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'IDB Manual for the calculation of Incidence Rates and Confidence Intervals'

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Contents:

A. Objective

This manual provides documentation and description of the method to calculate IDB Incidence Rates and National Estimates based on national Hospital Discharge Register and IDB data. The methodology is constructed for the:

a. Calculation of overall national Incidence Rate (IR)
b. Calculation of one year age group IRs
c. Calculation of five year age group IRs
d. Calculation of sex group IR

Note (a): the underlying assumptions for this method are:

(1) The calculation of Incidence Rates is based on the injuries treated on Emergency Departments (both admitted and non admitted cases). The minor injuries[1], not referring to an Emergency Unit, are not included.

(2) The percentage of admitted IDB cases (ADM) on the total of the National Hospital Discharge Register injury cases (DIS) (called Extrapolation Factor or RAT) is assumed to be equal to the percentage of non admitted IDB cases (No ADM) on the total national non admitted cases (No DIS). Therefore it serves as an estimate of the percentage of all IDB cases (ALL) on the total of the National injury cases – admitted and not-admitted cases (EST).

$$Rat = (ADM / DIS) * 100 \cong (ALL / EST) * 100$$

where:

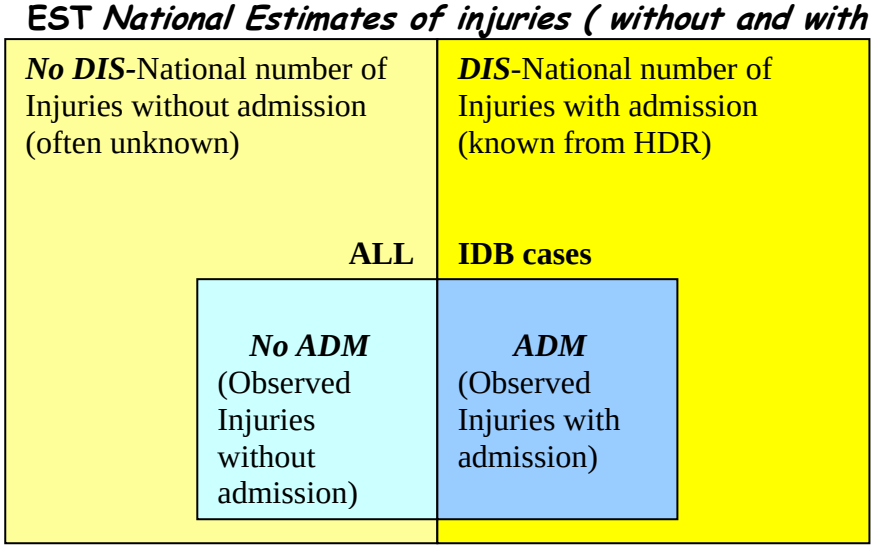
Acronym	Description	Source
Input data		
Adm	admitted IDB cases by sex and age Treatment code = 5 or 8	IDB Data
Dis	National Hospital Discharge Register injury cases by sex and age	National Hospital Discharge Register data: ICD-10 Injury Chapter (incl. explicit range)
All	all IDB cases by sex and age	IDB Data according to the IDB Coding Manual V.1.0 ("All Injuries")

[1] Selected minor injuries are treated at General Practitioner level in accordance to the national Health Care System of each Member State.

Pop	National Resident Population data by sex and age	National Population Register
Calculation data		
Rat	IDB Sample ratio	
Est	National Estimates	
IR	National Incidence Rate	

The following boxes (Figure 1) illustrate the correspondences between the IDB entities (ALL of ADM and noADM) and the related IDB National estimation entities (EST of DIS and noDIS).

Figure 1: Representation of relationship between IDB cases and IDB National Estimations.



B. Calculation procedure for Incidence Rate [IR]:

The following description explains the procedure recommended by the IDB Network Quality Task Force for the calculation of IR for the whole population and for age and/or sex groups.

***Note* (b):** General recommendation for a consistent age classification:

- Single year version

Some countries provided data up to a certain age (either 99 or 100 years). Therefore, the estimation of Rat for this last age group 95+ could be a little bit overestimated, since we miss population at risk at the denominator.
The provided solution only considers the population under 101, i.e. the population of age group 95+ corresponds to the population of age group 95-100.

- Five year version

Some countries provided data up to a certain age (either 99 or 100 years). Therefore, the estimation of Rat for this last age group 90+ could be a little bit overestimated, since we miss population at risk at the denominator.
The provided solution only considers the population under 101, i.e. the population of age group 90+ corresponds to the population of age group 90-100.

1. IDB SAMPLE RATIO CALCULATION [RAT] : EXTRAPOLATION FACTOR

1.1 Crude Sample Ratio

The Rate is calculated using the following formula:

$$Rat = (Adm / Dis) * 100$$

1.2 Sex-specific Sample Ratio

The Rate per sex is calculated using the following formula:

$$Rat\_sex = (Adm\_sex / Dis\_sex) * 100$$

1.3 Age-specific Sample Ratio (single year version)

The Rate per age is calculated using the following formula:

$$Rat\_age = (Adm\_age / Dis\_age) * 100$$

1.4 Age-group specific Sample Ratio (five year version)

The Rate per age group is calculated using the following formula:

$$Rat\_agegr = (Adm\_agegr / Dis\_agegr) * 100$$

1.5 Sex and age-specific Sample Ratio (single year version)

The Rate per sex and age is calculated using the following formula:

$$Rat\ sex, age = (Adm\ sex, age / Dis\ sex, age)) * 100$$

1.6 Sex and age-group specific Sample Ratio (five year version)

The Rate per sex and age group is calculated using the following formula:

$$Rat\ sex, agegr = (Adm\ sex, agegr / Dis\ sex, agegr)) * 100$$

1.7 Examples

Example 1: Calculation of the Specific Sample Ratio for Austria for males aged 28 in 2005.
Adm (m, 28) = 10
Dis (m, 28) = 996
Rat (m, 28) ≈ 1.00%.

Example 2: Calculation of the Specific Sample Ratio for Austria for males aged between 25 and 29 in 2005.
Adm (m, 25-29) = 71
Dis (m,25-29) = 4980
Rat (m, 25-29) ≈1.43%.

2. ESTIMATION OF THE NUMBER OF CASES AT NATIONAL LEVEL [EST]

The population data is distributed by year, country, sex and age.

2.1 Estimation of the number of cases at national level

The extrapolation of the number of cases at national level is performed using the following formula:

$$Est = (All / Rat)$$

2.2 Estimation of the number of cases at national level per sex

The extrapolation of number of cases at national level per sex is performed using the following formula:

$$Est\_sex = (All\_sex / Rat\_sex)$$

2.3 Estimation of the number of cases at national level per age (single year version)

The extrapolation of the number of cases at national level per age is performed using the following formula:

$$Est\_age = (All\_age / Rat\_age)$$

2.4 Estimation of the number of cases at national level per age group (five year version)

The extrapolation of the number of cases at national level per age group is performed using the following formula:

$$Est\_agegr = (All\_agegr / Rat\_agegr)$$

2.5 Estimation of the number of cases at national level per sex and per age (single year version)

The extrapolation of the number of cases at national level per sex and per age is performed using the following formula:

$$Est\ sex,age = (All\ sex,age / Rat\ sex, age)$$

2.6 Estimation of the number of cases at national level per sex and per age group (five year version)

The extrapolation of the number of cases at national level per sex and per age group is performed using the following formula:

$$Est\ sex,agegr = (All\ sex, agegr / Rat\ sex, agegr)$$

2.7 Examples

Example 1: Calculation of the number of accidents in Austria for males aged 28 in 2005.

All (m, 28) = 60
Rat (m, 28) ≈1.00%
Est_Nat (m, 28) ≈ 6000

Example 2: Calculation of the number of accidents in Austria for males aged between 25 and 29 in 2005.

All (m, 25-29) = 335
Rat (m, 25-29) ≈1.43%
Est_Nat (m, 25-29) ≈ 23.427

Example 3: Calculation of the number of accidents in Austria for females aged over 89 in 2005.

All_Nat (f, 89+) = 94

Rat (f, 89+) ≈1.37 %

Est_Nat (f, 89+) ≈ 6861

3. INCIDENCE RATE CALCULATION [IR]

3.1 Crude Incidence Rate

The Incidence Rate is calculated using the following formula:

$$IR = (Est / Pop) * 1000$$

3.2 Sex-specific Incidence Rate

The Incidence Rate per sex is calculated using the following formula:

$$IR\_sex = (Est\_sex / Pop\_sex) * 1000$$

3.3 Age-specific Incidence Rate (single year version)

The Incidence Rate per age is calculated using the following formula:

$$IR\_age = (Est\_age / Pop\_age) * 1000$$

3.4 Age-group specific Incidence Rate (five year version)

The Incidence Rate per age group is calculated using the following formula:

$$IR\_agegr = (Est\_agegr / Pop\_agegr) * 1000$$

3.5 Sex and age-specific Incidence Rate (single year version)

The Incidence Rate per sex and age is calculated using the following formula:

$$IR\ sex, age = (Est\ sex, age / Pop\ sex, age)) * 1000$$

3.6 Sex and age-group specific Incidence Rate (five year version)

The Incidence Rate per sex and age group is calculated using the following formula:

IR sex, agegr = (Est sex, agegr / Pop sex, agegr)) * 1000

3.7 Examples

Example 1: Calculation of the Specific Incidence Rate for Austria for males aged 28 in 2005.

Est (m, 28) = 6000

Pop (m, 28) = 51159

IR (m, 28) ≈ 117.3‰

Example 2: Calculation of the Specific Incidence Rate for Austria for males aged between 25 and 29 in 2005.

Est (m, 25-29) = 23427

Pop (m, 25-29) = 261672

IR (m, 25-29) ≈ 89.5‰

4. STANDARDIZED INCIDENCE RATE CALCULATION [SIR]

The Standardized Incidence Rate is calculated using the following formula:

$$SIR = \frac{\sum_i IR_{i*} Pop_i^S}{\sum_i Pop_i^S} \qquad \text{(F.1)}$$

With:

i = 1,…,k where k is the number of age groups

IR_i = specific Incidence Rate of a certain sex within the i^{th} group age

pop_i^s = total of standard population of a certain sex within the i^{th} group age

C. Calculation of Confidence Intervals

The Confidence Interval of the crude incidence rate is calculated using the score interval (Agresti & Coull -1998) [1]:

CI AGRESTI-COULL : ***(F.2)***

Lower limit =

$$L.L. = \frac{\hat{p} + \frac{z^2_{\alpha/2}}{2n} - z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n} + \frac{z^2_{\alpha/2}}{4n^2}}}{1 + z^2_{\alpha/2}/n}$$

Upper limit =

$$U.L. = \frac{\hat{p} + \frac{z^2_{\alpha/2}}{2n} + z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n} + \frac{z^2_{\alpha/2}}{4n^2}}}{1 + z^2_{\alpha/2}/n}$$

where

X denotes a binomial variable[2]

$X_i = EST_i =$ estimation of injuries per sex and age group at national level

n sample size by sex and age group

$n_i = POP_i =$ population per sex and age group at national level

$p = X / n$ denotes the sample proportion

$p_i = IR_i = EST_i / POP_i$ = estimation of incidence rate per sex and age group at national level

$Z_{\alpha/2}$ = denotes the $1-\alpha/2$ quantile of the standard normal distribution (i.e $z_{0.05/2}=1.96$)

and s.e. = $\sqrt{\frac{\frac{p(1-p)}{n}+\frac{z^2}{4n^2}}{(1+\frac{z^2}{n})^2}}$ represents the standard error of the IR.

The coefficient of Variation of IR is given by the following ratio:

$$C.V. = \frac{s.e.}{IR}$$

Example 1

Calculation of the Confidence Interval of the Crude Incidence Rate for Austria for males aged between 25 and 29 in 2005.

Step 1: Calculation of the sex and age-group specific Sample Ratio (five year version)

Adm (m, 25-29) = 71
Dis (m, 25-29) = 4980
Rat (m, 25-29) ≈1.43%.

Step 2: Estimation of the number of cases to national level per sex and per age group (five year version)

All (m, 25-29) = 335
Rat (m, 25-29) ≈1.43%
Est_Nat (m, 25-29) ≈ 23.427

Step 3: Calculation of the sex and age-group specific Incidence Rate (five year version)

Est (m, 25-29) = 23427
Pop (m, 25-29)= 261672
IR (m, 25-29) ≈ 89.5‰

Step 4: Calculation of 95% Confidence Intervals for the sex and age-group specific Incidence Rate (five year version)

1-α = 0.95

$z_{\alpha/2}$ = 1.96

$^{M}P_{25\text{-}29} = {}^{M}IR_{25\text{-}29}$ = 89.5

$^{M}n_{25\text{-}29}$ = 261672

Using the formula (F.2), we obtain the following Confidence Interval:

IR	89.5
s.e.	0.56
C.V.	0.006
Low*1,000	88.4
Up*1,000	90.6
CI	**88.4-90.6**

AGE-GENDER (DIRECT) STANDARDISED INCIDENCE RATE [SIR]

Standard error of IR

$$s.e. = \sqrt{\sum_i \frac{Injuries_i}{Pop_i^2} * \left(\frac{Pop_i^S}{Pop^S}\right)^2}$$

Coefficient of Variation of IR

$$C.V. = \frac{s.e.}{SIR}$$

The Confidence Interval of the age-gender (direct) standardised incidence rate is calculated using the following formula (C.L.Chiang - 1961) :

Lower limit = $$SIR - z_{1-\alpha/2}\sqrt{\sum_i \frac{Injuries_i}{Pop_i^2} * \left(\frac{Pop_i^S}{Pop^S}\right)^2}$$ ***(F.3)***

Upper limit = $$SIR + z_{1-\alpha/2}\sqrt{\sum_i \frac{Injuries_i}{Pop_i^2} * \left(\frac{Pop_i^S}{Pop^S}\right)^2}$$ ***(F.3)***

With:

i = 1,…,k where k is the number of age groups
$Injuries_i$ = total of cases of a certain sex within a group age
pop_i = total of population of a certain sex within a group age
pop_i^s = total of standard population of a certain sex within a group age
POP^s= total of standard population
$z_{1-\alpha/2}$ = denotes the 1-α quantile of the standard normal distribution (i.e $z_{1-0.05/2}$=1.96)

Example 2

Calculation of the Confidence Interval of the Standardized Incidence Rate for Austria in 2005.

Step 1: Calculation of SIR according to the Formula (F.1)

Step 2: Calculation of 95% Confidence Intervals for the Standardized Incidence Rate (five year version) according to the formula (F.3)

1-α = 0.95
$z_{\alpha/2}$ = 1.96

Using the formula (F.3) we obtain the following Confidence Interval:

SIR	80.0
s.e.	0.15
C.V	0.002
Low*1,000	79.7
Up*1,000	80.3
CI	**79.7-80.3**

D. References and Glossary

(A) REFERENCE

(1) Agresti A, Coull BA. Approximate is better than ''Exact'' for interval estimation of binomial proportions. Am Stat 1998; 52:119-26.

(B) GLOSSARY

(2) A Binomial Variable represents a proportion of the number of "successes" (in this case injuries) on the total of tests performed (in this case the population at risk). Hence the range of binomial variable is [0,1].

E. Quick reference and calculation example

Quick instruction

RAT Sex and age-group specific Sample Ratio (five year version)
The Rate per sex and age group is calculated using the following formula:

Rat sex, agegr = (Adm sex, agegr / Dis sex, agegr)) * 100

EST Estimation of the number of cases to national level per sex and per age group (five year version)

The estimation of the number of cases at the national level per sex and per age group is performed using the following formula:

Est sex,agegr = (All sex, agegr / Rat sex, agegr)

IR CRUDE INCIDENCE RATE Sex and age-group specific Incidence Rate (five year version)

The Incidence Rate per sex and age group is calculated using the following formula:

IR sex, agegr = (Est sex, agegr / Pop sex, agegr)) * 1000

Confidence Interval of IR
The Confidence Interval of the crude incidence rate is calculated using the score interval (Agresti & Coull -1998) [1]:

CI AGRESTI-COULL : *(F.2)*

Lower limit =

$$L.L. = \frac{\hat{p} + \frac{z^2_{\alpha/2}}{2n} - z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n} + \frac{z^2_{\alpha/2}}{4n^2}}}{1 + z^2_{\alpha/2}/n}$$

Upper limit =

$$U.L. = \frac{\hat{p} + \frac{z^2_{\alpha/2}}{2n} + z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n} + \frac{z^2_{\alpha/2}}{4n^2}}}{1 + z^2_{\alpha/2}/n}$$

Where:

X denotes a binomial variable(2)

$X_i = EST_i =$ estimation of injuries per sex and age group at national level

n sample size by sex and age group

$n_i = POP_i =$ population per sex and age group at national level

p = X / n denotes the sample proportion

$p_i = IR_i = EST_i / POP_i$ = estimation of incidence rate per sex and age group at national level

$Z_{\alpha/2}$ = denotes the 1-α quantile of the standard normal distribution (i.e $z_{0.05/2}$=1.96)

SIR (DIRECT) STANDARDIZED INCIDENCE RATE

The Standardized Incidence Rate is calculated using the following formula:

$$SIR = \frac{\sum_i IR_{i*} Pop_i^S}{\sum_i Pop_i^S}$$

Confidence Interval of SIR

The Confidence Interval of the age-gender (direct) standardised incidence rate is calculated using the following formula (C.L.Chiang - 1961) :

$$CI = SIR \pm Z_{1-\alpha/2} * \sqrt{[\ \sum_i Injuries_i / pop_i^2 \ * \ (pop_i^{stand} / POP^{stand})^2\ ]}$$

(F.3)

Lower limit = $$SIR - z_{1-\alpha/2}\sqrt{\sum_i \frac{Injuries_i}{Pop_i^2} * \left(\frac{Pop_i^S}{Pop^S}\right)^2}$$

Upper limit = $$SIR + z_{1-\alpha/2}\sqrt{\sum_i \frac{Injuries_i}{Pop_i^2} * \left(\frac{Pop_i^S}{Pop^S}\right)^2}$$

With:

i = 1,…,k where k is the number of age groups

$Injuries_i$ = total of cases of a certain sex within a group age

pop_i = total of population of a certain sex within a group age

pop_i^s = total of standard population of a certain sex within a group age

POP^s= total of standard population

$z_{1-\alpha/2}$ = denotes the 1-α quantile of the standard normal distribution (i.e $z_{1-0.05/2}$=1.96)

Specific example

Calculation of Crude and Standardized Incidence Rate and Confidence Interval for Austria. Male. 2005

Table 1. Calculation of Crude and Standardized Incidence Rate and 95% Confidence Interval for Austria. Males. 2005

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(L)	(M)	(N)	(O)	(P)
	Austria		*crude rate and 95% CI*					*standardized rate and 95% CI*						
Age group	Male	Male	Male					European Standard*						
	EST	Pop	IR	s.e.	C.V.	Lower Confidence Limit	Upper Confidence Limit	*pop_s*	*pop_s*IR*	*SIR*	s.e.	C.V.	Lower Confidence Limit	Upper Confidence Limit
0-4	19010	204912	92,8	0,64	0,007	91,5	94,0	80	7422		0,003			
5-9	23390	219641	106,5	0,66	0,006	105,2	107,8	70	7454		0,002			
10-14	32010	248527	128,8	0,67	0,005	127,5	130,1	70	9016		0,003			
15-19	29660	252013	117,7	0,64	0,005	116,4	119,0	70	8238		0,002			
20-24	23370	267160	87,5	0,55	0,006	86,4	88,6	70	6123		0,002			
25-29	23427	261672	89,5	0,56	0,006	88,4	90,6	70	6267		0,002			
30-34	19410	287515	67,5	0,47	0,007	66,6	68,4	70	4726		0,001			
35-39	20960	348761	60,1	0,40	0,007	59,3	60,9	70	4207		0,001			
40-44	20530	360392	57,0	0,39	0,007	56,2	57,7	70	3988		0,001			
45-49	16960	311619	54,4	0,41	0,007	53,6	55,2	70	3810		0,001			
50-54	12020	253834	47,4	0,42	0,009	46,5	48,2	70	3315		0,001			
55-59	14110	242547	58,2	0,48	0,008	57,3	59,1	60	3490		0,001			
60-64	12640	214729	58,9	0,51	0,009	57,9	59,9	50	2943		0,001			
65-69	11110	195627	56,8	0,52	0,009	55,8	57,8	40	2272		0,000			
70-74	12250	134675	91,0	0,78	0,009	89,4	92,5	30	2729		0,001			
75-79	9030	112495	80,3	0,81	0,010	78,7	81,9	20	1605		0,000			
80-84	7720	67621	114,2	1,22	0,011	111,8	116,6	10	1142		0,000			
85-89	2840	24117	117,8	2,08	0,018	113,8	121,9	5	589		0,000			
90+	1520	11498	132,2	3,16	0,024	126,1	138,5	5	661		0,000			
Total	**312040**	**4019355**	**77,6**	**0,13**	**0,002**	**77,4**	**77,9**	**1000**	**79997**	**80,0**	**0,15**	**0,002**	**79,7**	**80,3**

Legend:

Values to be inputted: Columns (A), (B)

Calculated values:

(C): Crude Incidence Rate [IR] = (A) / (B)

(D)= Standard Error =

=((((C5*(1000-C5))/B5)+($Z_{\alpha/2}$^2/(4*B5^2)))/(1+($Z_{\alpha/2}$^2/B5))^2)^0.5

(E)= Coefficient of Variation = (D)/(C)

(F): Lower Confidence Interval of Crude IR = *(see Formula F.2)*

= ((2*B*A+($Z_{\alpha/2}$ ^{2})*B –
(((2*A*C+($Z_{\alpha/2}$ ^{2})*B)^2)-4*((B^2)+($Z_{\alpha/2}$ ^{2})*B)*(A^2))^(0.5))/(2*(B^2)+(($Z_{\alpha/2}$ ^{2})*B)))*1000

(G): Upper Confidence Interval of Crude IR = *(see Formula F.2)*

= ((2*B*A+($Z_{\alpha/2}$ ^{2})*B +
(((2*A*C+($Z_{\alpha/2}$ ^{2})*B)^2)-4*((B^2)+($Z_{\alpha/2}$ ^{2})*B)*(A^2))^(0.5))/(2*(B^2)+(($Z_{\alpha/2}$ ^{2})*B)))*1000

(H) = given European Standard Population

(I) = (H)*(C)

(L): Standardized Incidence Rate [SIR] = (I) / (H)

(M)= Standard Error of SIR = (A)/ [(B)]^2* [(H)/1000]^2*(1000)^2

(N)= Coefficient of Variation = (M)/(L)

(O): Lower Confidence Interval of SIR = (L) - $Z_{\alpha/2}$ * (M)

(P): Upper Confidence Interval of SIR = (L) + $Z_{\alpha/2}$ * (M)

Note: General recommendation for a consistent age classification:

- <u>single year version</u>

Some countries provided data up to a certain age (either 99 or 100 years). Therefore, the estimation of Rat for this last age group 95+ could be a little bit overestimated, since we miss population at risk at the denominator.
The provided solution only considers the population under 101, i.e. the population of age group 95+ corresponds to the population of age group 95-100

- <u>five year version</u>

Some countries provided data up to a certain age (either 99 or 100 years). Therefore, the estimation of Rat for this last age group 90+ could be a little bit overestimated, since we miss population at risk at the denominator.

The provided solution only considers the population under 101, i.e. the population of age group 90+ corresponds to the population of age group 90-100.

F. Excel Table for Automatic calculation of confidence intervals

Example 290208.xls