Concepts in epidemiology: the cohort effect

Incidence rates of cancer vary over time;[1] this is called a "period effect". Incidence rates of cancer also tend to increase with age;[1] this is called an "age effect". Another time variable that is associated with the incidence of cancer is year of birth of the patient — the "cohort effect". Many authors have used real data to emphasise the importance of cohort effects for assessing trends in incidence.[2,3] Here, I present a simple, hypothetical example to illustrate the cohort effect.

Consider the data shown in the Box. In this hypothetical population, the age groups are 0–29, 30–59 and 60–89 years and everyone dies on their 90th birthday. The Box contains data for three years (1940, 1970 and 2000). For each year and age group, n denotes the size of the population, P denotes the probability of being diagnosed with cancer in the year, and EI denotes the expected incidence (the expected number of new cases of cancer), which is calculated with the formula:

$$EI = n \times P$$

In 1940, in the 0–29-year age group, there were 600 people, the probability of being diagnosed with cancer was 0.01, and the EI was thus $600 \times 0.01 = 6$. In the whole population, 41 of 1000 people are expected to be diagnosed with cancer.

In this scenario, a wonder drug that prevents cancer was discovered in 1941. However, it must be administered in utero, so only people born since 1941 can benefit.

In 1970, assume there were 100 people aged 0–29 years. In this group, the probability of being diagnosed with cancer was 0, because they were born since 1941, and the EI was 0. The 600 people, who were aged 0–29 years in 1940, were aged 30–59 years in 1970; the probability of being diagnosed with cancer in that age group was 0.05, as in 1940; so the EI was 30. In the whole population, 90 of 1000 people are expected to be diagnosed with cancer in 1970.

In 2000, only those aged 60–89 years were born before 1941. Overall, 120 of 1000 people are expected to be diagnosed with cancer.

Thus, in 1940 there would be 41 new cases in a population of 1000, in 1970 there would be 90 new cases in a population of 1000, and in 2000 there would be 120 new cases in a population of 1000. This trend suggests that things will be worse in 2030.

In fact, the disease will disappear in 2030.

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A hypothetical population that illustrates the cohort effect

	1940			1970			2000		
Age (years)	*n*	*P*	EI	*n*	*P*	EI	*n*	*P*	EI
0–29	600	0.01	6	100	0	0	300	0	0
30–59	300	0.05	15	600	0.05	30	100	0	0
60–89	100	0.20	20	300	0.20	60	600	0.20	120
0–89	1000		41	1000		90	1000		120

In this scenario, n denotes the population size, P denotes the probability of being diagnosed with cancer in the year and EI denotes the expected incidence of cancer, and a drug that prevents cancer when administered in utero was discovered in 1941. ◆

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2 Gardner MJ, Osmond C. Interpretation of disease time trends: is cancer on the increase? A simple cohort technique and its relationship to more advanced models. *J Epidemiol Community Health* 1983; 37: 274-278.
3 Holford TR. Understanding the effects of age, period, and cohort on incidence and mortality rates. *Annu Rev Public Health* 1991; 12: 425-457. ❑