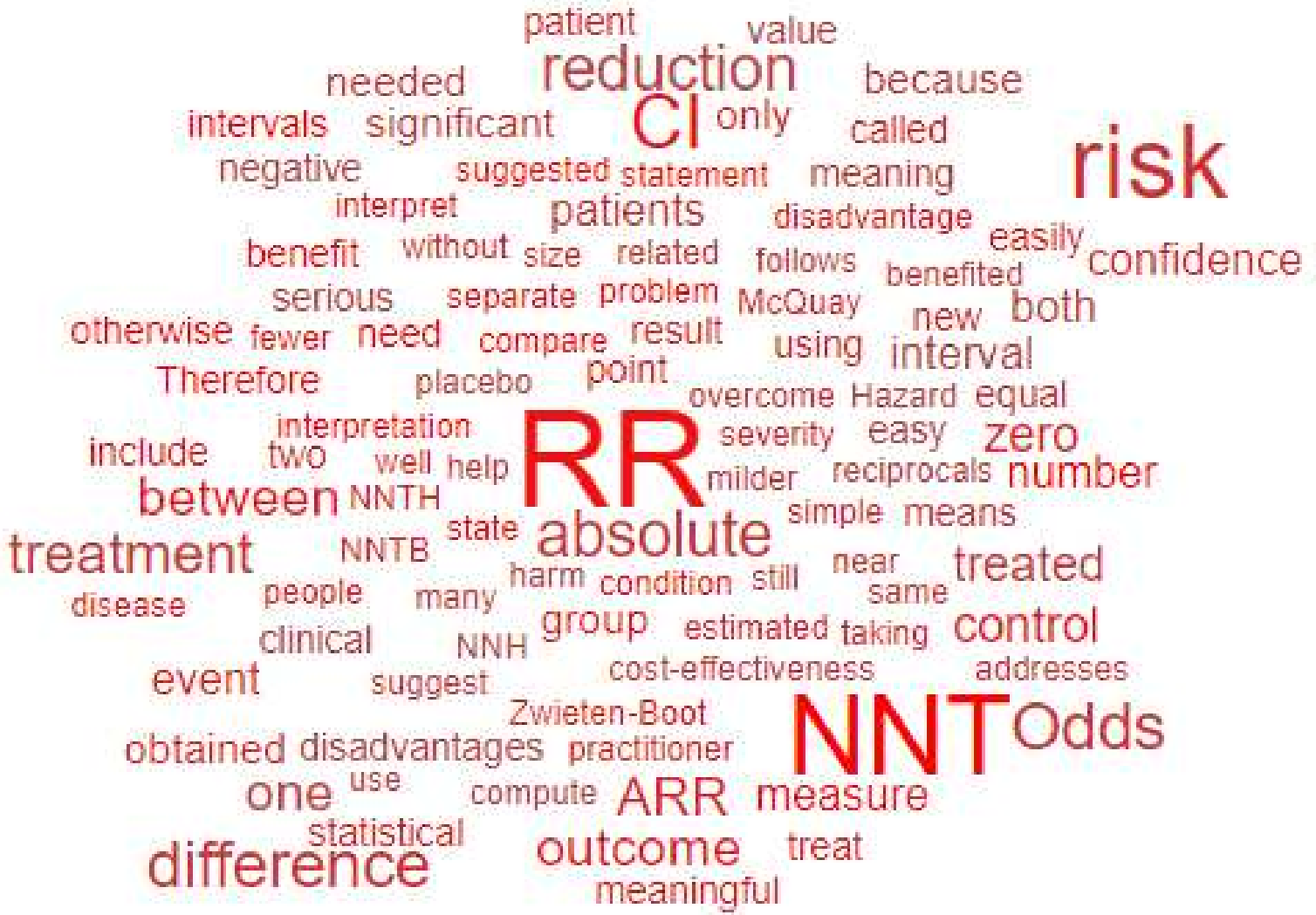
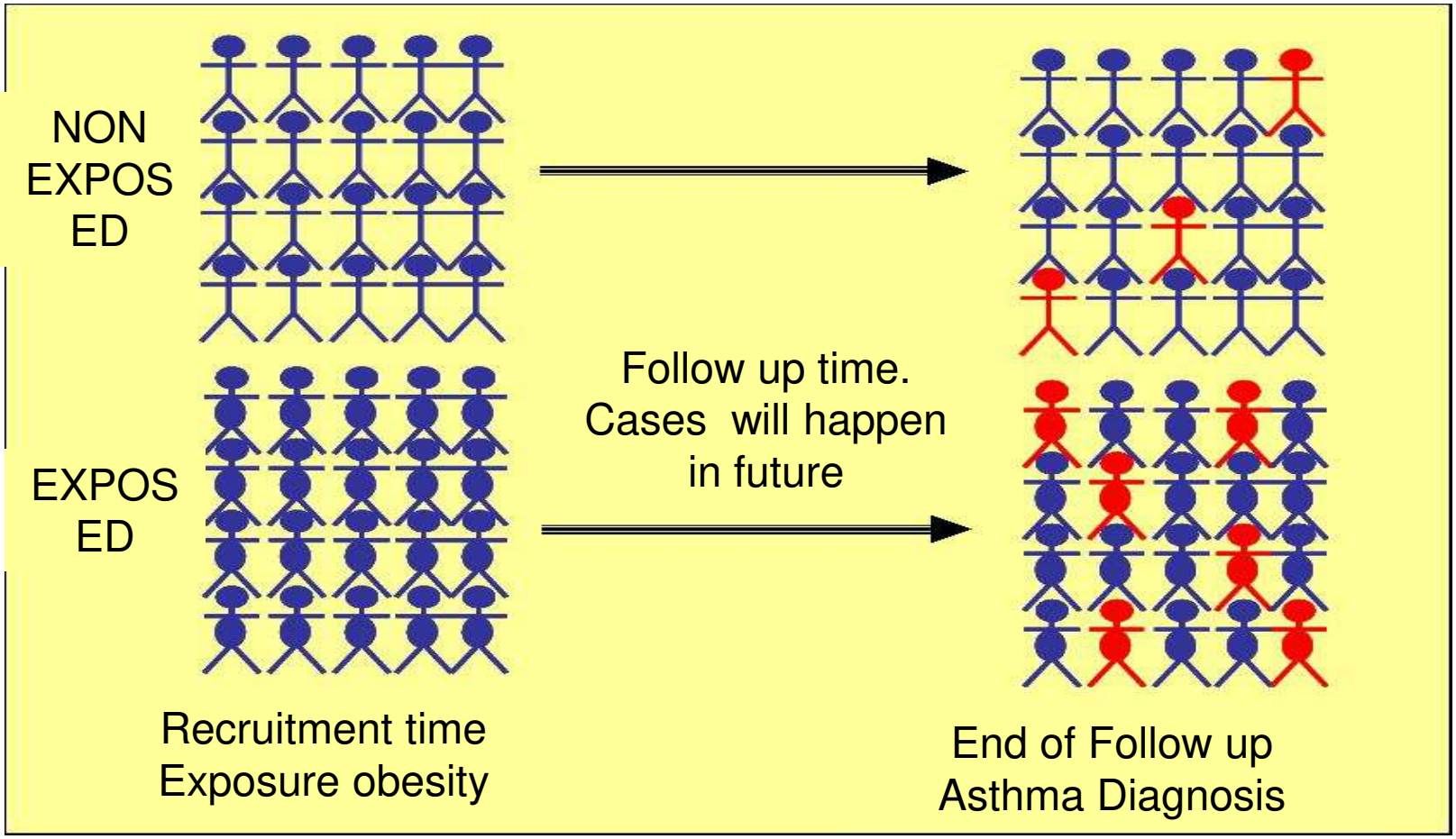
Confusion in use of effect measures



The Question

- When a researcher want to compare two exposures or treatments with a binary outcome, several measures appear
  - RISK
  - ABSOLUTE RISK REDUCTION
  - RELATIVE RISK
  - ATRIBUTABLE RISK FRACTION
  - PREVENTABLE RISK FRACTION
  - NUMBER NEEDED TO TREAT
  - ODDS
  - ODSS RATIO
  - HAZARD
  - HAZARD RATIO
  - ….

Cohort or follow up Studies

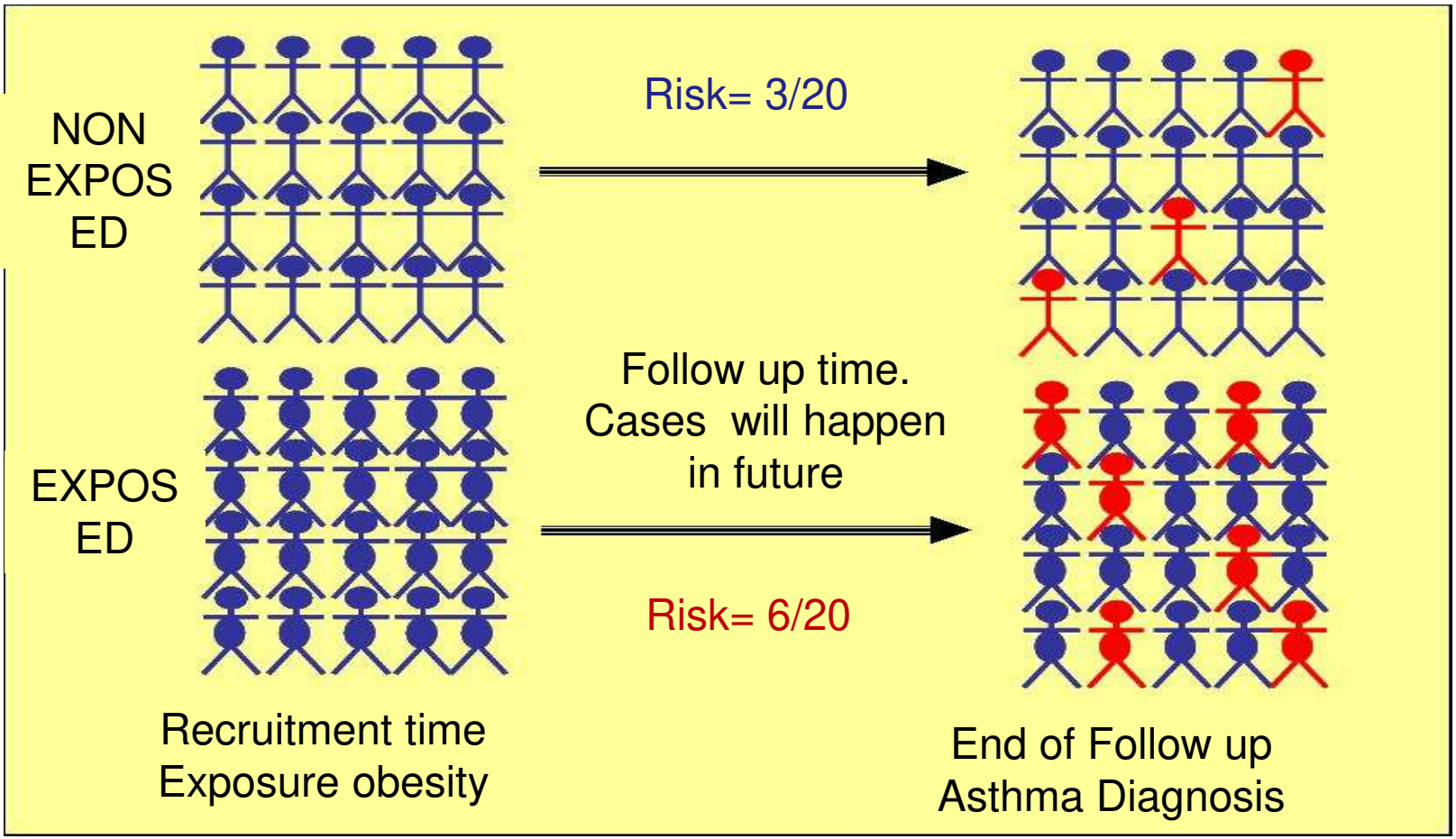


Cumulative Incidence or Risk

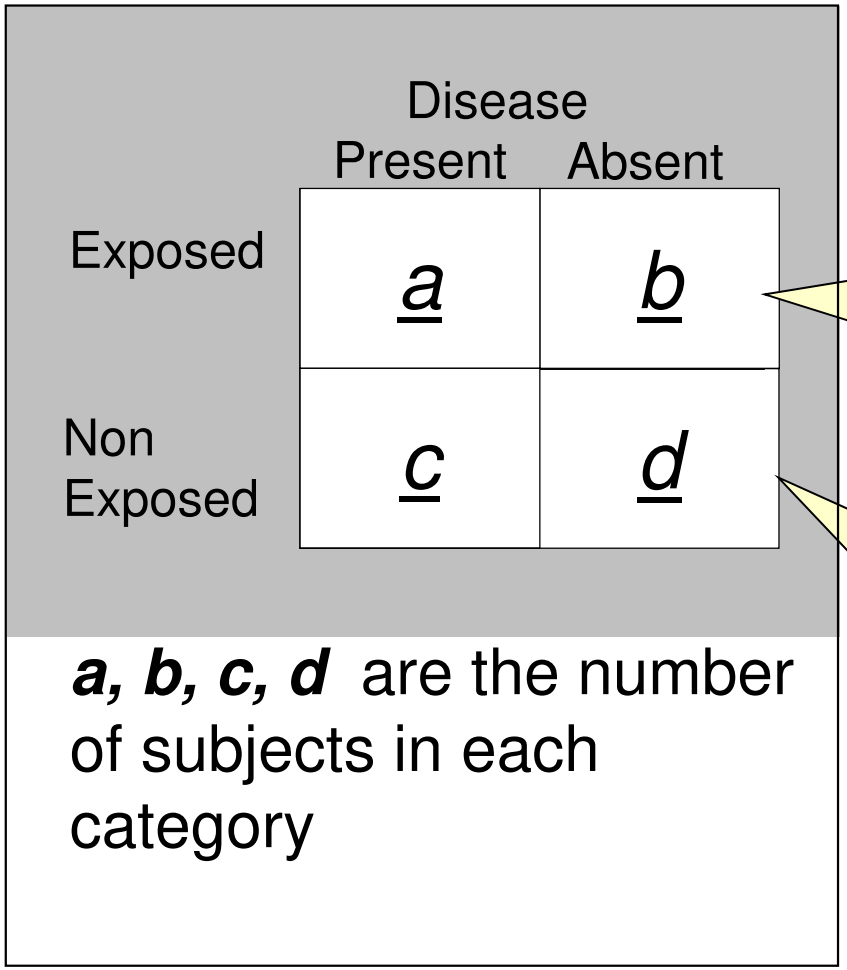
$$CI = \frac{\text{Number of new cases during a period}}{\text{Number of subjects at risk at the beginning of follow-up}}$$

- From a statistical view it's the **conditional probability** of **becoming a case** during a **specified period of time** given you are **exposed** or **in treatment** at the **beginning of follow up**

Cohort or follow up Studies



Risk



Risk of disease Exposed =

$$a/(a+b)$$

Risk of disease No Exposed =

$$c/(c+d)$$

Do not confound Risk with Prevalence

$Prevalence_t$

Cases of disease in a instant o r period of time t in a population. Probability one person of the population have the disease.

$$Prevalence = \frac{\text{Number of cases}}{\text{Number of subjects}}$$

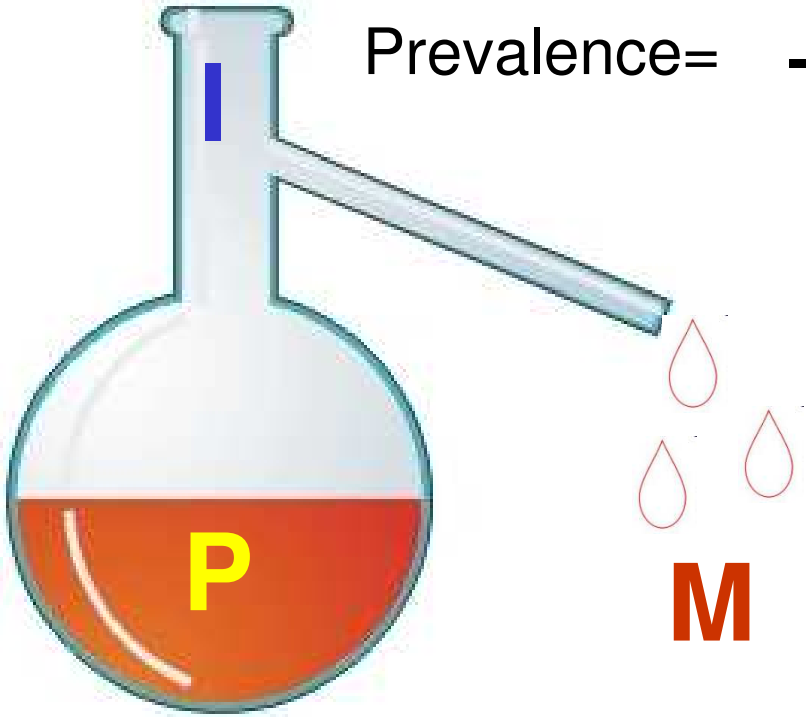
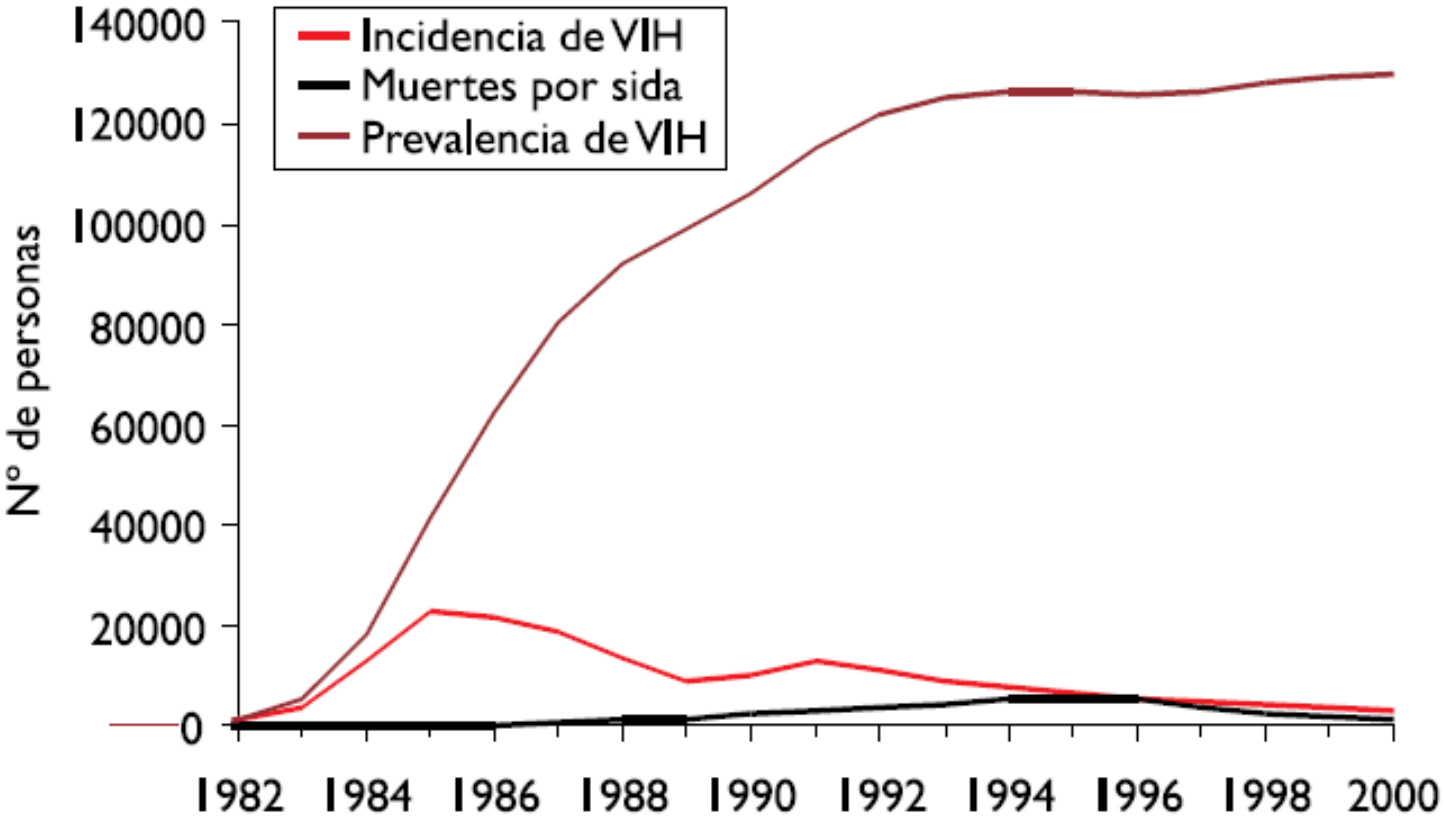


Figura 3. Simulación de la epidemia de VIH y sida en España.



One consideration interpreting risk

- Physicians tend to consider risk in terms of the group of patients that they treat,

Whereas

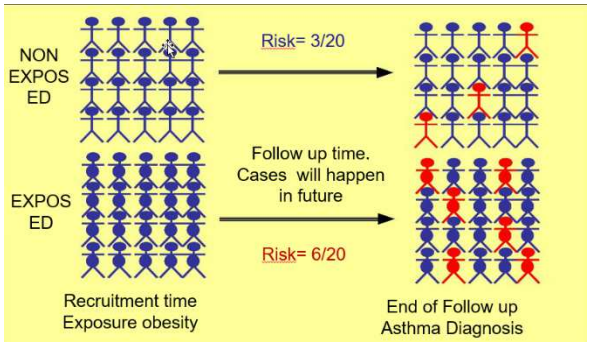
- Patients interpret risk as applying to their own individual case.

How to compare RISK

Difference of Risk or Absolute Risk Reduction

ARR= Risk in exposed- Risk in non exposed

- Easy to compute and calculate confidence interval
- 0 in the confidence interval means no risk difference
- The main problem is that the same risk difference means not the same depending the underlying risk



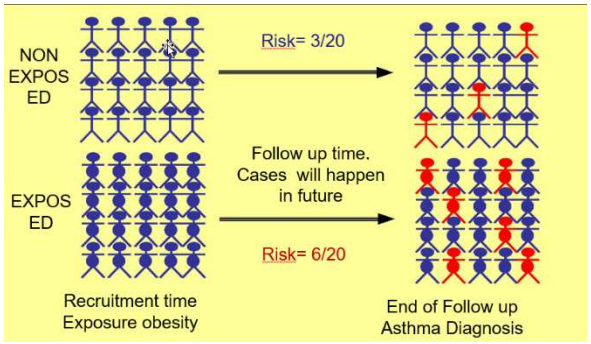
ARR=6/20-3/20=3/20

How to compare RISK

Relative Risk

$$RR = \frac{\text{Risk in exposed}}{\text{Risk in non exposed}}$$

- Easy to compute and interpret as the excess or deffect of risk of exposed vs unexposed
- >1 means excess of risk
- <1 means deffect of risk



$$RR = \frac{6/20}{3/20} = 2$$

Relative Risk (RR)

	Disease Present	Disease Absent
Exposed	*a*	*b*
Non exposed	*c*	*d*

a, b, c, d are the number of subjects in each category

Disease Risk in exposed relative to Disease risk in non exposed

$$\frac{a/(a+b)}{c/(c+d)}$$

Which is the effect of the exposure

Attributable risk fraction

ARF=RR -1 if RR>1

It is the excess of risk ought to factor exposure

Preventable risk fraction

PRF= 1-RR -1 if RR<1

It is the deffect of risk ought to factor exposure

Attributable Risk Fraction	RR	RR	Atributable Preventable Fraction
	1,0000	1,0000	
25% more	1,2500	0,8000	20% less
33% more	1,3333	0,7500	25% less
50% more	1,5000	0,6667	33% less
100% more	2,0000	0,5000	50% less
150% more	2,5000	0,4000	60% less
200% more	3,0000	0,3333	66% less
400% more	5,0000	0,2000	400% more

Number needed to treat (NNT)

Number Needed to Treat (NNT):

Number of persons who would have to receive an intervention for 1 to benefit.

Number Needed to Harm(NNH):

Number of persons who would have to receive an intervention for 1 to be experience a adverse event.

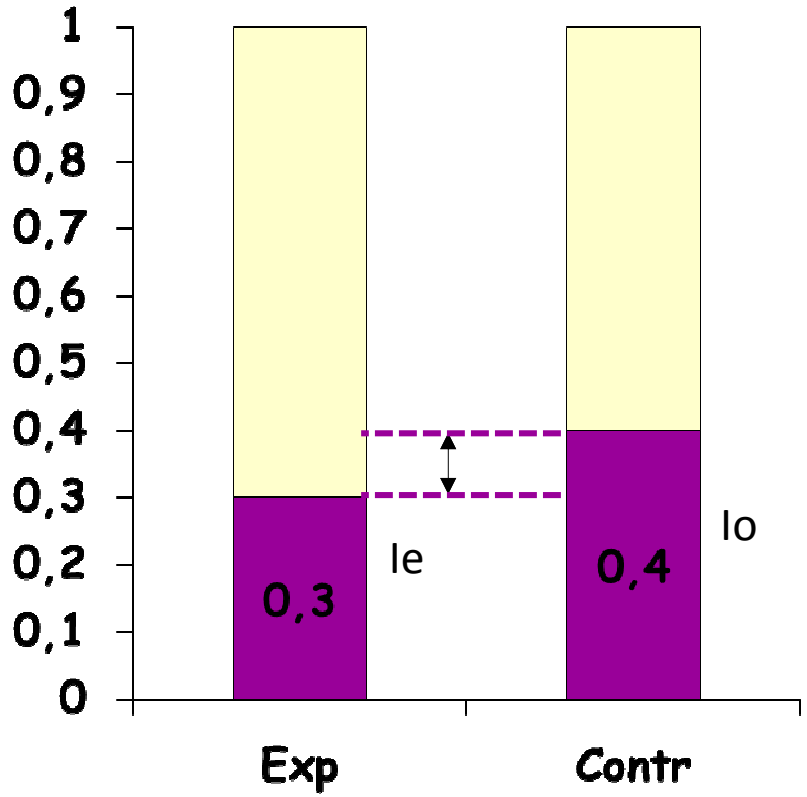
NNT= 1 /ARR=1

Effect measures in Clinical Trial

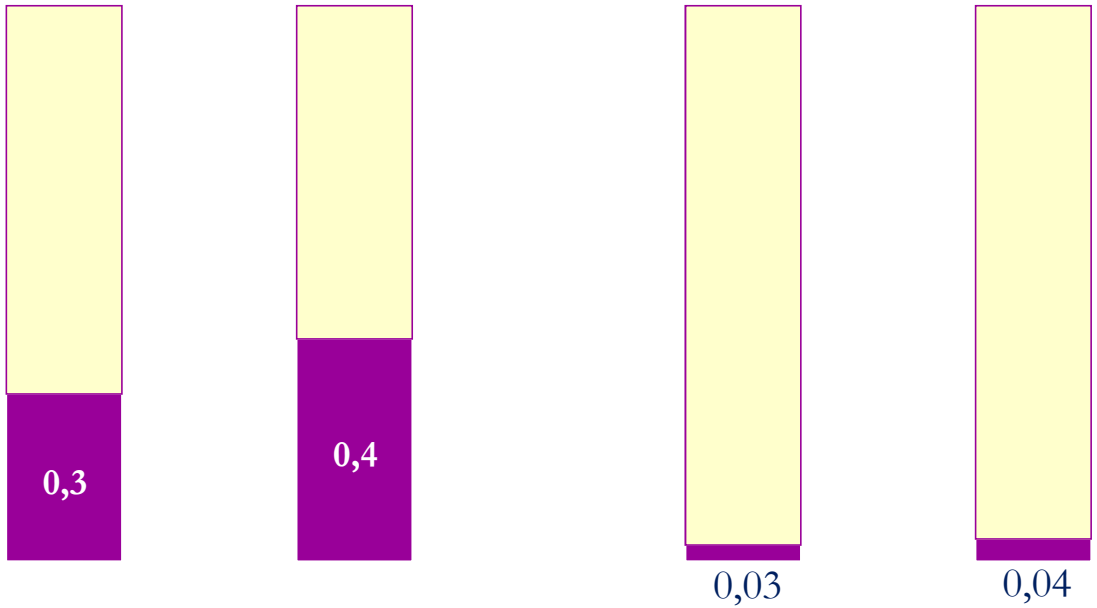
$$PRF = \frac{Io - Ie}{Io} = 1 - \frac{Ie}{Io} = 1 - RR$$

$$ARR = Io - Ie$$

$$NNT = \frac{1}{ARR}$$



Effect measures in Clinical Trial



RR = 0.75
ARR = 0,10
PRF = 25%
NNT = 10

RR = 0.75
ARR = 0,01
PRF = 25%
NNT = 100

Caution

Relation or excess of risk among exposed does not mean ~~CAUSALITY~~

How Common Is Attention-Deficit/ Hyperactivity Disorder?

Incidence in a Population-Based Birth Cohort in Rochester, Minn

William J. Barbaresi, MD; Slavica K. Katusic, MD; Robert C. Colligan, PhD; V. Shane Pankratz, PhD; Amy L. Weaver, MS; Kevin J. Weber, PhD; David A. Mrazek, MD; Steven J. Jacobsen, MD, PhD

Table 5. Cumulative Incidence of AD/HD in the 1976-1982 Birth Cohort*

	Cumulative Incidence of AD/HD by Age 19 Years, % (95% CI)	Mean ± SD Age at Which Research Criteria Were Fulfilled, y	M/F Relative Risk (95% CI)
Definite AD/HD			
Overall	7.5 (6.5-8.4)	10.2 ± 3.5	3.1 (2.3-4.0)
Males	10.8 (9.3-12.3)	10.0 ± 3.4	
Females	3.9 (2.8-5.1)	10.8 ± 3.8	
Definite AD/HD plus probable AD/HD			
Overall	9.4 (8.3-10.4)	10.4 ± 3.6	3.0 (2.3-3.8)
Males	13.3 (11.7-15.0)	10.2 ± 3.4	
Females	5.1 (3.8-6.4)	11.2 ± 4.0	
Definite AD/HD plus probable AD/HD plus questionable AD/HD			
Overall	16.0 (14.7-17.3)	10.6 ± 3.5	2.3 (2.0-2.8)
Males	21.1 (19.1-23.0)	10.3 ± 3.3	
Females	10.5 (8.8-12.2)	11.1 ± 3.8	

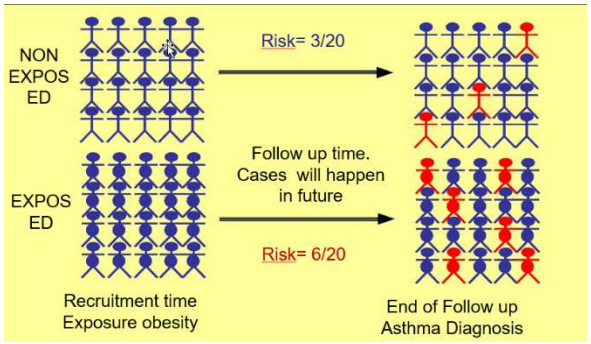
*AD/HD indicates attention-deficit/hyperactivity disorder; CI, confidence interval.

Other measure of risk: Odds

"Odds" is often known as the ratio of money that may be won versus the amount of money bet

In Statistics ,is the probability of being case vs the probability of being no case

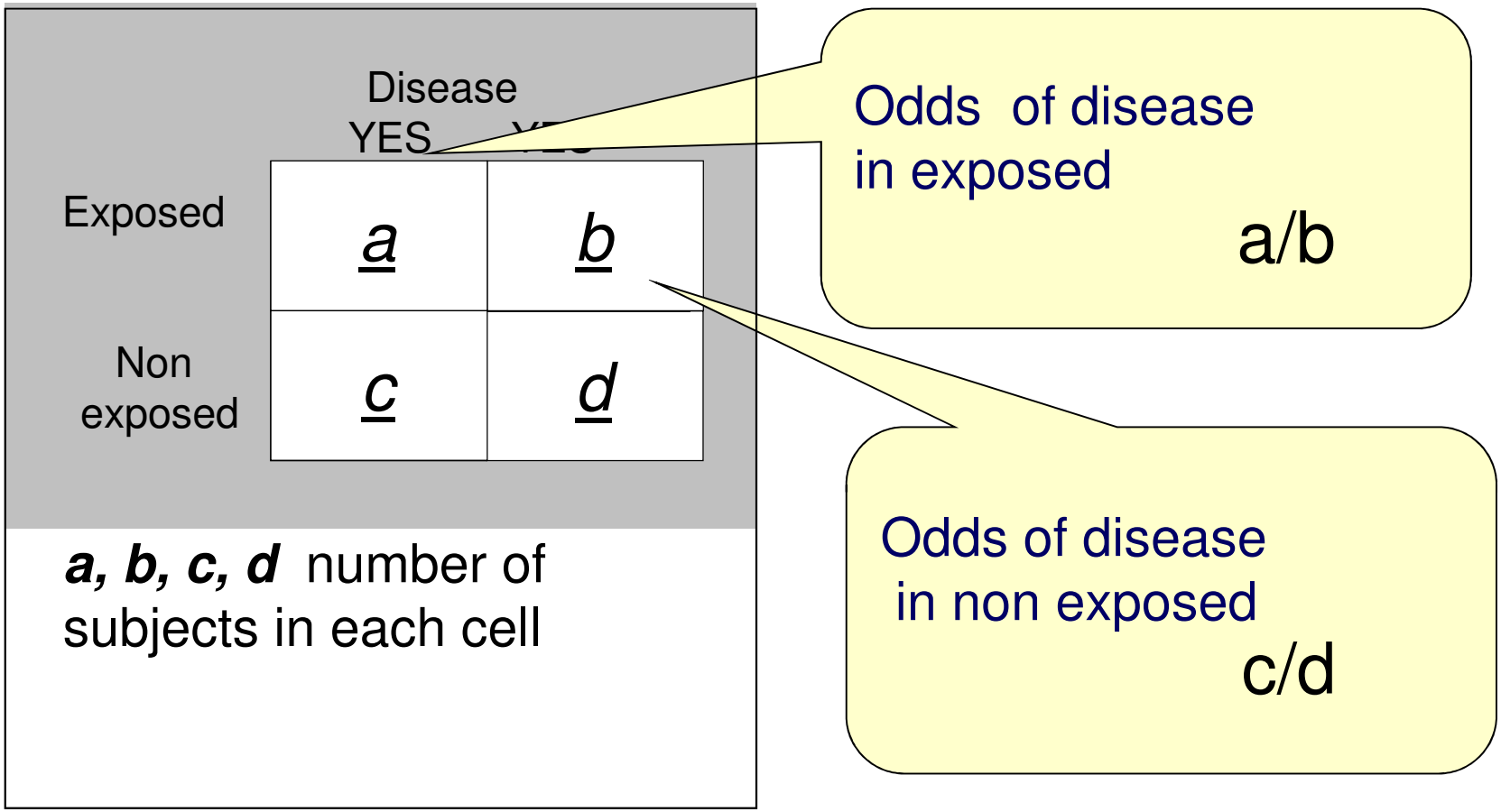
$$\text{ODSS} = \frac{\text{Number of cases}}{\text{Number of no cases}}$$



Odds Exposed=6/14

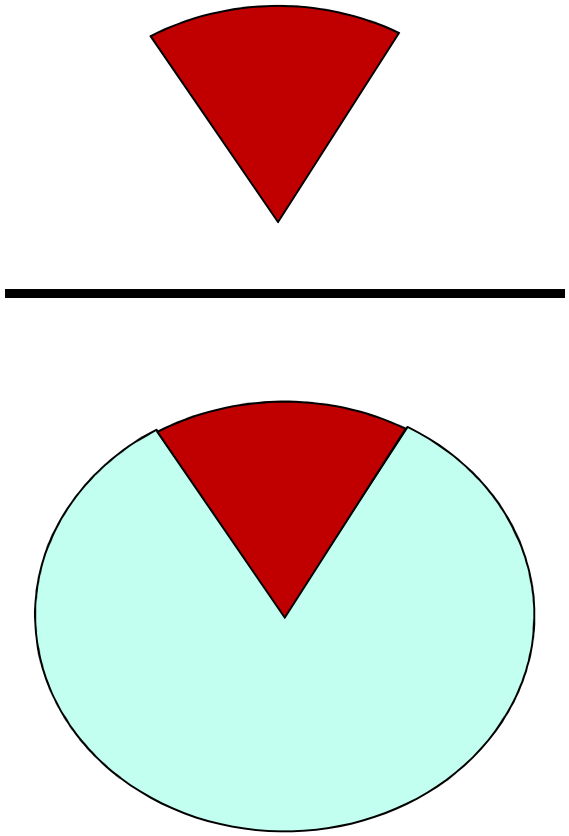
Odds no exposed= 3/17

ODDS

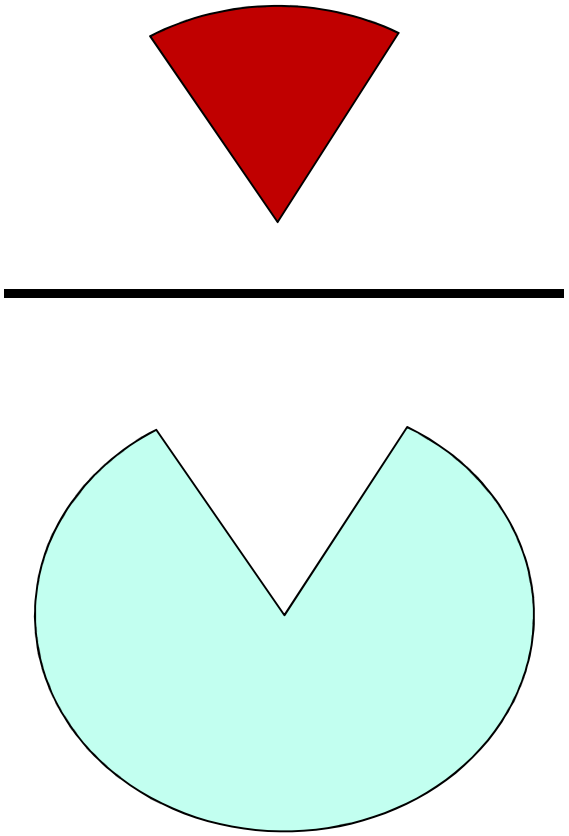

Disease
YES
Exposed
a
b
Non exposed
c
d
a, b, c, d number of subjects in each cell
Odds of disease in exposed
a/b
Odds of disease in non exposed
c/d

Odds vs Risk

Risk



Odds



Odds vs Risk

Cases	Non cases	Risk	Odds
1	999	0,0010	0,0010
10	990	0,0100	0,0101
100	900	0,1000	0,1111
200	800	0,2000	0,2500
300	700	0,3000	0,4286
400	600	0,4000	0,6667
500	500	0,5000	1,0000
600	400	0,6000	1,5000
700	300	0,7000	2,3333
800	200	0,8000	4,0000
900	100	0,9000	9,0000
990	10	0,9900	99,0000
999	1	0,9990	999,0000

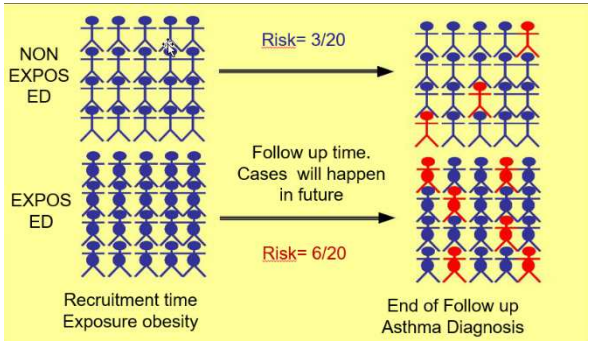
Odds Interpretation

- Difficult to interpret if you are not used to bets
- It can be calculated in cross-sectional and case/control studies (not need follow up)
- It is similar to Risk if incidence/prevalence is low

Odds Ratio

Odds Ratio

$$OR = \frac{\text{Odds in exposed}}{\text{Odds in non exposed}}$$

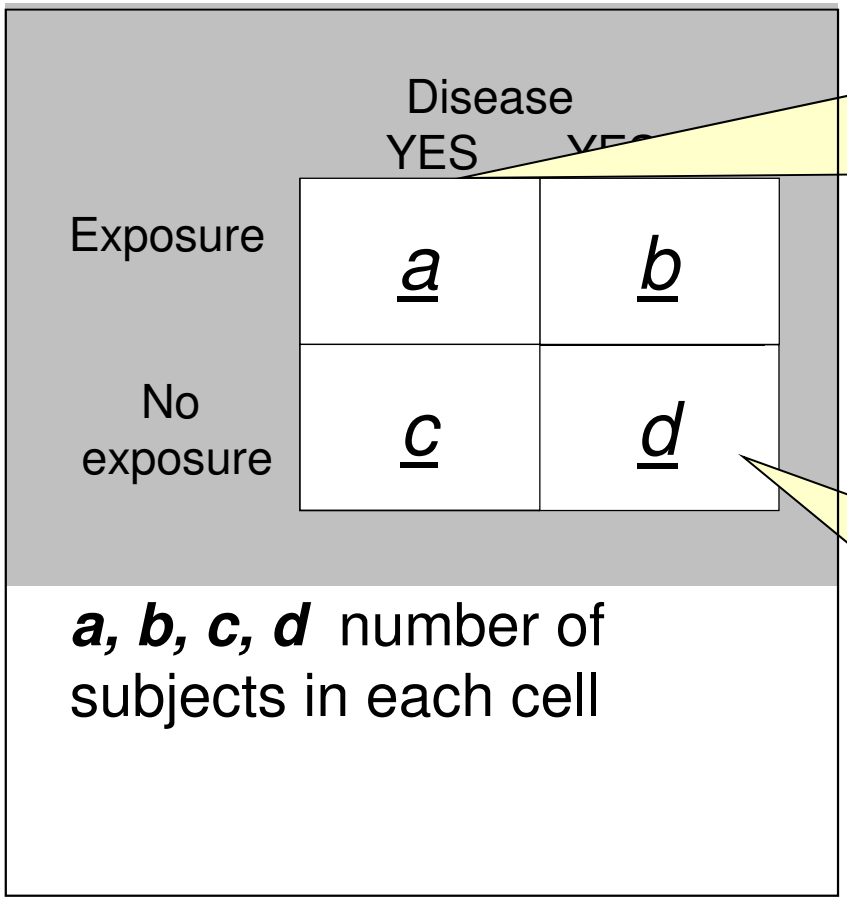


Odds Exposed=6/14

Odds no exposed= 3/17

OR= 6/14 / 3/17= 6* 17 /14*3 = 2.43

ODDS Ratio



Odds of disease in exposed

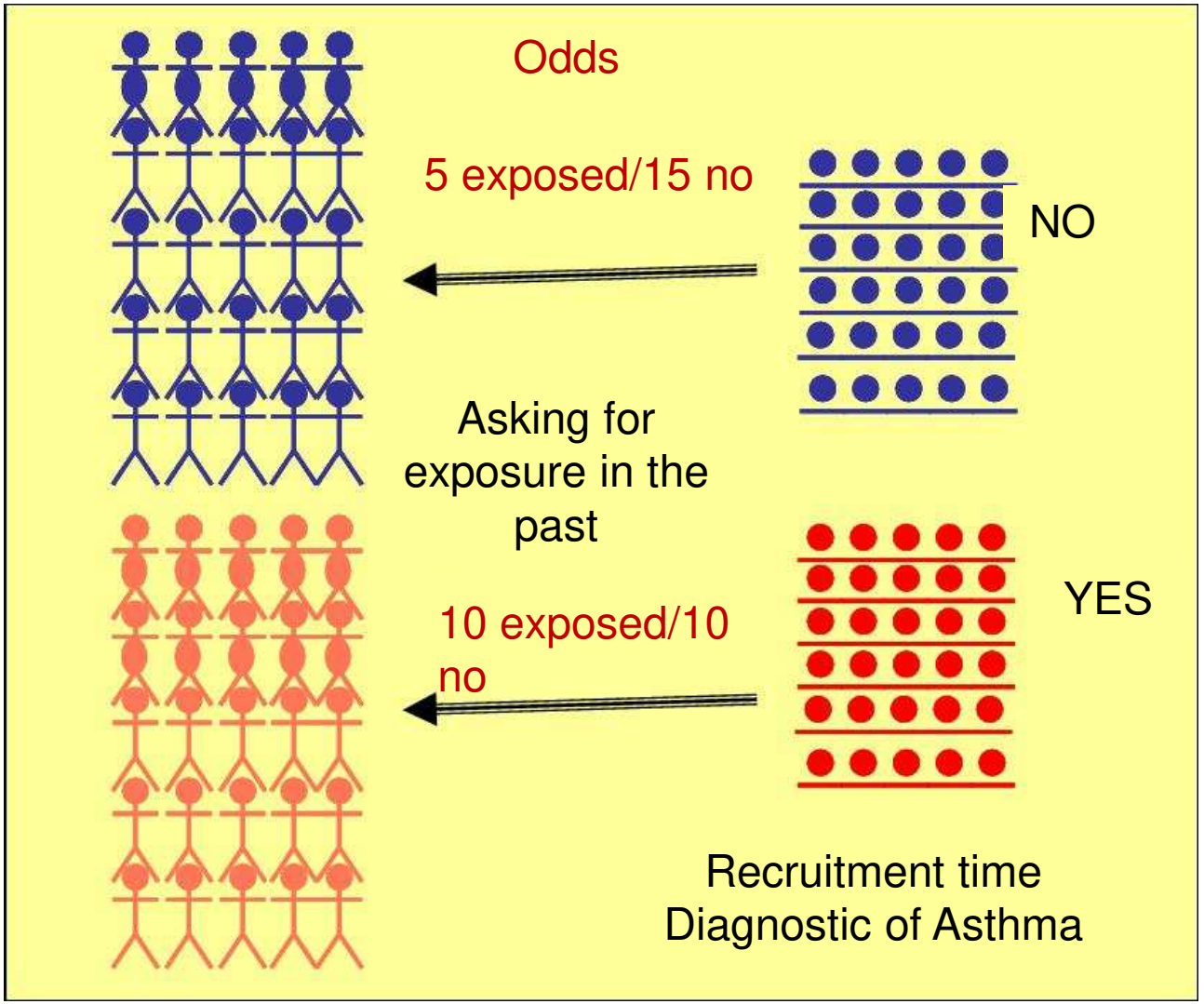
a/b

Odds of disease in non exposed

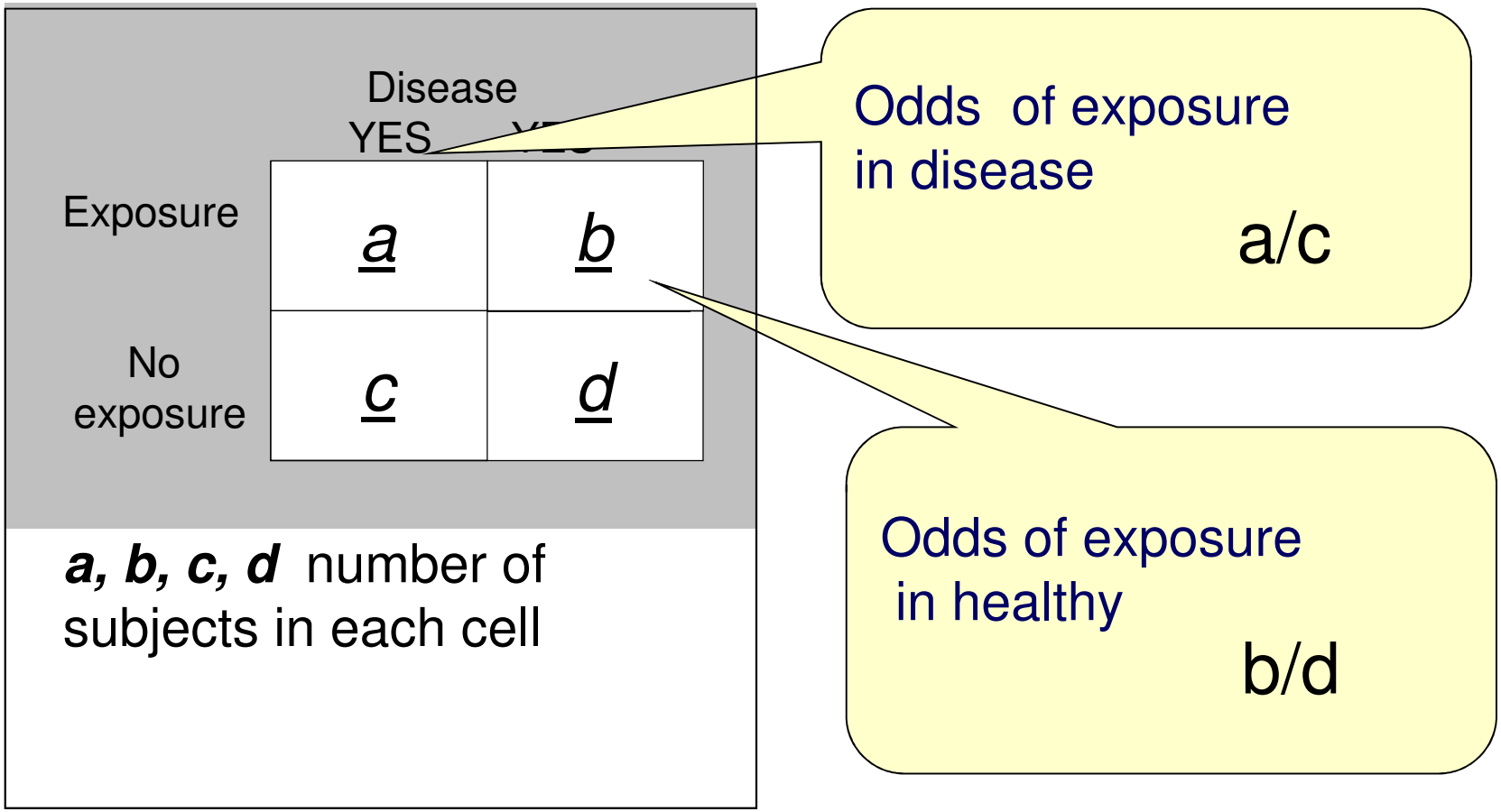
c/d

$$\frac{a/b}{c/d} = \frac{ad}{bc}$$

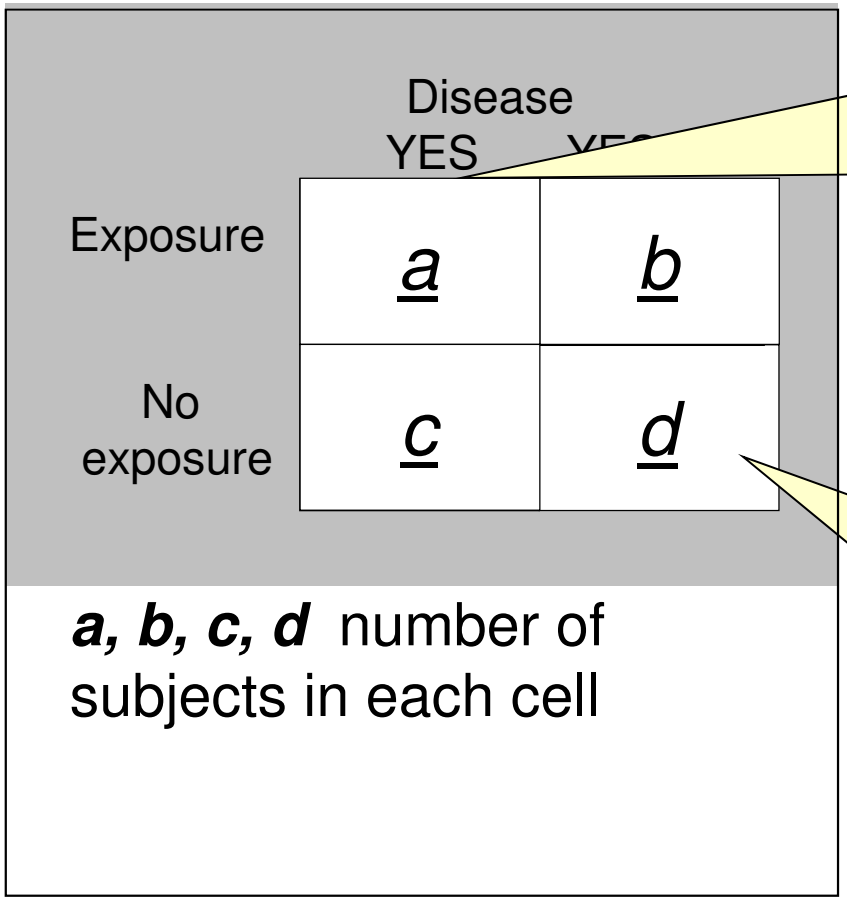
Case-Control Studies



ODDS


Disease
YES
Exposure
a
b
No exposure
c
d
a, b, c, d number of subjects in each cell
Odds of exposure in disease
a/c
Odds of exposure in healthy
b/d

ODDS Ratio



Odds of exposure in disease

a/c

Odds of exposure in healthy

b/d

$$\frac{a/c}{b/d} = \frac{ad}{bc}$$

OR=(10/10)/(5/15) =3

Example

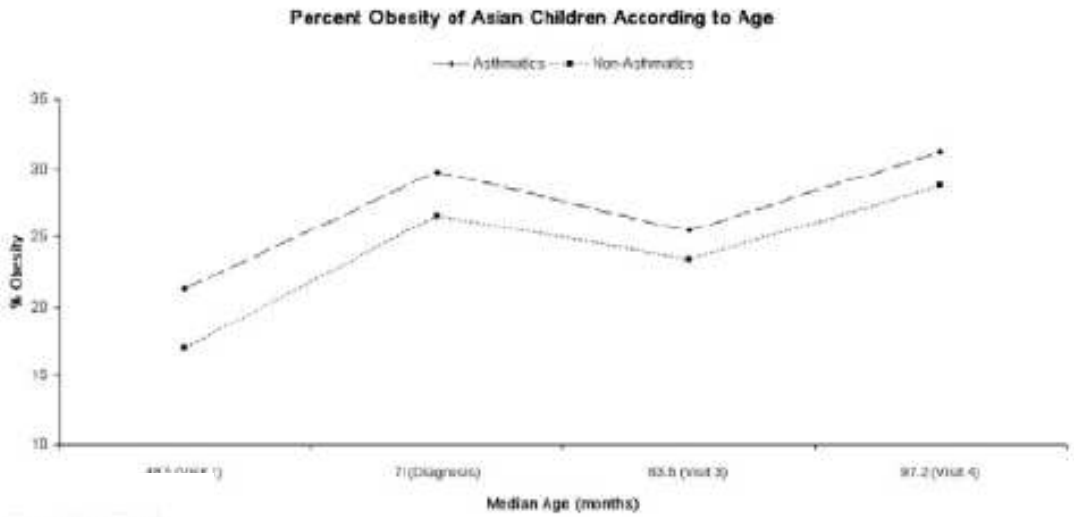


Table 2. Data for Asthma According to BMI Status in a Longitudinal Model

Model	Odds ratio (95% confidence interval) for cases[a]	p value
Age-adjusted model	1.30 (0.64 2.65)	.46
Model further adjusted for atopic dermatitis	1.20 (0.55 2.60)	.65
Model further adjusted for food and other allergies	1.18 (0.54 2.58)	.69
Model further adjusted for allergic rhinitis	0.92 (0.40 2.15)	.86

Abbreviation: BMI, body mass index.
[a] The reference group was controls (odd ratio of 1 for all).

ercentage overweight and risk of overweight of cases and ling to age and visit number.

Why use Odds Ratio?

- Provide an estimate(and confidence interval) or effect measure of the relationship between a binary outcome and an exposure or treatment variable
- The effects of other variables can be controlled using a logistic regression. The OR is the natural way of represent results for this regression model
- Can be used in case-control and cross-sectional models

Example Logistic Regression Case-Control Study

Table 1
Distribution of studied variables in cases and controls

	Case		Control		OR[a]	95% Confidence interval	
	N	%	*N*	%			
Influenza vaccine	168	58.5	318	61.0	0.91	0.68	1.23
Pneumococcal vaccine	112	41.9	169	34.3	1.34	0.98	1.84

Table 2
Effectiveness of the influenza vaccination in preventing emergency admission for pneumonia, adjusted analysis

	Odds ratio of being case	95% Confidence interval		*P*-value
Vaccinated for influenza	0.52	0.34	0.80	0.003
Pneumococcal vaccination	1.52	1.01	2.29	0.047
Co-morbidity				
Heart disease	1.59	1.08	2.35	0.020
COPD	2.97	1.84	4.78	<0.001
Asthma	2.34	0.94	5.83	0.068
Smoking habit				
Ex-smoker	0.70	0.34	1.42	0.318
Recent ex-smoker	0.28	0.09	0.87	0.027
Smoker	0.27	0.11	0.66	0.004
Visits to the doctor during the last 3 months				
1–2 times	3.49	0.87	13.99	0.078
3–6 times	3.97	1.03	15.29	0.045
More than 6	4.09	0.98	17.05	0.053
Barthel <60	3.71	0.84	16.37	0.083

Puig-Barberà, J., Diez-Domingo, J., Pérez Hoyos, S., Belenguer Varea, Á., & González Vidal, D. (2004). Effectiveness of the MF59-adjuvanted influenza vaccine in preventing emergency admissions for pneumonia in the elderly over 64 years of age. Vaccine, 23(3), 283–289.

Problems with the use of Odds Ratio?

- Difficult to understand for users. Two times more risk is understable, but not two times more of odds
- Odds Ratio are often missinterpreted as meaning the same as relative risk . It is not true. It depends on the disase magnitude.
- Only if frequency of disease is very low (rare disease) figures of odds ratio are similar to relative risk, in other case OR overestimate RR.
- However, the rank and the sense of the relation is the same for both effect measures.
- Several methods have been proposed for relate OR and RR but are confusing and have been criticized.

Relative Risk vs Odds Ratio

Table 2. Divergence of Odds Ratios From Relative Risks as the Probability of an Event in a Comparison Group (Nonmembers of the National Psoriasis Foundation) Increases*

	Probability of a Yes Outcome		Odds of a Yes Outcome		Members Compared With Nonmembers	
Example	Among Nonmembers	Among Members	Among Nonmembers	Among Members	Relative Risk of a Yes Outcome	Odds Ratio of a Yes Outcome
1	0.0001	0.0003	0.0001	0.0003	3	3.0006
2	0.001	0.003	0.002	0.003	3	3.01
3	0.01	0.03	0.01	0.03	3	3.06
4	0.02	0.06	0.02	0.06	3	3.13
5	0.05	0.15	0.05	0.18	3	3.35
6	0.1	0.3	0.11	0.43	3	3.86
7	0.15	0.45	0.18	0.82	3	4.64
8	0.2	0.6	0.25	1.5	3	6.0
9	0.25	0.75	0.33	3.0	3	9.0
10	0.3	0.9	0.43	9.0	3	21.0
11	0.33	0.99	0.49	99.0	3	201.0

*In all of these hypothetical cases, the probability of a yes outcome is lower among nonmembers than among members. Members are 3 times more likely than nonmembers to have a yes outcome. Therefore, the relative risk of a yes outcome is always 3. As the probabilities of a yes outcome proportionately increase among members and nonmembers, the odds ratios increase dramatically and increasingly diverge from the (constant) relative risks.

The (Relative) Risks of Using Odds Ratios Kenneth A. Katz, MD, MSc. ARCH DERMATOL/VOL 142, JUNE 2006

Relative Risk vs Odds Ratio

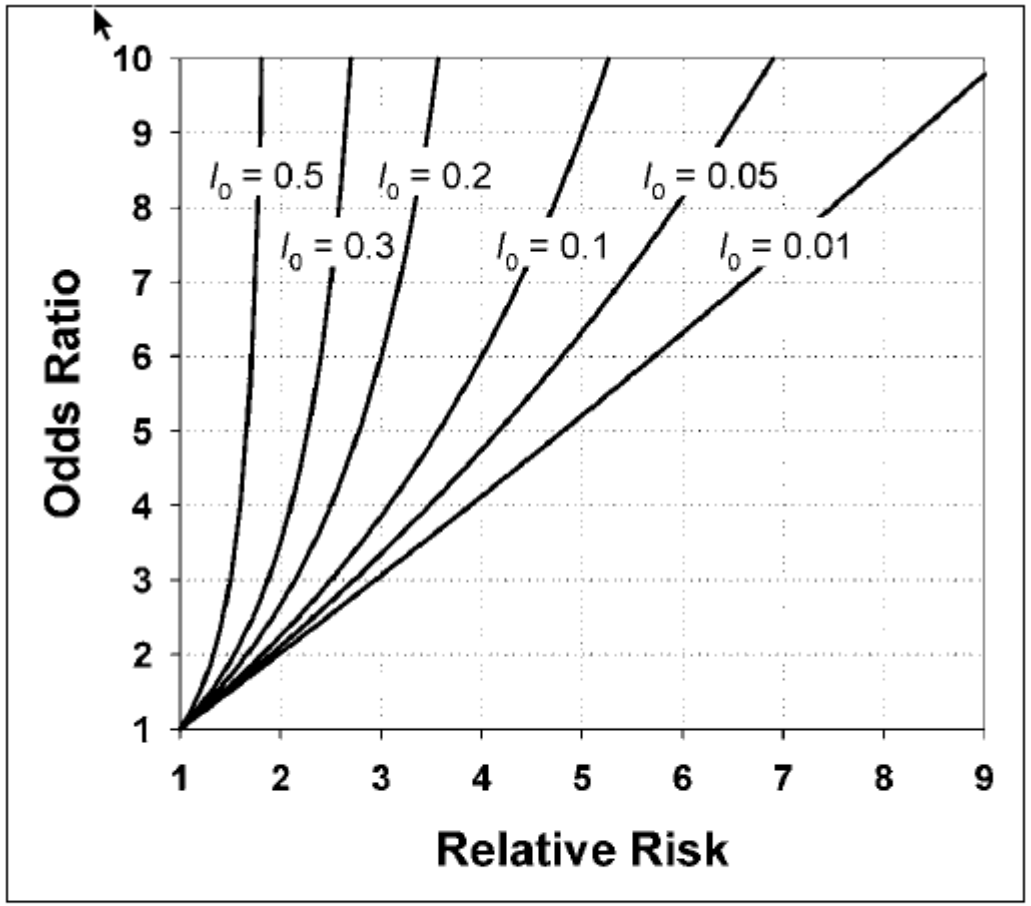


Figure 1 Relationship between Odds Ratio and Relative Risk for various incidence rates

When to use the odds ratio or the relative risk? Carsten Oliver Schmidt, Thomas Kohlmann Int J Public Health 53 (2008) 165–167

Relative Risk vs Odds Ratio

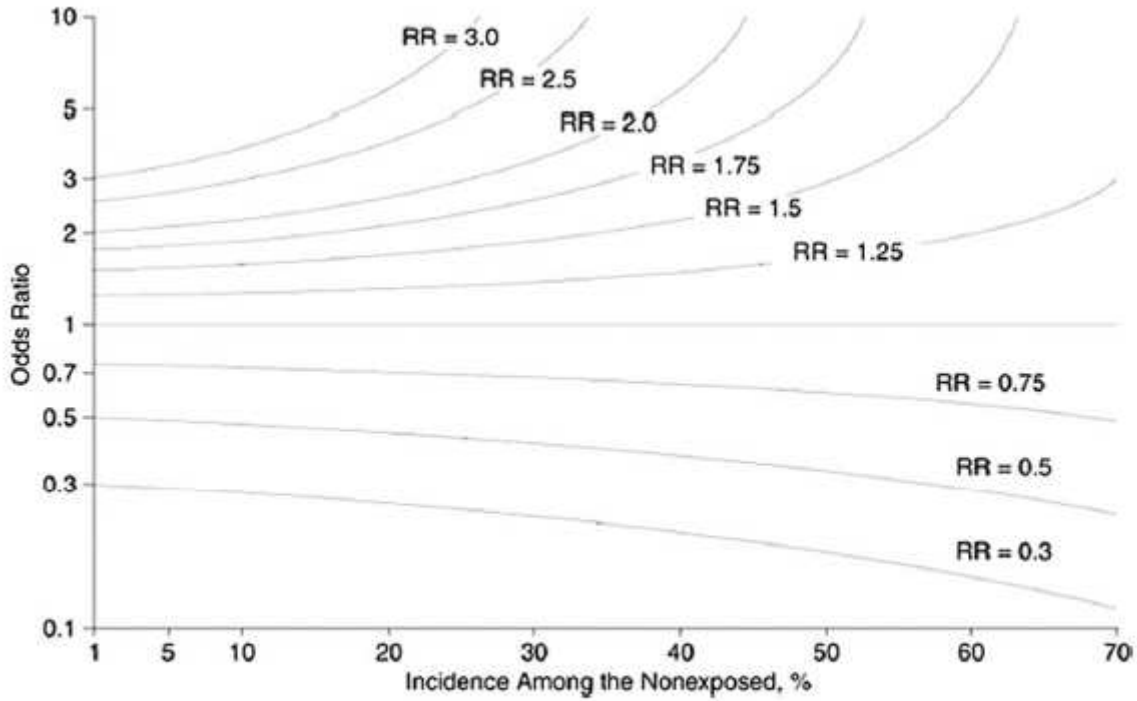
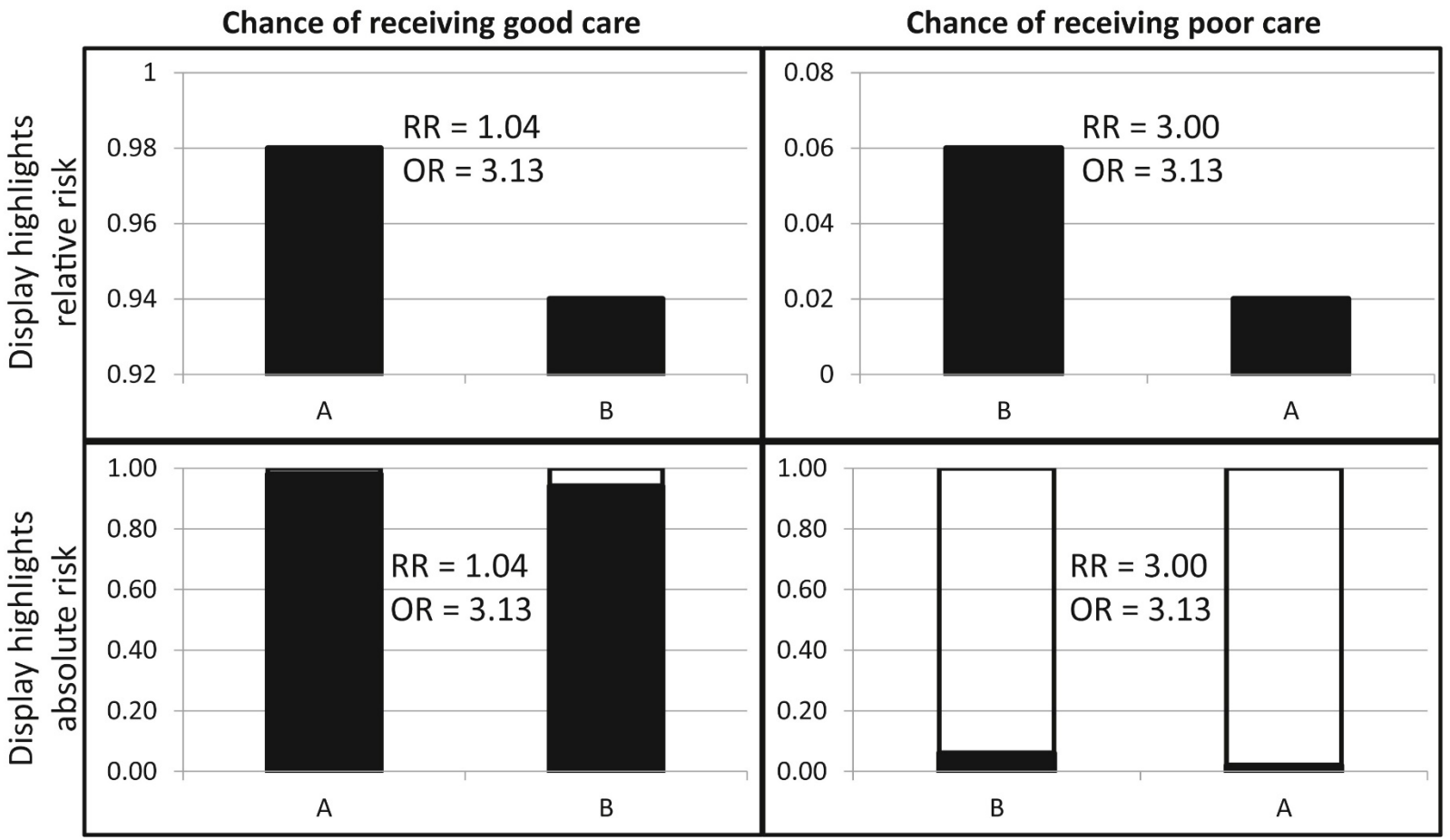


Fig. 2 The relationship between risk ratio (RR) and odds ratio by incidence of the outcome. Adapted from Zhang and Yu.[8]

Odds Ratios and Risk Ratios: What's the Difference and Why Does It Matter? Anthony J. Viera. *Southern Medical Journal* • Volume 101, Number 7, July 2008

Relative Risk vs Odds Ratio



Math Matters: How Misinterpretation of Odds Ratios and Risk Ratios May Influence Conclusions R. Christopher Sheldrick, PhD, Paul J. Chung, MD, MS, Robert M. Jacobson, MD. Academic Pediatrics 2017 17, 1-3DOI: (10.1016/j.acap.2016.10.008)

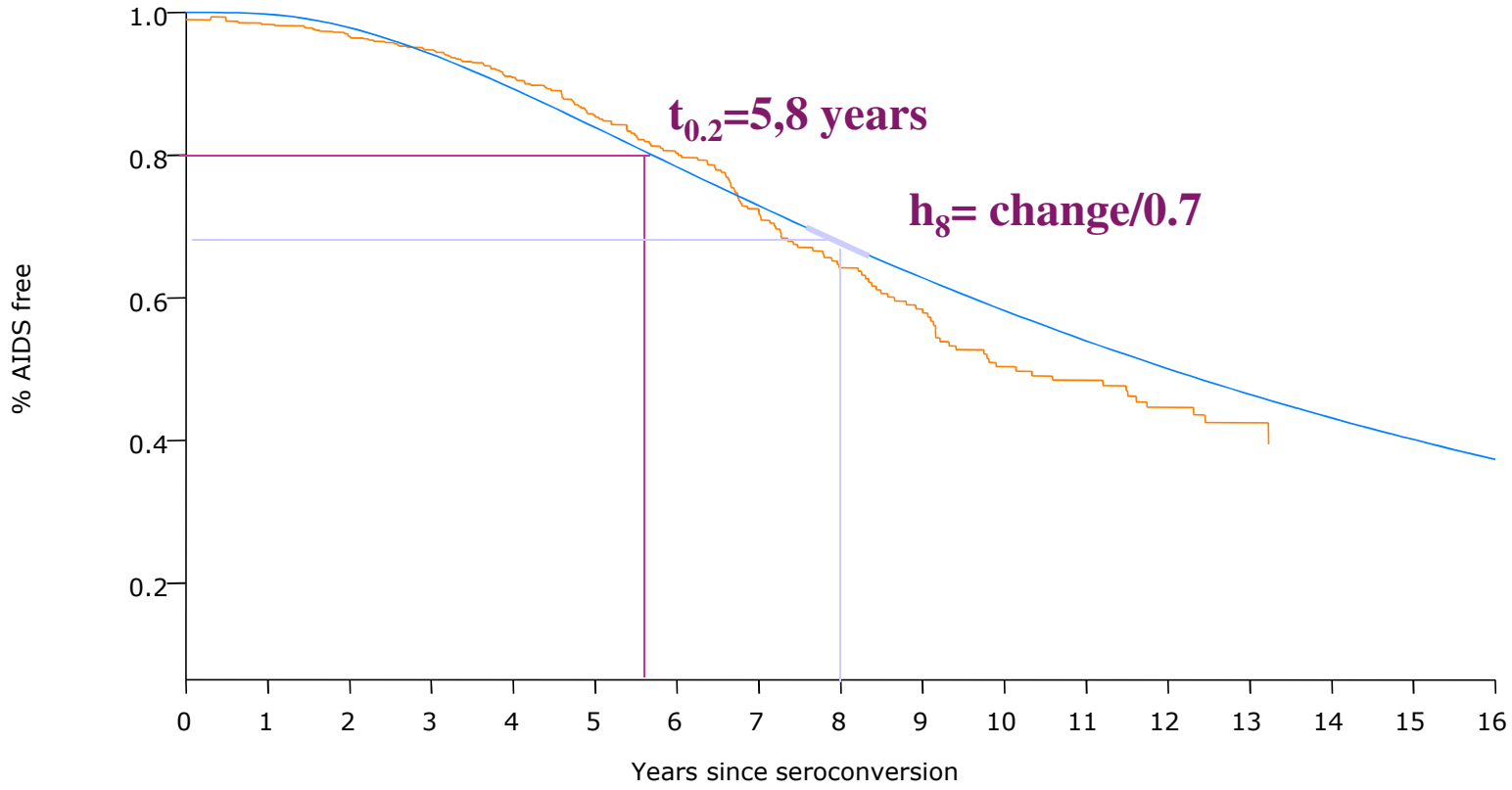
Hazard rate $\lambda(t)=h(t)$

Instantaneous probability of death in an infinitesimal interval knowing to be alive at the beginning

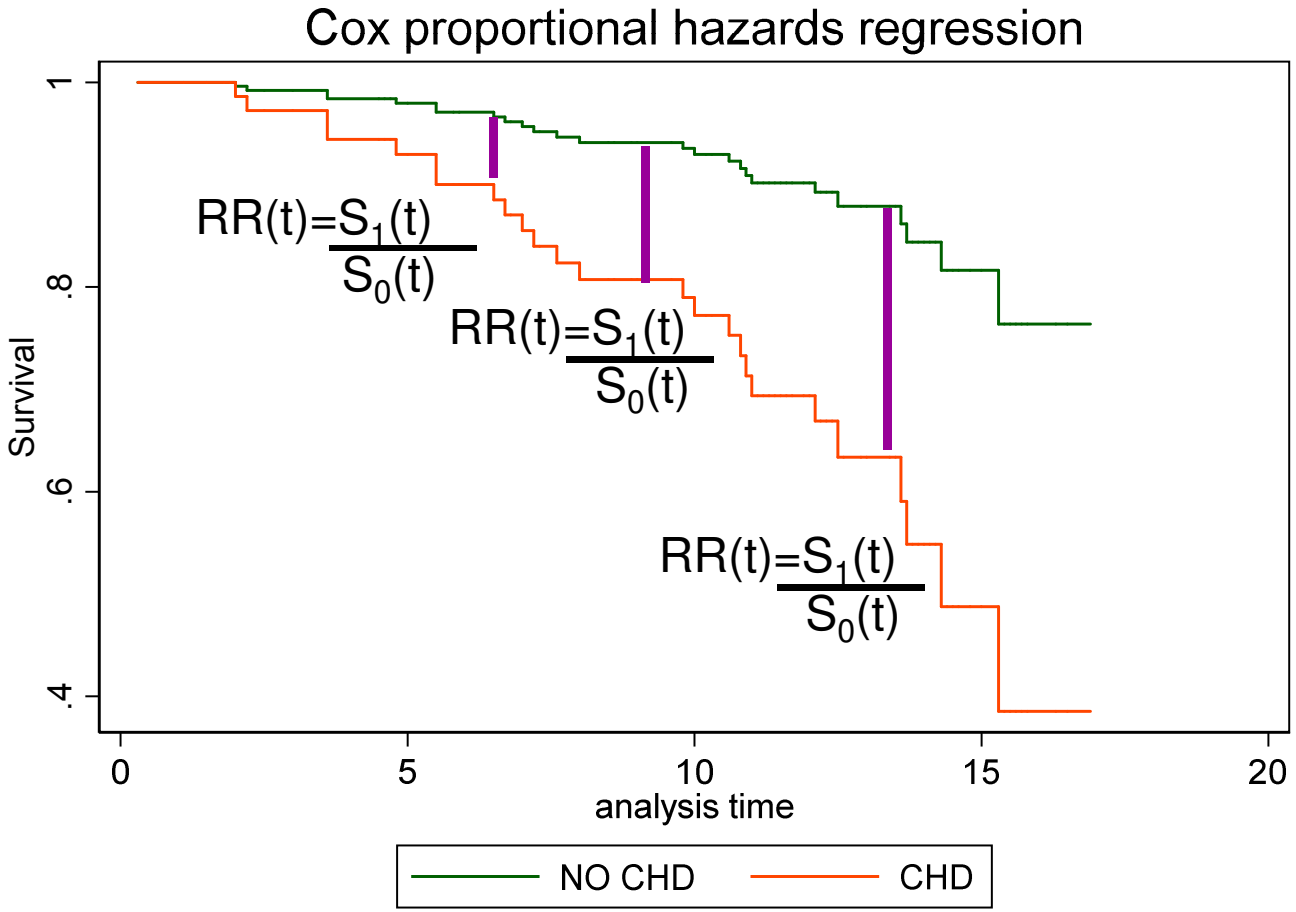
$\lambda(t)=\lim_{\Delta t\to 0}$ Prob(die in en $(t,t+\Delta t)$/alive at)$/\Delta t = f(t)/S(t)$

It is the speed of fall of the survival curve

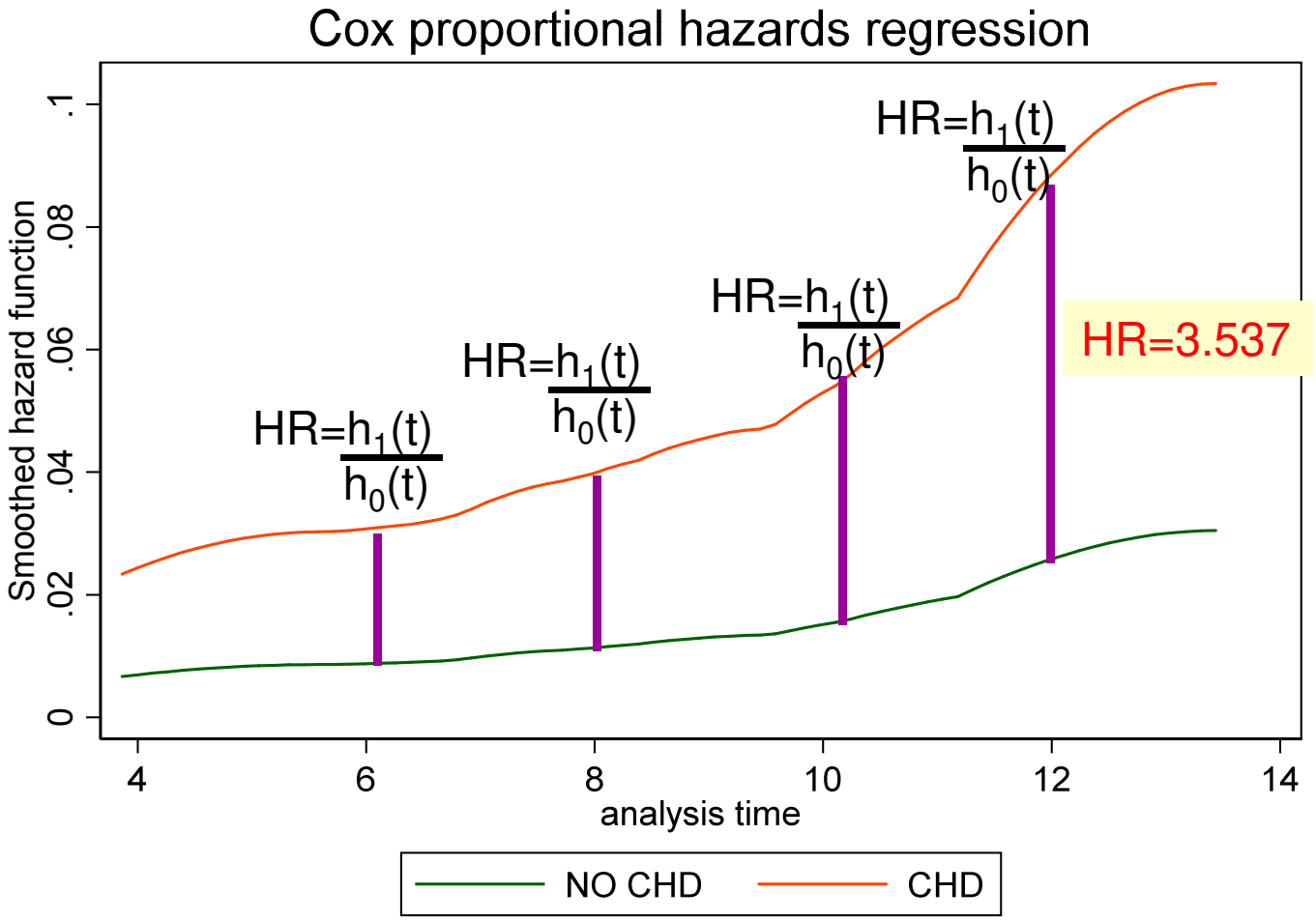
Hazard rate $\lambda(t)=h(t)$



Example survival curves



Hazard rate $\lambda(t)=h(t)$ & Hazard Ratio (HR)



Hazard Ratio (HR) vs Relative Risk (RR)

- HR is depending on time, but in a Cox model, HR is fixed an not dependent on time, is *fixed*.
- HR is a ratio of rates, RR is a ratio of probabilities
- So, HR is not an estimation of RR
- The direction of the relation is the same for both
- HR=2 must be interpreted as: The instantaneous rate at any time during follow up is twice for the exposed group
- The RR at any time of experience the event is not twice for the exposed group
- RR is not constant among time

Summary

- Risk is the conditional probability of an event given an exposure
- Relative Risk is a measure of the effect of an exposure
- RR>1 means excess and RR<1 means less
- OR is the ratio of ODDS, but it is only aproximate to RR for a low frequency event
- HR is used in survival analysis and it is not a R
- Be careful interpreting Effect measures

Any Question ?

References

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