بسم الله الرحمن الرحيم

Epidemiology

L VII

25-10-2023

MEASURES OF DISEASE FREQUENCY

Part 2

22-10-2023

Prof DR. Waqar Al – Kubaisy

Country, Other	Total Cases	New Cases	Total Deaths	New Deaths	Total Recovered	Active Cases	Serious, Critical	Tot Cases/ 1M pop	Deaths/ 1M pop	Total Tests	Tests/ 1M pop	Population
Morocco	327,528		5,396		275,158	46,974	1,007	8,832	146	3,814,442	102,861	37,083,615
Switzerland	304,593	+4,241	4,277	+55	211,500	88,816	524	35,092	493	2,592,950	298,735	8,679,774
Portugal	268,721	+3,919	4,056	+85	184,233	80,432	506	26,385	398	4,318,338	423,999	10,184,777
Austria	254,710	+4,377	2,577	+118	182,620	69,513	704	28,217	285	2,929,927	324,579	9,026,852
Sweden	225,560		6,500	+15	N/A	N/A	192	22,279	642	2,914,088	287,831	10,124,317
Nepal	224,078	+1,790	1,361	+24	204,858	17,859		7,637	46	1,681,299	57,299	29,342,758
Jordan	192,996	+4,586	2,380	+78	125,433	65,183	460	18,841	232	2,408,242	235,105	10,243,280
Ecuador	185,944		13,225		164,009	8,710	365	10,477	745	622,833	35,092	17,748,657
Hungary	181,881	+3,929	4,008	+117	44,020	133,853	638	18,847	415	1,528,302	158,365	9,650,510
UAE	161,365	+1,310	559	+5	150,261	10,545		16,238	56	15,960,104	1,606,023	9,937,659
Panama	155,658		2,973		137,004	15,681	146	35,853	685	838,981	193,246	4,341,525
Bolivia	144,034	+56	8,916	+9	119,548	15,570	71	12,273	760	353,955	30,160	11,735,888
Kuwait	140,795	+402	870	+2	133,407	6,518	75	32,778	203	1,062,076	247,254	4,295,477
Dominican Republic	139,111	+282	2,313	+2	113,134	23,664	172	12,773	212	687,292	63,106	10,891,021

Population at risk

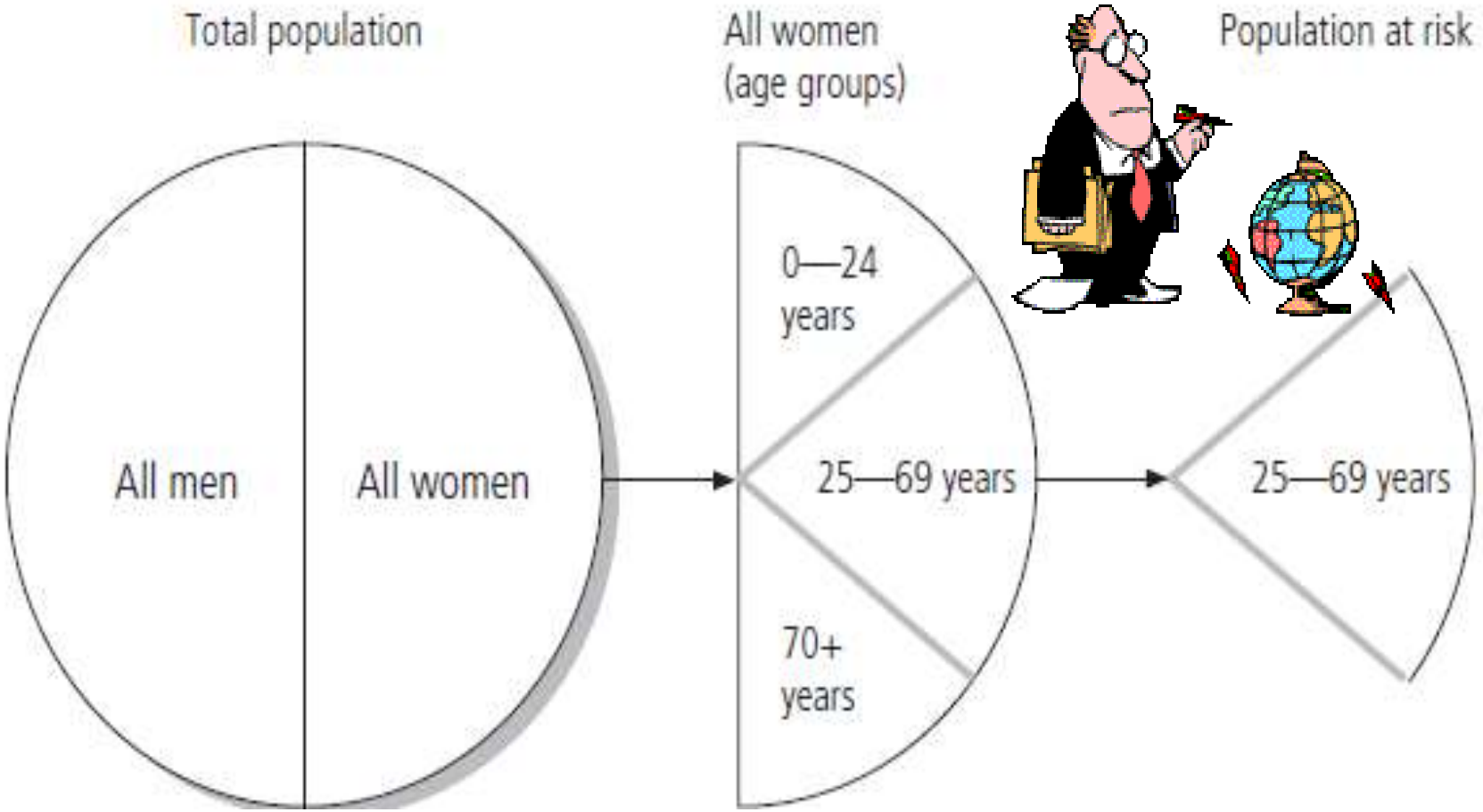
- The people who are susceptible to a given disease are called the population at risk, and can be defined by demographic, geographic or environmental factors.
- **An important factor in calculating measures** of disease frequency is **the correct estimate of the numbers of people under study.**
- **Ideally these numbers should only include people who are potentially susceptible to the diseases being studied.**

- **For instance, men should not be included when calculating the frequency of cervical cancer**

The population at risk is the group of people susceptible to develop a characteristic. For example when studying measles, the population at risk used for the calculation should be the children under five years of age, because measles is rare after that age. The population at risk is used as the denominator when calculating proportions or rates

Population at risk

Figure 2.1. Population at risk in a study of carcinoma of the cervix



2 Attack rate:

- **A specific form of incidence rate in which there is a limited period of risk as in:**
  - **cases of epidemics reflecting the virulence of the organisms.**

3 Secondary attack rate = $\frac{\text{№. of secondary cases}}{\text{№. of susceptible}} \times 100$

- This rate is used to **measure the ease of communicability** in case of communicable diseases
- The **length of incubation period** is important to identify the secondary cases.
- **Immune Individuals (whether due to natural infection or immunization) should be excluded from the denominator**

Prevalence

morbidity
- Incidence
- Prevalence
- Attack Rate

Prevalence

is the № of All cases of disease,, or condition, present at a particular time , in relation to the size of population from which it is drown.

Prevalence means ALL. (Old+ New)

Prevalence

quantifies the proportion of individuals in a population who have the disease at a specific time

Prevalence: in the **number of cases** of a disease present **in a defined population** at a given **point of time**
***Proportion of a population already affected by a particular disease at a particular time**

A study done on 1500 school children at Al-Karak , during 2022 found 20 with TB. By follow up during 2023 the number of students with TB was 28

- Incidence new cases only 2022 = 8

prevalence ?? 2022

prevalence ?? 2023

- Prevalence 2022 =

  20/1500x1000=13.33/1000population/year

- Prevalence 2023

  =28/1500X1000=18.66/1000population/year

Thus, prevalence can be thought of as the status of the disease in a population at a point in time and as such is also referred to as point prevalence

example,

visual examination survey conducted in Al Karak among individuals , 52 - 85 years of age, during 2022

310 of the 2477 persons examined had cataracts at the time of the survey. ???????

The prevalence of cataract in that age group was

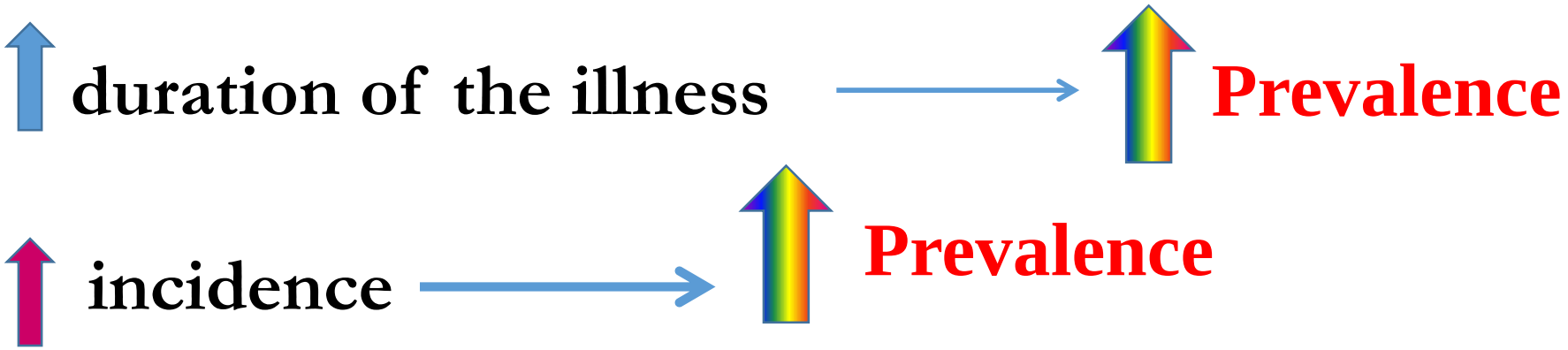
$$P = \frac{\text{№ of existing cases of a disease}}{\text{total population at risk at a given point in time}} \times 100$$

310 / 2477 X100 ,=12.5% prevalence of cataract among population aging 52 - 85 years in Al Karak during 2022

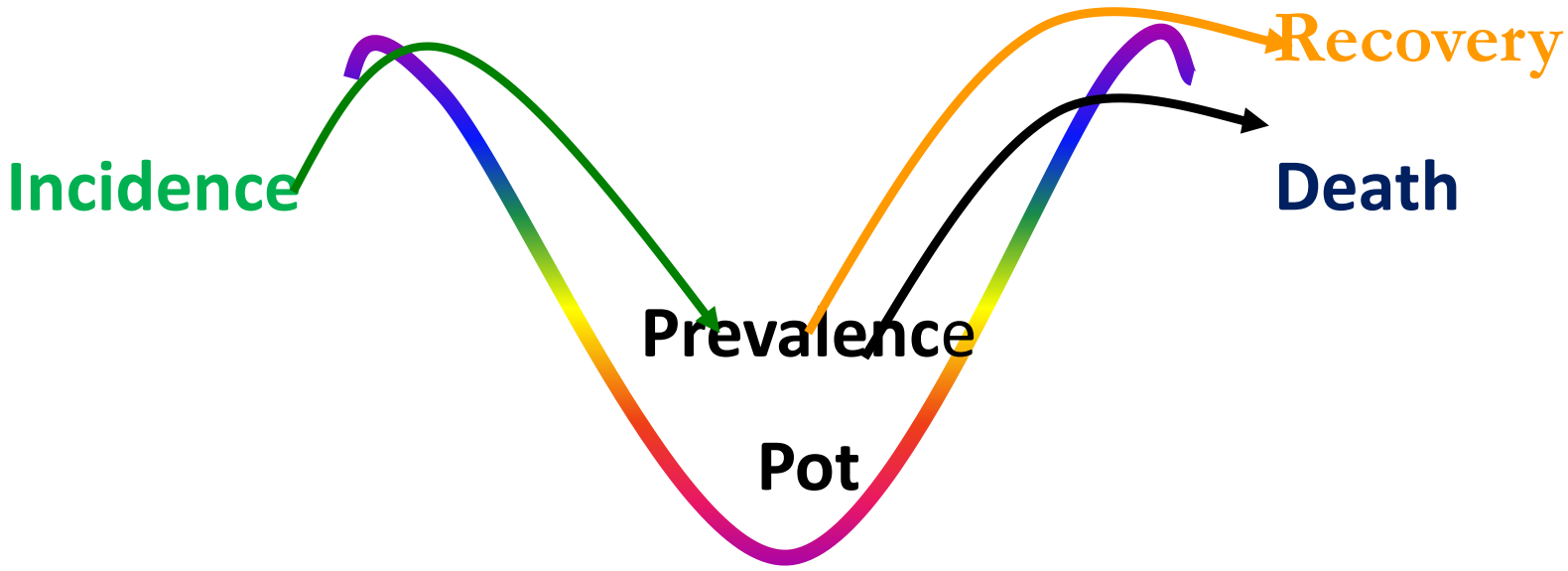
Prevalence is controlled by two elements

- No. of individuals who have been diseased in the past
- the length or duration of the illness.

Prevalence will vary in direct relation — Duration and Incidence



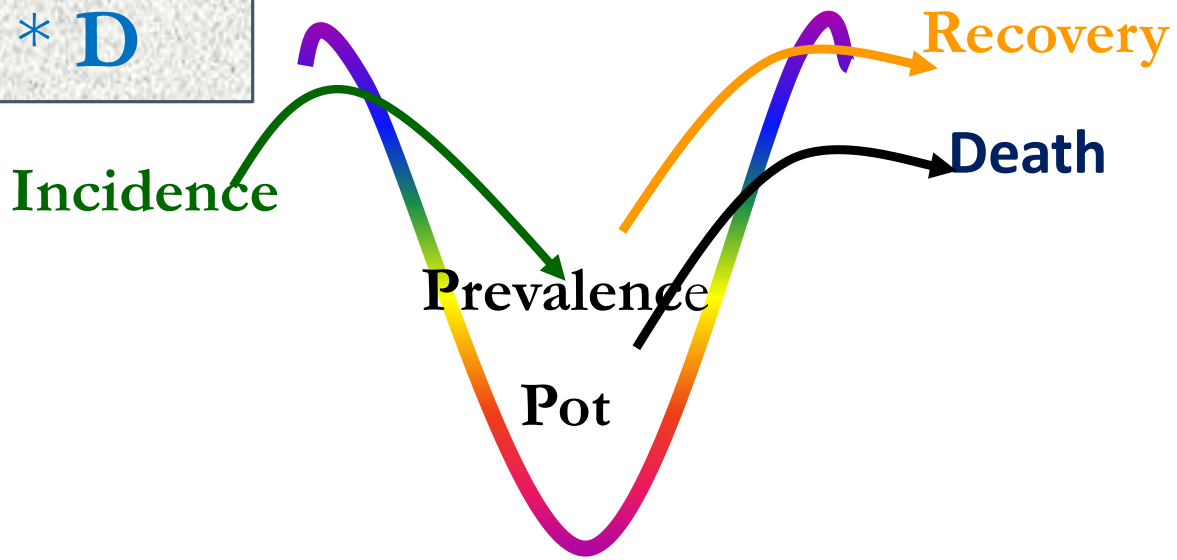
Relationship Between Incidence and Prevalence



Incidence is all new cases of the disease.
They enter the prevalence pot.
If no cases leave the prevalence pot, it continues to Fill, adding to the number of cases unless
some cases either recover or die reducing the prevalence.

Relationship Between Incidence and Prevalence

Prevalence = I * D



I = incidence

D = duration

Prevalence will vary in **direct relation** **Duration and Incidence**

Increased by:

- longer duration of disease
- prolongation of life without cure
- Increase in the incidence of the disease
- Immigration of cases
- out migration of healthy people
- improved diagnosis
- Better reporting

Prevalence

Decreased by:

-short duration of disease

-high case-fatality rate from disease

decrease incidence

in-migration of healthy people

-Emigration of cases

-improved cure rate

-Immunization prevents new cases

-Prolongation of non diseased & healthy population

Types of Prevalence

1. Period Prevalence
2. Point Prevalence

A study done on 1500 school children at Al Karak during 2022 found 20 with TB. By follow up of school children during 2023 the number of students with TB was 28

prevalence 20 2022

prevalence 28 2023

Period prevalence:

Number of cases that occur **during a specified period of time**

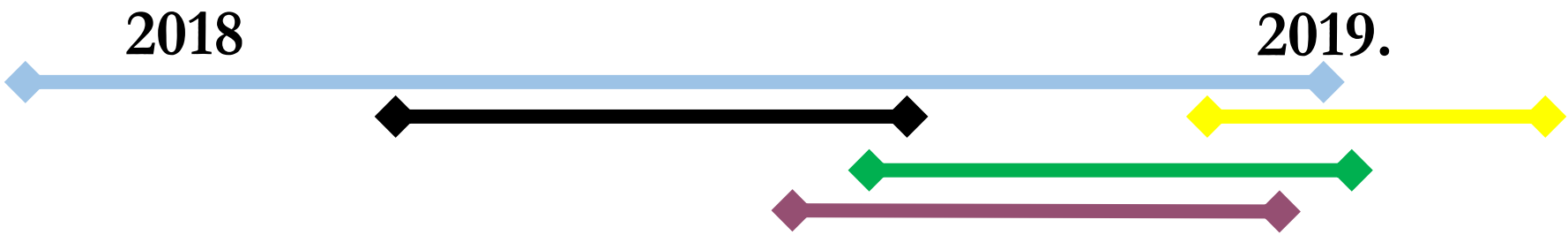
2022 –2023

Period Prevalence

includes the total individuals who had have the dis. of concern at any time during the specific time period 2018-2019. S0

Period .P

started at a point of time and stop at a point of time included all persons with the dis.



- that have carried over from the previous time period or
- have become ill at the end of the time period

- New cases (incidence) occurring within the time period
- recurrences during a succeeding time period

Point Prevalence

is the No. of cases of individuals with a disease, condition, or illness at a single specific point in time
The No. of existing cases at point in time.

$$P = \frac{\text{№ of existing cases of a disease}}{\text{total population at risk at a given point in time}} \times 100$$

Point .P

measure the presence of the disease or condition on a single short – time point

example

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The prevalence of cataract in that age group was

310 / 2477 X100 ,=12.5%

prevalence of cataract among population aging 52 - 85 years in Al Karak during 2022

Point prevalence:

Number of cases present at a specified moment of time 2022

Period Prevalence =

$$\frac{\text{№. of existing cases of a disease within time period}}{\text{Average study population within time period}} \times 1000$$

Point Prevalence =

$$\frac{\text{№. of existing cases of the disease at a point in time}}{\text{Total study population at a point in time}} \times 1000$$

Factors affecting the prevalence and incident rate:

1. In and out migration of susceptible or of the resistant (immune)
2. Changes in the environmental quality (air and water sanitation)
3. Changes in the social customs (tobacco smoke) and travel abroad.
4. Changes in the reporting system.
5. Changes in the preventing program (immunization)

Mortality rates

- Analogous to incidence but refers to the process of dying rather than the process of becoming ill.

Crude death rate: =

№ of deaths in certain population in a year & locality

№ of population in the same year and locality

- The crude death rate is
- calculated for the total population irrespective of age, sex, or any other characteristics of importance in determining death
- If the population is growing or shrinking, use the population size at the midpoint of the time interval as
- an estimate of the average population at risk.
- E.g. death rate for 1993, use population of July 1st 1993 for the denominator.

Country, Other	Total Cases	New Cases	Total Deaths	New Deaths	Total Recovered	Active Cases	Serious, Critical	Tot Cases/ 1M pop	Deaths/ 1M pop	Total Tests	Tests/ 1M pop	Population
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2. Age and sex specific death rate:

A. Age Specific Death Rate:

$$\frac{\text{No. of persons dying in a certain age and a certain year and area}}{\text{Total № of the same age group in the same year and same area}} \times 1000$$

Example of age specific mortality rates::

- **Infant mortality rate=**

$$\frac{\text{Total № of deaths aged from zero to less than one year during a year and a given locality}}{\text{Total № of live births in the same Year and locality}} \times 100$$

B. Sex Specific Death Rate:

$$\frac{\text{№ of deaths in a certain sex during a year in a certain locality}}{\text{Total № of the same sex during the same year \&locality}} \times 1000$$

3. Cause Specific Mortality Rate=

Total № of deaths due to a certain cause during a year and a given locality / Estimated midyear population during the same year & locality X 100

4. Case Fatality Rate=

Total №. of deaths from certain disease in specific time & place / Total № of those having the same disease in the same time &place X1000

5. Proportionate Mortality Rates=

Total № of deaths due to a certain cause during a year in given locality / Total № of deaths from all causes during the same year & locality X1000

Uses of Morbidity and Mortality Rates

1) Case fatality rate is used for measuring the pathogenesis and virulence of agent of the disease.
2) Secondary attack rate is used to measure the ease of communicability of communicable diseases.
3) Morbidity and mortality rates can be used to allow comparison of disease frequencies and deaths in different population and all over years

Uses of Morbidity and Mortality Rates

4) Comparison of two rates result in a ratio (relative risk or risk ratio) e.g.:

- If the incidence rate of diarrheal disease among bottle fed (a)is 20 % while among breast fed (b)is 2 %,
- then the relative risk or risk ratio = 20/2= 10,
- i. e. the bottle fed children have a 10 times greater risk of developing diarrheal disease than the breast fed.

interpretation

Relative risk = incidence a / incidence b

If both are equal then it is 1 → (no risk)

If a > b then it is more than one, → it is risky

If a < b then it is less than one, → protective

Uses of Morbidity and Mortality Rates

5. Difference between two incidence rates is called attributable risk=

Incidence of disease rate among exposed- incidence of disease rate among non-exposed X100

Incidence rate of disease among exposed

In the previous example: Attributable risk = $\frac{20-2}{20}$ X100

= 90%child/year (this is the risk of diarrhea attributing to bottle feeding.

interpretation

Attributable risk = $\frac{\text{incidence a - incidence b}}{\text{incidence a}}$

If both are equal then it is 0 (no risk)

If a > b then it is more than zero, it is risky

If a < b then it is less than zero, protective

example

In a study in the United States of America, the incidence rate of stroke was measured in a population of women who were 30–55 years of age and free from coronary heart disease, stroke and cancer in 1976. A total of 274 stroke cases were identified in eight years of follow-up .

Never smoked : 70 cases among 395 594

Ex-smoker : 65 cases among 232 712

Smoker: 139 cases among 280 141

Calculate

-Incidence for each group

-Relative for smoking

-attributable risk for smoking (ignore ex-smoker

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Smoking category	Number of cases of stroke	Person-years of observation (over 8 years)
Never smoked	70	395 594
Ex-smoker	65	232 712
Smoker	139	280 141
Total	274	908 447

Table 2.4. Relationship between cigarette smoking and incidence rate of stroke in a cohort of 118 539 women[13]

Smoking category	Number of cases of stroke	Person-years of observation (over 8 years)	Stroke incidence rate (per 100 000) person-years)
Never smoked	70	395 594	17.7
Ex-smoker	65	232 712	27.9
Smoker	139	280 141	49.6
Total	274	908 447	30.2

Relative risk = 49.6/ 17.7 = 2.80

Attributable risk= $\frac{49.6 - 17.7}{49.6}$ X100= 46.31 %

Risk difference (attributable risk)

- the risk difference tells you the amount of disease that potentially could be prevented if the risk factor could be eliminated
- Attributable risk can be useful as a measure of the public health impact of a particular exposure

Population Attributable Risk (PARs)

PAR tells us about the amount of extra disease occurring in the exposed group because of exposure.

- How much of disease in the whole community can be attributed to the exposure

$$PAR = I_T - I_0$$

I_T is the incidence rate in the population

I_0 is the incidence rate in the unexposed group

Population Attributable Risk(PARs)

$$PAR = I_T - I_0$$

- **PAR estimate the excess rate of disease in the total study population of exposed and non-exposed individuals that is attributable to the exposure.**

PAR, helps determine which exposures have the most relevance to the health of a community

❑ Population AR Versus AR

AR tell us how much disease in exposed group can be attributed to exposure

PAR: how much disease in the whole population can be attributed to exposure

❑ The population attributable-risk percent (PAR%)

PAR% expresses the **proportion of disease in the study population that is attributable to the exposure and thus could be eliminated (removed) if the exposure were eliminated**

$$PAR\% = \frac{PAR}{I_T} \times 100$$

RISK ESTIMATES(Odds ratio)

Odds ratio (OR)

Results of a study can be presented in a **2x2 table** as follow

	Case (diseases)	control	Total
Exposed	a	b	a+b
Unexposed	c	d	c+d
Total	a+c	b+d	N

OR= a/(a+c) ÷ b/(b+d)= a/c ÷ b/d =ad/bc

c/(a+c) d/(b+d)

which is the ratio of the odds of exposure among the cases to the odds of exposure among the controls.

Example:

A study was conducted to test the association between smoking and cancer of the pancreas. Of the 100 cancer pancreas cases 60 of them were smokers , while of the 400 have no cancer pancreas, 100 were smokers. Calculation of the OR from

Table 1. smoking and ca pancreas

Exposure	Ca pancr	no Ca pancr	Total
Smokers	60 (a)	100 (b)	160
Non Smokers	40 (c)	300 (d)	340
Total	100	400	500

$$OR = \frac{60 \times 300}{100 \times 40}$$

$$OR = 4.5$$

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


THANK YOU ALL

Example

Data from a cohort study of oral contraceptive (OC) use and bacteriuria among women aged 16-49 years

	Bacteriuria		
	Yes	No	Total
OC use			
Yes	27	455	482
No	77	1831	1908
Total	104	2286	2390

Data from D. A. Evans et al., Oral contraceptives and bacteriuria in a community-based study. *N. Engl. J. Med.* 299:536, 1978.

The population attributable risk of bacteriuria associated with OC use can therefore be calculated as:

PAR=I_T - I_0= 104/2390 - 77/1908 == 316/10^5/year

Thus, if OC use were stopped, the-excess annual incidence rate of bacteriuria that could be eliminated among women in this study is 316 per 100,000.

$$\text{Relative Risk } (RR) = \frac{27/482}{77/1908} = 1.4$$

example

The 11587(6213 females& 5365 males) adults ,concerning a NCD during 2020 they found , 12 female and 24 males having NCDs. One year later in 2021, the number of NCDs were 16 and 33 among female and male respectively
Calculate the prevalence and incidence rates,
If male sex was the risk factor what is the relative and attributable risks for this factor.

Incidence among males
Incidence among females
Total incidence
Relative risk
Attributable risk
PAR
PAR%

Prevalence among males
Prevalence among females
Total prevalence

example

The following table shows the data concerning a NCD among adults during a year in a certain community. Calculate the prevalence and incidence rates,
If male sex was the risk factor what is the relative and attributable risks for this factor.

	New case	Old case	Total population
females	4	12	6213
males	9	24	5365
Both sexes	13	36	11578

Incidence among males
Incidence among females
Total incidence
Relative risk
Attributable risk

Prevalence among males
Prevalence among females
Total prevalence

(for prevalence old + new case)