NHS Performance Indicators

INDIRECT STANDARDISATION METHODOLOGY

In the June 1999 High Level Performance Indicator (HLPI) and Clinical Indicator (CI) publications, the Hospital Episode Statistics (HES) indicators were directly standardised for age using the European Standard Population (ESP). The indicators were not standardised for sex.

In the July 2000 publication, and in all successive publications of performance indicators, there are three changes to the previous standardisation method:

1. Indirect standardisation is used instead of direct standardisation, and the ratios (and their confidence intervals) are then converted into absolute rates.

2. The indicators are standardised for age **and** sex, not just age. (Some indicators are also standardised for other factors such as method of admission and/or case type.)

3. For each indicator, the reference population used for standardisation will be the appropriate relevant population for that indicator, as opposed to the European Standard Population. For PCTs the reference population is the actual PCT populations. For the CIs, the reference population is the number of hospital admissions (as appropriate for each indicator) for both the PCTs and Trusts.

These changes bring the method of standardisation in line with that used for the Scottish and Welsh clinical indicators.

NOTE: Exceptions to the use of indirect standardisation are the "Our Healthier Nation" mortality indicators for PCTs, which remain directly age-standardised to the European Standard Population in line with OHN policy. The use of the European Standard Population allows the possibility of European comparisons for these indicators.

REASONS FOR CHANGE

The main reasons behind the change in standardisation methodology were:

- Indirect standardisation is more robust with small numbers and avoids the distortions caused by direct standardisation based on unstable age-specific rates.

- It is more flexible to future refinements, such as standardising for other factors such as deprivation or co-morbidity.

- As there are gender variations in health outcomes, person rates need to be standardised for age **and** sex.

- The age distribution of a hospital population is different to that of a general population such as the ESP, hence the former is a more appropriate basis for standardisation for the Clinical Outcome PIs.

POPULATION BASED INDICATORS: WORKED EXAMPLE

Consider the following data for an indicator on asthma and diabetes admission rates for PCT X:

Age range	PCT asthma and diabetes admissions, *x(j)*		PCT population, *n(j)*		England asthma and diabetes admissions, *xs(j)*		England population, *ns(j)*	
j	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
0	15	7	2453	2014	700	258	295911	281949
1-4	89	45	9344	9112	9098	4713	1240851	1181019
5-9	35	29	11951	12045	4870	2954	1653798	1571495
10-14	20	19	9971	9765	3641	2998	1655804	1570112
15-19	4	17	10276	9943	1926	2833	1568534	1474906
20-24	2	11	11080	11201	1602	2495	1518381	1444074
25-29	4	9	14589	13943	1814	2566	1801441	1702114
30-34	12	11	16778	15643	1894	2659	2057535	1944893
35-39	10	29	15032	14157	1785	2562	2082882	1989728
40-44	6	11	12834	11693	1726	2263	1759034	1723870
45-49	3	8	10907	11219	1626	2127	1580329	1574714
50-54	8	12	10210	10845	1737	2172	1702124	1709499
55-59	8	7	6995	9176	1703	1855	1347189	1366597
60-64	4	9	7234	7634	1822	1886	1177686	1220605
65-69	2	11	5978	7126	1913	2020	1028451	1115838
70-74	2	15	4003	5432	1875	2197	882579	1060962
75-79	3	5	3793	5783	1508	2194	693081	978043
80-84	8	2	1632	3829	1009	1735	381372	666247
85+	2	4	1732	3561	704	1749	270041	723412
Total	**237**	**261**	**166792**	**174121**	**42953**	**44236**	**24697023**	**25300077**

Expected asthma and diabetes admissions are then calculated for each sex and age group using the formula:

Expected number of admissions = $n(j) * \frac{xs(j)}{ns(j)}$

where

n(j) = population in age group *j* in PCT X

xs(j) = number of occurrences in age group *j* in the standard population

ns(j) = population in age group *j* in the standard population

So for age 0, the expected number of male admissions
= 2453 * (700/295911) = 5.8

and the expected number of female admissions
= 2014 * (258/281949) = 1.8

The full set of expected admissions is shown in the following table:

Age range	Expected admissions *e(j)*	
j	**Male**	**Female**
0	5.8	1.8
1-4	68.5	36.4
5-9	35.2	22.6
10-14	21.9	18.6
15-19	12.6	19.1
20-24	11.7	19.4
25-29	14.7	21.0
30-34	15.4	21.4
35-39	12.9	18.2
40-44	12.6	15.3
45-49	11.2	15.2
50-54	10.4	13.8
55-59	8.8	12.5
60-64	11.2	11.8
65-69	11.1	12.9
70-74	8.5	11.2
75-79	8.3	13.0
80-84	4.3	10.0
85+	4.5	8.6
Total	**290.1**	**304.4**

The standardised ratio (SR) for persons is then calculated as:

$$SR = \frac{\text{Sum of all observed values}}{\text{Sum of all expected values}} = \frac{\sum x(j)}{\sum e(j)}$$

where

x(j) = number of observed occurrences in age group *j* for PCT X

e(j) = number of expected occurrences in age group *j* for PCT X

So in the example,
SR = (237 + 261)/(290.1 + 304.4) = 0.837

The final indicator value is produced by multiplying through by the England crude rate per 100,000, i.e.
Indicator value = SR * England crude rate

So in the example,

England crude rate = ((42953 + 44236)/(24697023 + 25300077)) * 100000 = 174.39

Hence, the indicator value per 100,000 = 0.837 * 174.38 = 145.96

This crude rate multiplication is used in both the Scottish and Welsh clinical indicators and is done in order to produce a more useable and interpretable final value.

Note: The 2002 data are standardised on 2001 and the standardised ratio will be multiplied through by the crude rate for England for 2001.

CLINICAL OUTCOME INDICATORS: WORKED EXAMPLE

Consider the following data for emergency readmissions following treatment for hip fracture for PCT/Trust X.

Age range	PCT / TRUST X				England			
	Numerator		Denominator		Numerator		Denominator	
	Denominator spells where patient is readmitted <28 days, *x(j)*		Spells with emergency admission for hip fracture, *n(j)*		Denominator spells where patient is readmitted <28 days, *xs(j)*		Spells with emergency admission for hip fracture, *ns(j)*	
j	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
0	0	0	0	0	0	1	5	10
1-4	0	0	1	0	3	0	27	20
5-9	0	0	0	0	1	0	23	17
10-14	0	0	1	0	2	1	74	31
15-19	0	0	0	0	2	0	51	14
20-24	0	0	1	0	1	0	35	13
25-29	0	0	0	0	1	0	60	12
30-34	0	0	0	0	6	1	117	19
35-39	0	0	0	0	7	1	112	38
40-44	1	0	1	2	7	2	140	49
45-49	0	0	0	0	11	7	155	103
50-54	0	0	1	4	28	13	270	269
55-59	0	1	0	3	28	22	332	403
60-64	0	0	1	2	34	51	399	682
65-69	0	1	4	6	48	89	580	1261
70-74	0	3	6	14	95	194	969	2597
75-79	2	4	7	29	164	409	1453	5036
80-84	1	3	15	40	155	588	1510	6837
85+	3	9	9	73	239	1124	1964	12394
Total	**7**	**21**	**47**	**173**	**832**	**2503**	**8276**	**29805**

Expected hip fracture readmissions are calculated for each sex and age group using the formula:

Expected number of readmissions = $n(j) * \frac{xs(j)}{ns(j)}$

where

n(j) = population in age group *j* in PCT/Trust X

xs(j) = number of readmissions in age group *j* in the standard population

ns(j) = population in age group *j* in the standard population

So for age 80-84, the expected number of male readmissions

= 15 * (155/1510) = 1.54

and the expected number of female readmissions

= 40 * (588/6837) = 3.44

The full set of expected readmissions are shown in the following table:

Age range	**PCT/Trust X**	
	Expected readmissions *e(j)*	
j	**Male**	**Female**
0	0.00	0.00
1-4	0.11	0.00
5-9	0.00	0.00
10-14	0.03	0.00
15-19	0.00	0.00
20-24	0.03	0.00
25-29	0.00	0.00
30-34	0.00	0.00
35-39	0.00	0.00
40-44	0.05	0.08
45-49	0.00	0.00
50-54	0.10	0.19
55-59	0.00	0.16
60-64	0.09	0.15
65-69	0.33	0.42
70-74	0.59	1.05
75-79	0.79	2.36
80-84	1.54	3.44
85+	1.10	6.62
Total	**4.76**	**14.47**

The standardised ratio (SR) for persons is then calculated as:

$$SR = \frac{\text{Sum of all observed values}}{\text{Sum of all expected values}} = \frac{\sum x(j)}{\sum e(j)}$$

where

x(j) = number of observed readmissions in age group *j* for PCT/Trust X

e(j) = number of expected readmissions in age group *j* for PCT/Trust X

So in the example,

SR = (7 + 21) / (4.76 + 14.47) = 1.46

The final indicator value is produced by multiplying through by the England crude rate per 100,000, i.e.

Indicator value = SR * England crude rate

So in the example,

England crude rate = ((832 + 2503) / (8276 + 29805)) * 100000 = 8757.65

Hence, the indicator value per 100,000 = 1.46 * 8757.65 = 12786.17

This crude rate multiplication is used in both the Scottish and Welsh clinical indicators and is done in order to produce a more useable and interpretable final value.

Note: The 2002 data are standardised on 2001 and the standardised ratio will be multiplied through by the crude rate for England for 2001.

CONFIDENCE INTERVALS

The lower limits (LL) and upper limits (UL) for the standardised ratio (SR) are obtained *prior* to multiplying through by the crude rate. By exploiting the general relationship between confidence limits and test statistics, the limits may be found by solution of equations involving Poisson probabilities, for which Byar's approximation is sufficiently accurate. For a 95% confidence interval, Byar's approximation gives:

$$LL = \frac{x}{e} * \left(1 - \frac{1}{9x} - \frac{1.96}{3\sqrt{x}}\right)^3$$

and

$$UL = \frac{(x+1)}{e} * \left(1 - \frac{1}{9(x+1)} + \frac{1.96}{3\sqrt{(x+1)}}\right)^3$$

where *x* is the observed number of events and *e* is the expected number of events.