BMJ

BMJ 2012;345:e8223 doi: 10.1136/bmj.e8223 (Published 17 December 2012)

FEATURE

CHRISTMAS 2012: THOUGHTS FOR TODAY

Using speed of ageing and "microlives" to communicate the effects of lifetime habits and environment

Public communication of chronic lifestyle risks is generally opaque and potentially misleading. **David Spiegelhalter** suggests using the concept of ageing faster or slower, by expressing the daily effect of lifestyle factors as changes in "microlives" (half hours of life expectancy)

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We are bombarded by advice about the benefit and harms of our behaviours, but how do we decide what is important? I suggest a simple way of communicating the impact of a lifestyle or environmental risk factor, based on the associated daily pro rata effect on expected length of life. A daily loss or gain of 30 minutes can be termed a microlife, because 1 000 000 half hours (57 years) roughly corresponds to a lifetime of adult exposure. From recent epidemiological studies of long term habits the loss of a microlife can be associated, for example, with smoking two cigarettes, taking two extra alcoholic drinks, eating a portion of red meat, being 5 kg overweight, or watching two hours of television a day. Gains are associated with taking a statin daily (1 microlife), taking just one alcoholic drink a day (1 microlife), 20 minutes of moderate exercise daily (2 microlives), and a diet including fresh fruit and vegetables daily (4 microlives). Demographic associations can also be expressed in these units—for example, being female rather than male (4 microlives a day), being Swedish rather than Russian (21 a day for men) and living in 2010 rather than 1910 (15 a day). This form of communication allows a general, non-academic audience to make rough but fair comparisons between the sizes of chronic risks, and is based on a metaphor of "speed of ageing," which has been effective in encouraging cessation of smoking.

Communication about chronic risks

Quantities such as hazard ratios, standardised mortality ratios, and population attributable fractions arise naturally from standard epidemiological study designs. For example, a recent study reported that consumption of an extra portion of red meat (85 g) a day was associated with a hazard ratio for all cause mortality of 1.13.[1] This was greeted in the popular media with exaggerated headlines and little comprehension—for example, "if people cut down the amount of red meat they eat … to less than half a serving a day, 10% of all deaths could be avoided" (*Daily Express* 4 Mar 2012).

Such relative risk terminology is known to communicate a greater size of risk than measures of absolute risk.[2] Current guidelines from the Association of the British Pharmaceutical Industry state that relative risks should not be used without absolute risks when reporting the results of clinical trials (clause 7.2). Absolute risks are sometimes provided in terms of the numbers of early deaths delayed: for example, the recent estimate that a 40% reduction in alcohol consumption to a median of 5 g/day would delay 4500 deaths a year in England.[3]

An alternative absolute measure is change in life expectancy, for example, an estimated average two year extension by reducing excessive sitting in the US population to less than three hours a day.[4] Hazard ratios can be converted to changes in life expectancy if a lifelong effect from a specified age is assumed, so if the above hazard ratio for eating red meat is applied to UK life tables from, say, age 35, a lifetime habit of an extra portion of red meat per day is associated with a reduction in male life expectancy of around one year, from age 80 to 79.

This does not look very impressive, as people tend to dismiss effects that are perceived to lie in the distant future. As author Kingsley Amis said, "No pleasure is worth giving up for the sake of two more years in a geriatric home at

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Extra material supplied by the author. Appendix 1: Figures showing the influence of lifelong hazard ratios on microlives lost or gained, applied to baseline ages of 25 and 45 years. Appendix 2: Details of studies that were the basis for estimated effects of risk factors on change in life expectancy (see http://www.bmj.com/content/345/bmj.e8223?tab=related#webextra)

Weston-super-Mare." But the loss of one year over 45 years is 1/45th, which pro rata is roughly one week a year or half an hour per day. So an alternative, possibly more engaging, narrative is that a lifelong habit of eating burgers for lunch is, when averaged over the lifetimes of many people, associated with a loss of half an hour a day in life expectancy. Which is, unless you are a quite a slow eater, longer than it takes to eat the burger.

A half hour of adult life expectancy can be termed a microlife as it is loosely equivalent to one millionth of life after 35. An average 35 year old man and woman in England has a life expectancy of 45 and 48 years respectively (394 000 and 420 000 hours) assuming current mortality rates. Since life expectancy has been increasing by three months a year for decades,[5] a current 35 year old might realistically be expected to live another 55 years, which is 481 000 hours—or nearly a million half hours.

Translating hazard ratios into microlives

Specific hazard ratios can be converted to life expectancies using interim life tables for England and Wales,[5] and the ratio of the effect on life expectancy to the life expectancy remaining gives a measure of the implicit change in the speed at which life is being led. The figure⇓ shows the influence of lifelong hazard ratios, applied to the future life of a 35 year old, on microlives lost or gained per day (appendix 1 on bmj.com shows the effect of taking the baseline age of 25 or 45 years, in which case the gradient decreases or increases respectively by about 20%).

The near linearity with log(r) was previously identified by Haybittle,[6] and fitting a straight line shows that, for hazard ratios between 0.75 and 1.3, the daily change in microlives is well approximated by 10.9 log(r) for men and 9.3 log(r) for women: even more roughly, each 10% extra annual hazard corresponds to a loss of one microlife. Technically, a proportional hazard model, parameterised in terms of hazard ratios, is being re-expressed as an approximate accelerated failure time model[7] parameterised in terms of ratios of life expectancies.

As noted above, life expectancy at age 35 has been growing by around three months per calendar year. Naively, this may be considered as ageing only 18 hours a day, and getting a "bonus" six hours or 12 microlives per day, but the average benefit over a lifetime is likely to be considerably less.

Example of microlives lost or gained

The table⇓ illustrates the translation of selected hazard ratios into "speed of ageing." A common hazard ratio is assumed for men and women unless separate estimates are available. These assessments are very approximate and based on numerous assumptions. The hazard ratios are primarily derived from recent meta-analyses, but inevitably they rely on published results that may be contentious, particularly in dietary studies.

Smoking works out at about 10 microlives for every 20 cigarettes smoked, around 15 minutes per cigarette (a previous basic analysis[8] estimated 11 minutes pro rata loss in life expectancy per cigarette). The table⇓ shows that, averaged over a lifetime habit, a microlife can be "lost" from smoking two cigarettes, being 5 kg overweight, having the second and third alcoholic drink of the day, watching two hours of television, or eating a burger. On the other hand microlives can be "gained" by drinking coffee, eating fruit and vegetables, exercising, and taking statins. Air pollution has been placed under "behaviour" since exposure is, in principle, optional.

The table also shows the effects of demographic factors. Thus, the survival penalty of being male is roughly equivalent to smoking eight cigarettes a day, living in Russia rather than Sweden is equivalent to smoking 40 cigarettes a day for a man and 20 a day for a woman, while living in 1910 or 1980 as opposed to the present is equivalent to around 30 or 10 cigarettes a day respectively.

The idea of microlives encourages a metaphor of "accelerated ageing" due to harmful exposures: for example, smoking 20 cigarettes a day (10 microlives) is as if you are rushing towards your death at 29 hours a day instead of 24. Similarly, the idea of "heart age" (the age of an average person who has the same cardiovascular risk profile as yourself) is becoming widely used,[9] while communicating "lung age" has been effective in promoting smoking cessation.[10]

Limitations

Microlives are averaged over populations and lifetimes; they ignore variability between people in their response to harmful or beneficial exposures and do not apply either to specific ages or a single exposure (who knows what damage a few cigarettes do?). Secondly, they are based on the epidemiological difference between groups of people and not necessarily the causal effect of the behaviour. Neither do they necessarily express the effect of change of behaviour in individuals.

Thirdly, the estimates are rough, both due to sampling variability and, more importantly, the inevitable limitations of epidemiological studies. While hazard ratios adjusted for other risk factors can be used when available, quantifying the effect associated with a single risk factor in isolation is open to criticism due to residual confounding. The estimates also rely on the assumption of a constant hazard ratio throughout an entire lifetime.

Fourthly, some definitional choices have to be made. Effects can be framed as loss (microlives lost by a harmful activity) or gain (microlives gained by avoiding a harmful activity), which can change perception. Here, we used the most common behaviour as the reference category. The choice of a baseline age of 35 is arbitrary, although the results are reasonably robust for changes up to 10 years each side.

Fifthly, there is no consideration of quality of life, so behaviour is evaluated only in terms of adding years to life, rather than life to years. However, a "healthy microlife" could be adopted were data available.

Finally, it is possible that presentation in these simple terms could encourage the idea of trading off risks—for example, taking some exercise to compensate for drinking alcohol. However, this may not always be unreasonable. The EPIC study[11] considered four risk factors—smoking, alcohol consumption, physical activity, and diet—whose hazard ratios were estimated individually, adjusted for age, sex, body mass index, and social class. Joint analysis suggests their associations were independent: multiplying up the four independent ratios for harmful behaviours would give an overall hazard ratio of 3.99, compared with their estimate of 4.04 for all four unhealthy behaviours existing concurrently.

Conclusions

The metaphor of speed of ageing and use of the term microlife are intended for popular rather than scientific consumption, but they could also be useful for health professionals. They could perhaps best be communicated with phrases such as "When averaged over a lifetime habit of many people, it is as if each

burger were taking 30 minutes off their life." These quantities bring long term effects into the present and help counter temporal discounting, in which future events are considered of diminishing importance.[12]

In spite of the limitations listed above, a reasonable idea of the comparative absolute risks associated with chronic exposures can be vividly communicated in terms of the speed at which one is living one's life. Of course, evaluation studies would be needed to quantify any effect on behaviour, but one does not need a study to conclude that people do not generally like the idea of getting older faster.

Competing interests: The author has completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declares: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Provenance and peer review: Not commissioned; externally peer reviewed.

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Accepted: 15 November 2012

Cite this as: *BMJ* 2012;345:e8223

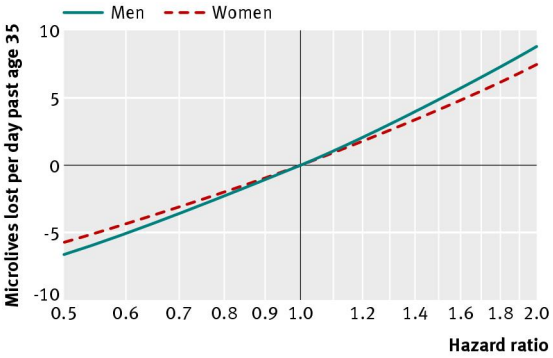
Table

Table 1| Estimated effects of long term lifestyle and demographic risk factors on change in life expectancy for men and women aged 35 years, and corresponding change in microlives (30 minutes of life expectancy) per day of exposure.* See appendix 2 on bmj.com for studies on which these estimates are based

	Men			Women		
Risk factor and definitions of daily exposure	**Hazard ratio**	**Change in life expectancy (years)**	**Microlives per day**	**Hazard ratio**	**Change in life expectancy (years)**	**Microlives per day**
Behaviours						
Smoking[w1]:						
Smoking 15-24 cigarettes	2.17	−7.7	−10	2.17	−7.3	−9
Alcohol intake[w2]:						
First drink (of 10 g alcohol)	0.90	1.1	1	0.90	0.9	1
Each subsequent drink (up to 6)	1.06	−0.7	−½	1.12	−0.6	−½
Obesity[w3]:						
Per 5 units above body mass index 22.5	1.29	−2.5	−3	1.29	−2.4	−3
Per 5 kg above optimum weight for average height	1.09	−0.8	−1	1.10	−0.9	−1
Sedentary behaviour[w4]:						
2 hours watching television	1.08	−0.7	−1	1.08	−0.8	−1
Diet:						
Red meat, 1 portion (85 g, 3 oz)[w5]	1.13	−1.2	−1	1.13	−1.2	−1
Fruit and vegetable intake, ≥5 servings (blood vitamin C >50 nmol/L)[w6]	0.66	4.3	4	0.75	3.8	4
Coffee intake[w7]:						
2-3 cups	0.90	1.1	1	0.87	0.9	1
Physical activity[w8]:						
First 20 minutes of moderate exercise	0.81	2.2	2	0.81	1.9	2
Subsequent 40 minutes of moderate exercise	0.94	0.7	1	0.94	0.5	½
Statins[w9]:						
Taking a statin	0.91	1	1	0.91	0.8	1
Air pollution[w10]:						
Living in Mexico City *v* London		0.6	−½		0.6	−½
Demography						
Sex[w11]:						
Being male *v* female		−3.7	−4		—	—
Geography[w12]:						
Resident of Sweden *v* Russia		−14.1	−21		−7.6	−9
Era[w12]:						
Living in 2010 *v* 1910		13.5	15		15.2	15
Living in 2010 *v* 1980		7.5	8		5.2	5

*Estimates based on assuming a constant hazard ratio from a lifetime exposure, with comparisons relative to most frequent category.

Figure



Average microlives (half hours of life expectancy) lost or gained per day of exposure to a specified hazard ratio for all cause mortality, averaged over life after 35 years of age. For example, a lifetime habit with a hazard ratio of 1.4 leads to an average loss of about 4 microlives a day for a man, which could be thought of as ageing 26 hours a day