How fast does the Grim Reaper walk?

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Objective To determine the speed at which the Grim Reaper (or Death) walks.

Design Population based prospective study.

Setting Older community dwelling men living in Sydney, Australia.

Participants 1705 men aged 70 or more participating in CHAMP (Concord Health and Ageing in Men Project).

Main outcome measures Walking speed (m/s) and mortality. Receiver operating characteristics curve analysis was used to calculate the area under the curve for walking speed and determine the walking speed of the Grim Reaper. The optimal walking speed was estimated using the Youden index (sensitivity+specificity−1), a common summary measure of the receiver operating characteristics curve, and represents the maximum potential effectiveness of a marker.

Results The mean walking speed was 0.88 (range 0.15-1.60) m/s. The highest Youden index (0.293) was observed at a walking speed of 0.82 m/s (2 miles (about 3 km) per hour), corresponding to a sensitivity of 63% and a specificity of 70% for mortality. Survival analysis showed that older men who walked faster than 0.82 m/s were 1.23 times less likely to die (95% confidence interval 1.10 to 1.37) than those who walked slower (P=0.0003). A sensitivity of 1.0 was obtained when a walking speed of 1.36 m/s (3 miles (about 5 km) per hour) or greater was used, indicating that no men with walking speeds of 1.36 m/s or greater had contact with Death.

Conclusion The Grim Reaper's preferred walking speed is 0.82 m/s (2 miles (about 3 km) per hour) under working conditions. As none of the men in the study with walking speeds of 1.36 m/s (3 miles (about 5 km) per hour) or greater had contact with Death, this seems to be the Grim Reaper's most likely maximum speed; for those wishing to avoid their allotted fate, this would be the advised walking speed.

Introduction

The Grim Reaper, the personification of death, is a well known mythological and literary figure.[1-4] Reported characteristics include a black cloak with cowl, a scythe, and cachexia. High quality scientific research linking the Grim Reaper to mortality has been scarce, despite extensive anecdotes.

Walking speed is a commonly used objective measure of physical capability in older people, predicting survival in several cohort studies.[5-7] A recent meta-analysis found that being in the lowest fourth of walking speed compared with the highest was associated with a threefold increased risk of mortality.[8] Moreover, the association between slow walking speed and mortality seems consistent across several ethnic groups and shows a dose-response relation.[8] Although the association between walking speed and mortality has been well documented, the plausible biological relation between the two remains unclear.

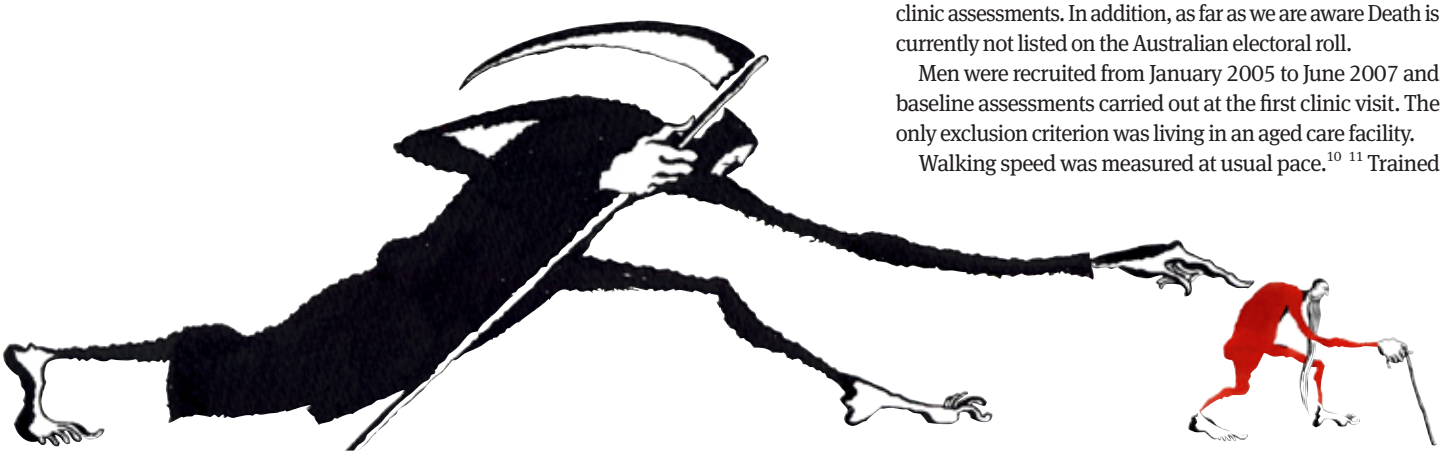
We assessed whether the relation between slow walking speed and mortality results from the increased likelihood of being caught by Death. By assessing this relation using receiver operating characteristics curve analysis, we hypothesised we would be able to determine the walking speed of the Grim Reaper—information of importance to public health.

Methods

We analysed data from the Concord Health and Ageing in Men Project (CHAMP), a cohort study of men aged 70 and over living in several inner city suburbs of Sydney, Australia.[9] Participants were recruited from the electoral roll, which, as voting is compulsory in Australia, provides a representative population sample. As "living" in the study area was a criterion for entry to the study, we were unable to obtain Death's participation in clinic assessments. In addition, as far as we are aware Death is currently not listed on the Australian electoral roll.

Men were recruited from January 2005 to June 2007 and baseline assessments carried out at the first clinic visit. The only exclusion criterion was living in an aged care facility.

Walking speed was measured at usual pace.[10 11] Trained



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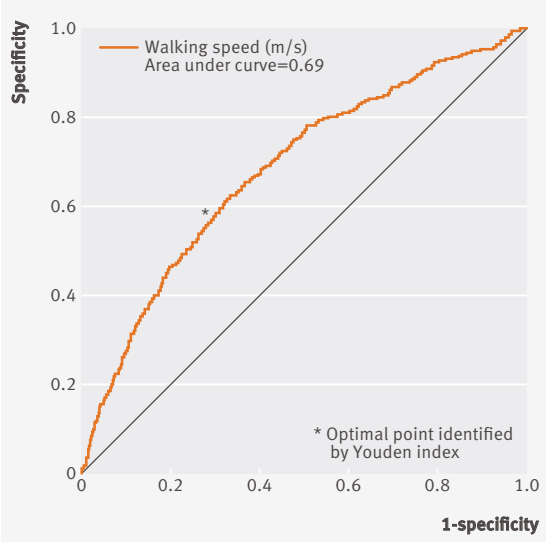

Receiver operating characteristics curve for mortality over five years in relation to walking speed. *Optimal point identified by Youden index

staff used a stopwatch to record the time taken by the men to walk 6 m. The fastest time from two trials was used. Walking speeds were adjusted for height based on the definition of frailty used in the Cardiovascular Health Study.[11]

The men were followed-up by telephone at four-monthly intervals from the baseline assessment, and at clinic visits at two and five years, which enabled survival data to be updated. For both the baseline and follow-up visits, the men completed a questionnaire at home before coming to the clinic at Concord Hospital. Men who were not contactable by phone were sent letters every four months, or if unavailable a nominated contact was telephoned. If men withdrew from the study but agreed to passive follow-up, we ascertained any deaths through the New South Wales registry of births, deaths, and marriages. Follow-up times varied between men (mean 59.3 months). Follow-up began at the baseline assessment and ended on the date of death or the end of the study period. For withdrawals, the end date was the date at which we contacted the death registry.

Statistical analyses

Analysis was done using SAS version 9.2.We used receiver operating characteristics curve analysis (Sigmaplot program, version 11.0, Systat Software) to calculate the area under the curve for walking speed and to determine the optimal cut-off value for avoiding contact with Death. On the basis of our hypothesis, we took this optimal cut-off for walking speed to be the best estimation of the Grim Reaper's pace. The area under the curve describes the test's overall performance and can be used to compare different tests. A value of 1 indicates perfect discrimination, whereas a value of 0.5 indicates discrimination no better than chance.

We also calculated sensitivity and specificity. The optimal cut-off point was obtained by using the Youden index (sensitivity+specificity−1), without adjusting for covariates. This index represents the maximum potential effectiveness of a marker.[12] Statistical significance was set at less than 0.05. We also estimated the walking speed providing a sensitivity of 1.0 (a "negative" test result being a speed above the cut-off) as this cut-off would indicate the speed at which no men had contact with Death and therefore the maximum ambulatory speed of the Grim Reaper. This maximum speed might be used in particular instances where people are attempting to outrun Death and avoid their allotted fate. Cox regression analysis was also carried out to estimate the hazard ratio (95% confidence intervals) for mortality for men with walking speeds above and below that estimated for the Grim Reaper. The walking speed was also tested as a continuous variable.

Results

Of 2815 eligible men contacted, 1511 (53.7%) participated in the study. An additional 194 men living in the study area heard about the study (from friends or the local media) and were recruited before receiving an invitation letter, giving a final sample of 1705. As the CHAMP study area has a high proportion of immigrants, only 49.8% of men in the CHAMP study were born in Australia and 19.6% in Italy. Other main countries of birth were Great Britain (4.6%), Greece (3.9%), and China (2.7%). The men have been followed for a mean of 59.3 months. Walking speed at baseline was not available in 77 men, mostly through inability to complete the test. A total of 266 deaths occurred during follow-up.

The mean walking speed was 0.88 (range 0.15-1.60) m/s. The figure shows the receiver operating characteristics analysis. The highest Youden index (0.293) was observed at a walking speed of 0.82 m/s (2 miles (about 3 km) per hour), which corresponded to a sensitivity of 63% and a specificity of 70%. Cox regression analysis showed that older men with a walking speed above 0.82 m/s were 1.23 times less likely to die (95% confidence interval 1.10 to 1.37) than those who had a slower walking speed (P=0.0003). For every one unit (m/s) increase in walking speed, the hazard ratio for increased mortality was 2.77 (95% confidence interval 2.08 to 3.68; P<0.001). Moreover, a sensitivity of 1.0 was obtained when a walking speed of 1.36 m/s (3 miles (about 5 km) per hour) or greater was used, indicating that no men with walking speeds of 1.36 m/s or greater had contact with Death.

Discussion

Based on receiver operating characteristics analysis and estimation of the Youden index, a walking speed of 0.82 m/s (2 miles (about 3 km) per hour) was most predictive of mortality. Therefore, we predict that this is the likely speed at which the Grim Reaper prefers to ambulate under working conditions. Older men who walked at speeds greater than 0.82 m/s were 1.23 times less likely to encounter Death. In addition, no men walking at speeds of 1.36 m/s (3 miles (about 5 km) per hour) or above were caught by Death (n=22, 1.4%).

This supports our hypothesis that faster speeds are protective against mortality because fast walkers can maintain a safe distance from the Grim Reaper. Interestingly, the predicted walking speed of Death estimated in the present study is virtually identical to the gait speed (0.80 m/s) associated with median life expectancy at most ages and for both sexes in a recent meta-analysis of gait speed and mortality using data from diverse populations.[8] This indicates that the preferred walking speed of the Grim Reaper while collecting souls is relatively constant irrespective of people's geographical location, sex, or ethnic background.

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"This raises the research question—does the Grim Reaper prefer to walk on level surfaces? Researchers who are able to access data directly from the Grim Reaper may like to pursue this line of investigation." Anne-Marie Hill, Freemantle Australia

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Does the 27 club exist?

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Objective To test the "27 club" hypothesis that famous musicians are at an increased risk of death at age 27.

Design Cohort study using survival analysis with age as a time dependent exposure. Comparison was primarily made within musicians, and secondarily relative to the general UK population.

Setting The popular music scene from a UK perspective.

Participants Musicians (solo artists and band members) who had a number one album in the UK between 1956 and 2007 (n=1046 musicians, with 71 deaths, 7%).

Main outcome measures Risk of death by age of musician, accounting for time dependent study entry and the number of musicians at risk. Risk was estimated using a flexible spline which would allow a bump at age 27 to appear.

Results We identified three deaths at age 27 amongst 522 musicians at risk, giving a rate of 0.57 deaths per 100 musician years. Similar death rates were observed at ages 25 (rate=0.56) and 32 (0.54). There was no peak in risk around age 27, but the risk of death for famous musicians throughout their 20s and 30s was two to three times higher than the general UK population.

Conclusions The 27 club is unlikely to be a real phenomenon. Fame may increase the risk of death among musicians, but this risk is not limited to age 27.

Introduction

The recent tragic death of the singer Amy Winehouse, aged 27, reignited talk of the "27 club", as a seemingly unusual number of well known musicians have died at this age.[1] A rock 'n' roll lifestyle is often associated with excess drinking and taking psychoactive drugs. These behaviours greatly increase the risk of death from an accident or overdose,[2 3] but why would these deaths occur specifically at age 27? One explanation might be that musicians often become famous in their early twenties, and their risk taking peaks four to five years later. Another explanation is that joining the 27 club has become attractive to musicians who want to be more famous (whether consciously or subconsciously), and hence their risky behaviour peaks at this age, or they may even commit suicide at 27. An alternative explanation is that the 27 club exists by chance and is an example of confirmation bias, where people focus on results that support their hypothesis and ignore those that refute it.[4 5]

We investigated whether a true increase in risk exists by creating a retrospective cohort of famous musicians and using survival analysis to search for a peak in risk at age 27.

Methods

Sampling scheme

We aimed to create a cohort of famous musicians with an unbiased and transparent sampling scheme. We defined famous musicians as those who had had a number one album in the UK charts. We chose the UK charts because they were a long running and reasonably consistent marker of success. For musicians in bands, we sampled all the band members listed on the album. We collected data from 1956, when the UK charts began, until the end of 2007. The first number one was Frank Sinatra's *Songs for Swingin' Lovers!* on 28 July 1956, and the last number one was Leona Lewis' *Spirit* on 18 November 2007.

We obtained data from Wikipedia (http://en.wikipedia.org) using the lists of number one albums by decade. In a test of 42 scientific articles, Wikipedia had a similar accuracy to Encyclopaedia *Britannica*.[6] We took a simple random sample of 48 musicians using a random number generator in the R software, and verified the Wikipedia date of birth as correct (using biographies or official web sites) for 41 (85%). Two dates (4%) had differences of less than six months, and for the remaining five (10%) no confirmatory date could be found.

For each musician we recorded their date of birth, date of number one, and date of death. Musicians who were still

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Not the 27 club: Brian Jones, Amy Winehouse, Kurt Cobain

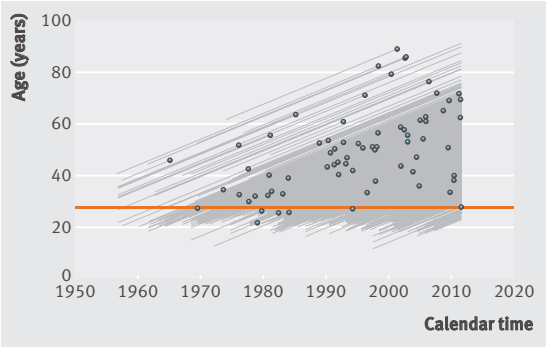

Fig 1 | Lexis diagram of musicians with a number one UK album from 1956 to 2007. Each grey line shows a musician's lifetime, starting at their number one album and ending in their death (points) or censoring in 2011

alive were censored on 1 August 2011, two weeks before the data were extracted. The date of number one was used as the time dependent study entry and the date from which musicians were at risk (when their fame began). Musicians who became famous after age 27 cannot be part of the 27 club, but their data are still useful for estimating the overall mortality curve. For musicians with multiple number one albums we used the earliest album. Musicians in our cohort were at risk after their first number one album, in the same way that a patient is at risk of a ventilator associated pneumonia after being ventilated.[7]

We excluded 114 musicians with no recorded date of birth, and five unlucky musicians with posthumous number one albums (as they were never alive and famous according to our definition).

Statistical methods

We used a Lexis diagram to display all data by calendar time and age at death.[8] We also plotted the number of deaths for each age (in whole years), the number of musicians at risk, and the death rate per 100 musician years. This was to show the number and rate of deaths at age 27 compared with other years, and the denominator of the number at risk.

To estimate the death rates per 100 musician years we used a survival analysis with age as a time dependent exposure.[9] To give any potential peak in risk at age 27 a high chance of being found, we smoothed the death rates using a natural spline for age and tested models with two to 12 degrees of freedom.[10] The higher the degrees of freedom, the more flexible the spline and hence the greater chance of the model finding a "bump" in the risk. However, more degrees of freedom also mean a more complex model. Therefore, we compared the fit of the models using the Akaike information criterion.[11] The model was fitted using a Poisson distribution with age as the independent variable.

For comparison with musician death rates, we drew the death rates per 100 person years in the UK population by decade of birth. We made this comparison to check that there was no peak in death rates in the UK population at age 27, which would be repeated in our musician cohort. These data were from a publicly available database (the human mortality database from University of California and Max Planck Institute for Demographic Research at www.mortality.org, downloaded 11 August 2011).

All analyses were done using R with the Epi and MVNA packages. All the data used were publicly available, and no ethics applications were made.

Results

Our final sample contained 1046 musicians, with 71 deaths (7%). The sample included crooners, death metal stars, rock 'n' rollers, and even Muppets (the actors, not the puppets). The sample consisted mostly of men (899, 86%). The median age at first number one was 26 years (inter-quartile range 23 to 30 years). The total follow-up time was 21 750 musician years, with an average per musician of 21 years.

The Lexis diagram shows the lifetime of every musician (fig 1). For example, the highest line shows a musician who had a number one in 1974 aged 61, and who died in 2001 aged 88 (Perry Como). This lifetime highlights that not all

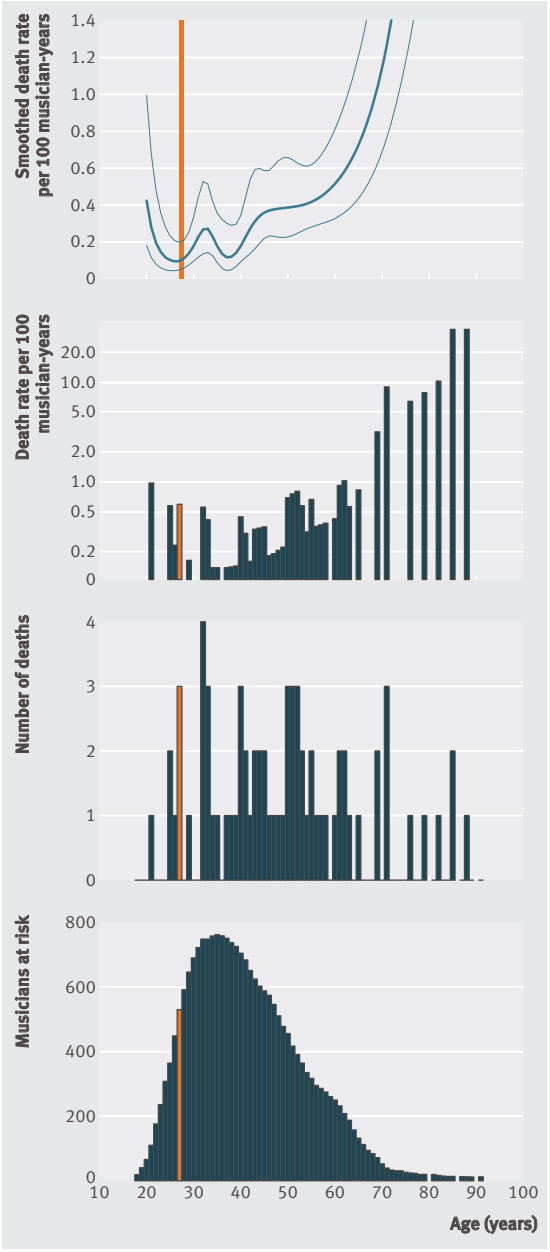

Fig 2 | Smoothed mean death rate per 100 musician years using a spline with a 95% confidence interval (top), mean death rate per 100 musician-years (second from top) number of deaths (third from top), and number of musicians at risk (bottom) by age in years. Age 27 is marked in red. Y axis for smoothed death rates restricted to 0 to 1.4 to focus on the ages of interest. Y axis for mean death rates is on log scale to focus on younger ages

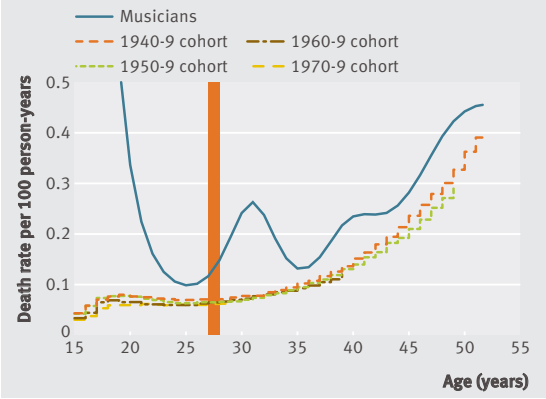

Fig 3 | Death rates in the general UK population per 100 person years by age and decade of birth (cohort) for ages 18 to 50, and smoothed death rate per 100 musician years. Vertical red line indicates age 27, with no increase in risk. Each cohort's line ends at the age where no more data are available

musicians in our cohort were at risk at age 27, because their first number one occurred when they were older. We repeated all the analyses using a subcohort of musicians who had a number one album before age 28 (624 musicians, 60%), which gave similar results and conclusions.

Our sample contained only three deaths at age 27 (in 1969, 1994, and 2011), but there were a few near misses in the late 1970s and early 1980s. We noted a group of relatively young deaths (ages 20 to 40) in the 1970s and early 1980s, followed by an absence of deaths in this age group from 1985 to 1992 despite there being many musicians at risk. There were no deaths at any age between 1985 and 1987.

Figure 2 shows the number of deaths at each age and the number of musicians at risk. The death rates per 100 musician years were calculated by dividing the number of deaths by the number of musicians at risk and multiplying by 100. There were three deaths at age 27 amongst 522 musicians at risk, giving a death rate of 0.57 per 100 musician years. Similar death rates were observed at ages 25 (rate=0.56) and 32 (rate=0.54). The smoothed death rate shows a peak at age 32 and no peak at age 27. Risk increased greatly after age 60. The best fit for the smoothed death rate (smallest Akaike information criterion) used seven degrees of freedom.

Figure 3 shows the death rates in the general UK population by decade of birth, and the smoothed death risk from the top panel of figure 2. Death rates in the UK show the well known steady increase in risk with ageing, and the reduction in risk for younger cohorts. Death rates for the cohort of famous musicians during their 20s and 30s were two to three times higher than in the UK population.

Discussion

Our analysis found no peak in the risk of death for musicians at age 27, despite using a flexible spline model that would have allowed even a small bump in risk to appear. The study indicates that the 27 club has been created by a combination of chance and cherry picking.

We found some evidence of a cluster of deaths in those aged 20 to 40 in the 1970s and early 1980s. This pattern was particularly striking because there were no deaths in this age group in the late 1980s, despite the great number of musicians at risk. This difference may be due to better treatments for heroin overdose, or the change in the music scene from the hard rock 1970s to the pop dominated 1980s.

WHAT IS ALREADY KNOWN ON THIS SUBJECT

The notion of the "27 club"—a group of well known musicians who died at age 27—has led some to believe that a high risk of death among musicians at this age is a real phenomenon

WHAT THIS STUDY ADDS

Famous musicians do not have an increased risk of death at age 27, but they do have a generally increased risk of death during their 20s and 30s compared with the UK population

Thorough statistical analysis is essential before apparently unusual clusters of deaths are declared real

Limitations

Our sampling scheme only captured three of the seven most famous 27 club members (http://en.wikipedia.org/wiki/Club_27), as one fell outside our time period (Robert Johnson, who died in 1938), and three did not have a number one UK album (Jimi Hendrix, Janis Joplin, and Jim Morrison). We used a clear, specific, and measurable a priori definition of fame, rather than working backwards from the known 27 club members, an approach that had the potential to create a biased sample. Our a priori definition in combination with a cohort design allows the calculation of our main outcome: death rates in famous musicians by age.[12] Although we only captured three of the seven famous 27 club members, we did capture seven Muppets.

The 114 (10%) musicians with no recorded date of birth were likely to be less famous (for example, bass players and backing singers). If these people had died in tragic or dramatic circumstances (especially at age 27), then their birth and death dates would probably have been recorded in Wikipedia. If these musicians are more likely to be alive than the musicians with recorded dates, then our estimated musicians' death rate will be too high.

Our definition of fame was based on a number one album in the UK, so our conclusions only hold for musicians famous in the UK. Results may be different for other settings, such as the US music scene, especially if the trappings and pressures of fame differ by country. Other studies based on alternative definitions of fame are needed before we can definitively state that the 27 club is a chance finding. Two example definitions are: using a number one UK single rather than album, which would capture one-hit wonders; and using a number one album in the US.

We compared the death rates of musicians from multiple countries with death rates based on UK population data. The higher rate of deaths in musicians should therefore be interpreted in light of this mismatch in populations (although most of the musicians were from western countries, with broadly similar death rates to the UK). The comparison to the general UK population might be also prone to information bias,[12] as the death rates were obtained from different sources.

Conclusion

The myth of the 27 club supposes that musicians are more likely to die aged 27, whereas our results show that they have a generally increased risk throughout their 20s and 30s. This finding should be of international concern, as musicians contribute greatly to populations' quality of life, so there is immense value in keeping them alive (and working) as long as possible.

References are in the version on bmj.com

Morbidity and mortality in a Borsetshire village

Rob Stepney ponders Ambridge's vital statistics

In a landmark paper, Crayford et al reported that the mortality rate for characters in the television soap operas *Coronation Street* and *EastEnders* exceeded those of bomb disposal experts and racing drivers.[1] Many deaths were violent, and the overall five year survival of recently introduced characters was poorer than that for many cancers. Does the dramatic imperative lead the long running BBC radio series *The Archers* to contain a similarly high level of mortality and medical incident? Or does radio, and the bucolic setting, give everyday country folk a better chance in life?

The village of Ambridge, at the centre of the programme, is set in a rural area south of Birmingham in the English Midlands. Among the population of 700, employment in farming is higher than average but the age distribution is thought to be similar to the national average, with 20% aged under 16 years and 20% aged 65 and over.[2]

We are directly acquainted with 60 inhabitants but have knowledge of a further 55, giving a total—for epidemiological purposes—of 115 (58 men and 57 women). In such a small sample, few events of epidemiological significance are likely to occur in any given year. In calculating birth and death rates, I have therefore pooled data for the 20 years preceding the time of writing (September 2011). I describe significant non-fatal illnesses and medical interventions for the same period.

Table 1 | Deaths by cause September 1992 to September 2011 among Ambridge population of whom we are aware (n=115)

Type of death	Year of death	Name	Age (years)	Cause or circumstance of death
Accident	1994	Mark Hebden	38	Road traffic accident
	1998	John Archer	22	Tractor overturned
	2011	Nigel Pargetter*	51	Fall from roof
Suicide	2004	Greg Turner	41	Self inflicted gunshot wound
Cardiac (confirmed)	1996	Martha Woodford	73	Myocardial infarction
	1996	Guy Pemberton	65	Myocardial infarction†
	2005	George Barford	76	Myocardial infarction
	2005	Betty Tucker	55	Myocardial infarction†
	2010	Sid Perks*	65	Myocardial infarction
Presumed cardiac	2005	Julia Pargetter	81	Died in her sleep
	2010	Phil Archer	81	Found dead in armchair
Malignancy	1996	Irene Barraclough	76	Site of tumour not specified
	2007	Siobhan Donovan née Hathaway*	‡	Melanoma
Unexplained	1998	Tom Forrest	‡	Died in care home
	1998	Pru Forrest	‡	Died in care home six days after Tom

*Death did not occur in Ambridge itself.
†Having had non-fatal myocardial infarction some weeks previously.
‡Siobhan was middle aged; both Tom and Pru were elderly.

Mortality

Calculating a mortality rate for *Archers* characters and comparing it with the country as a whole requires approximations. I assume that the age, sex, and social class distribution of the population of Ambridge reflects that of England and Wales and that Ambridge's demographics remained constant over two decades. Not censoring data at the time of characters' deaths means that they continue to contribute person years to the population at risk, which introduces imprecision. In comparing Ambridge with England and Wales, I have not standardised mortality data for age. However, the epidemiology of a fictional world cannot be as exact as that of the real. Because of the very small number of people involved and the high degree of variability from one year to the next, a broad margin of potential error exists around any mortality estimates made for Ambridge. This is especially so when the events in question (such as deaths from trauma) occur particularly infrequently. This imprecision is reflected in the wide 95% confidence intervals noted for certain estimates below.

Of the 15 deaths recorded over the 20 years to September 2011, nine were of male characters and six of female characters (table 1). This equates to a mortality rate of 7.8 per 1000 population per year for males. For comparison, the mortality rate for England and Wales mid-way through our period of interest was 8.5 per 1000.[2] For females, the mortality rate calculated from the

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Ambridge data is 5.2 deaths per 1000, and the comparable national rate is 5.8. Hence the overall mortality rate in Ambridge over the 20 years to September 2011 was marginally lower than that in the country as a whole.

That said, do the causes of death in and around Ambridge reflect wider experience? Among male *Archers* characters, the three accidental deaths and one suicide (27% of the total mortality) seem to substantially over-represent the risk evident nationally. In 2000 accidents accounted for only 4% of deaths in men.

Mark Hebden seems to have been particularly unlucky. In the year of his car crash, the national fatality rate from road traffic accidents was 7 per 100 000. That in Ambridge represents an annual incidence of 40 per 100 000. However, the confidence interval around this estimate ranges from 1 to 240 per 100 000 and thus includes the lower national figure. So we cannot conclude that the rate in Ambridge exceeds that for the country as a whole to a statistically significant degree.

The five confirmed cardiac deaths account for 33% of total mortality in Ambridge (rising to 47% if two probable myocardial infarctions are included). Yet cardiac deaths nationally in 2000 accounted for only 23% of mortality in males and 17% of that in females. In Ambridge, ischaemic heart disease seems to have a particularly poor prognosis. (This would make sense for practical reasons, as the sudden death of characters is sometimes necessitated by the sudden death of the actors who portray them.) However, the confidence interval around the Ambridge figure of 33% extends from 15% to 58%, again encompassing the observed national rates. Cardiac mortality in Ambridge therefore seems excessive, but the fact that it is higher than the national figure has not been conclusively demonstrated.

In contrast to cardiac mortality, that due to cancer seems under-represented in *The Archers*. If the national pattern prevailed, cancers would account for roughly a quarter of deaths among characters. The two deaths observed (one from melanoma and the other from a malignancy of unspecified site) represent only 13% of the total. But, again, this does not exclude the possibility that the Ambridge experience is compatible what that nationally.

Fertility

To compensate for the 15 deaths in the past 20 years, 13 children have been born to the 115 characters (table 2). The crude annual live birth rate in Ambridge in 1992-2011 was 5.6 per 1000 (all ages). In England and Wales in 2001 it was 11.4 per 1000. Notable among the births were those of Phoebe Aldridge in a tepee during the Glastonbury Festival and of the Pargetter twins. Two births were sufficiently premature to require the services of a neonatal intensive care unit, one of them owing to pre-eclampsia.

Morbidity

In addition to the obstetric complications noted in table 2, Ambridge characters have experienced a range of life threatening accidental injuries and acute and chronic physical and psychiatric morbidity (table 3). For example, the Hebden family suffered further ill luck when Daniel developed juvenile arthritis, which has a prevalence of only 1-2 per 1000 children. However, despite the poor prognosis associated with systemic onset below the age of 5, the condition has fully resolved.

Ruth Archer's breast cancer was oestrogen receptor negative and multifocal, requiring mastectomy. She went on to have another child after adjuvant chemotherapy and is free of relapse at 10 years. No cases of colorectal, prostate, or lung cancer have occurred among the 115 characters followed since 1992. With the possible exception of Joe Grundy's dubious self diagnosis of farmer's lung, little respiratory disease has occurred.

With the exception of infidelity, nothing captures an audience more completely than death, a complicated birth, or an interesting illness

The medical histories of Ambridge characters illustrate well the series' interest in creating complex and slow burning story lines. Elizabeth Archer (born with congenital heart disease in 1967) had two early corrective procedures for tetralogy of Fallot,[3] but more than 20 years later she had a valve replacement (after a twin pregnancy); then, after a further decade, ventricular tachycardia led to implantation of a cardioverter-defibrillator in March 2011. (Nationally, fewer than 100 such implants were carried out in 2009, so she may have had privileged access to expensive devices.)

It was only eight years after her mastectomy, and after a near affair, that Ruth had a breast reconstruction. A consequence of Greg Turner's suicide was mental health problems for Helen Archer, which were still being played out six years later. The way in which the slow but relentless unravelling of Jack Woolley's world has been portrayed over the six years since Alzheimer's disease was first suspected has been appreciated by critics.[4]

A significant lag may occur between the suggestion of a medical storyline and its use. John Wynn Jones, a general practitioner advising the programme in 1992, identified depression and suicide as an aspect of rural life that could be covered.[5] Greg Turner's illness and death occurred more than 10 years later.

Discussion

With the exception of infidelity, nothing captures an audience more completely than death, a complicated birth, or an interesting illness. Simon Dover, medical adviser to *The Archers* in 1989, shortly before the period under review, reported that the programme's production team had a particular liking for medical stories.[3] However, in the case of overall mortality over the following 20 years, *The Archers*—by luck or good editorial judgment—reflected almost exactly the experience of the wider population of England and Wales. In its rate of births, village life seemed less eventful than reproductive life nationally. The epidemiological features that seem to stand out as dramatically different from the norm are the high proportion of deaths due to accidental or self inflicted injury, which is sevenfold greater than that expected on the basis of national data, and the poor survival after myocardial infarction. However, the small number of events in Ambridge means that we cannot conclude with certainty that Ambridge is exceptional even in these respects.

Undoubtedly, certain of the conditions that appear in fictional Ambridge are rare in real life. The low incidence of juvenile arthritis nationally has been mentioned, and for one of only 115 characters to have long term consequences from tetralogy of Fallot (found in only 0.3 per 1000 live births) is unusual. However, given the thousands of conditions with a low incidence, that the occasional one or two should appear even in a small population when studied for 20 years is not surprising. Other morbidities portrayed, such as stroke, depression, and dementia, are of course relatively common in any group.

Conclusion

Although the confidence intervals around relevant estimates are wide, *The Archers* seems to have a higher than expected number of traumatic deaths. In this respect, it would be similar to soap operas set in urban environments and on television. However, in overall mortality, which in epidemiological terms is the most important outcome, *The Archers* ploughs its own furrow. Is that the charm of the rural, or of radio?

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References and tables 2 and 3 are in the version on bmj.com.

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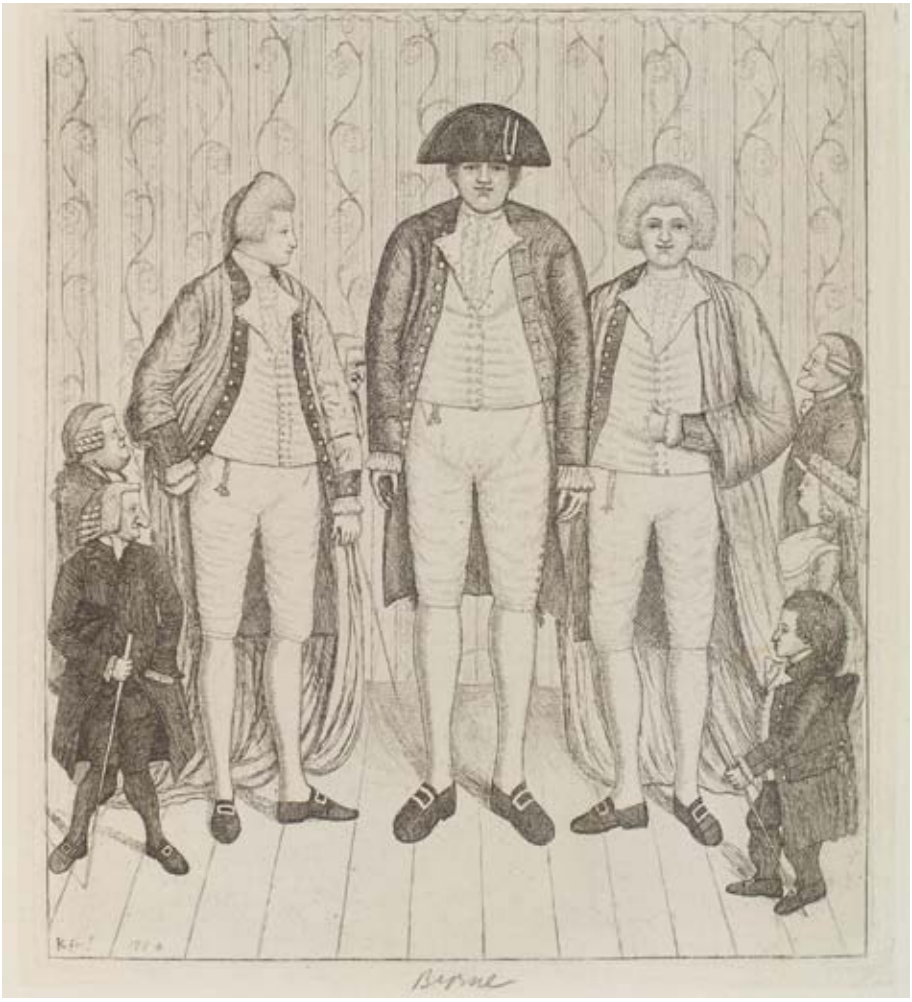
Should the skeleton of "the Irish giant" be buried at sea?

It's not too late to grant Charles Byrne's wish, argue **Len Doyal** and **Thomas Muinzer**

The skeleton of Charles Byrne, the famous "Irish giant," has been displayed at the Hunterian Museum in the Royal College of Surgeons for almost 200 years. It played an important part in linking acromegaly with the pituitary gland. In 1909 the American surgeon Harvey Cushing removed the top of Byrne's skull and observed an enlarged pituitary fossa, confirming a relation between the disease and adenoma. This finding has enabled the diagnosis and early treatment of people with acromegaly. At the beginning of this year, further important research led by Marta Korbonits used the DNA from two of Byrne's molars to establish a genetic link between him and several people from a particular area of Northern Ireland.[1 2] Aside from giving those susceptible to the disease the opportunity for appropriate medical care, this link perhaps helps to explain the long tradition of mythology about giants in Irish history.

Just as Byrne himself did when alive, so his skeleton continues to entertain the public.[3] We believe that it should now be removed from display and buried at sea, as Byrne intended for himself. Others have expressed similar although not necessarily identical views.[4-7] Byrne's burial wish was not fulfilled because the pre-eminent surgeon and anatomist of the time, John Hunter, was determined to possess Byrne's cadaver for his own purposes.[8]



Charles Byrne and the Knipe twins, with some lesser mortals for comparison

Byrne and Hunter

Byrne was born in County Londonderry (part of a unified Ireland) in 1761. From a young age it was clear that he had a growth disorder. Historical accounts of his size vary, but his skeleton suggests he was about 7 feet 7 inches tall.[9]

While still an adolescent, Byrne acquired a manager and was exhibited for money as a curiosity. With the prospect of earning more money, he travelled to London in 1780. The civilised, amiable Irishman entertained his audiences and made friends from different social classes. As his condition worsened, however, his health began to deteriorate, with the inevitable associated pain and emotional distress; he regularly used alcohol to relieve his symptoms. In 1783 while drinking at a local tavern he was robbed of his fortune, the then considerable sum of £700. He died a month later, aged 22, probably from the effects of the disease.

Byrne was gripped with fear of Hunter, who used grave robbers ("resurrectionists") to provide him with unauthorised exhumed bodies. Because of Hunter's reputation for collecting unusual specimens for his private museum, Byrne was concerned that Hunter wanted his body for dissection (a fate reserved for executed criminals) and probable display. Byrne's native religious beliefs may have also fuelled his fear.

Byrne told friends that when he died his body should be sealed in a lead coffin and buried at sea. When Hunter found out he managed to bribe one of them and when the friends stopped overnight on their way to bury Byrne in the English Channel, his body was replaced with heavy objects. Hunter thus acquired the body. Possibly out of fear of revenge, he immediately boiled Byrne's body down to the skeleton. He hid it for four years before it became a key feature of his museum, generating badly needed funds.

Hunter died in 1793. Six years later his collection was bought by the British government and eventually given to the Royal College of Surgeons. There it continues to be displayed as part of the Hunterian Museum. Despite knowledge of the skeleton's provenance and formal requests to remove it, the trustees of the museum and the college have not complied, arguably contravening their current policy about such matters.[10 11]

Are there legal reasons to remove Byrne's skeleton?

There is no evidence to suggest that Byrne lacked the capacity or competence to make an "advance decision" about the disposal of his body. It is unlikely too that Hunter would have been prosecuted, because the human body then as now was not classed as conventional property. That which is not property cannot be stolen.[12]

Moreover, even when burial instructions are stipulated in a will, an executor appointed to arrange the burial, and monies set aside for the purpose, such wishes are not legally enforceable.[13] A will is only legally binding with regard to something in it that is recognised as property. A specific form of burial may be requested, as in Byrne's case, but the force of such a request is moral and not legal.

Nonetheless, Byrne's fate would be impossible now. The Human Tissue Act 2004 states that if, before death, people explicitly and competently refuse the use of their bodies for medical research, those wishes must be respected. Part of the background to this legislation was the public's moral outrage that the organs of dead children were being used for medical purposes without the parents' informed consent. (Ironically, similar public outrage was expressed in Byrne and Hunter's time about the activities of grave robbers.) The 2004 act prevents such moral misuse of organs from being repeated by embedding in law the right of people or legally designated proxies to make autonomous decisions about the use of bodies for research.[14] This act cannot, however, be applied retrospectively to Byrne.

Moral arguments about displaying Byrne's skeleton

In recent years debate has been considerable about the moral right of people to determine what happens to their bodies after death. An important dimension of this debate has focused on organ donation.[15] Given both the scarcity of donor organs (primarily derived from corpses) and the high demand for organs, this controversy highlights the tension between the deceased's right to self determination and the needs of living people.

Some have argued that the needs of those requiring organs ought to trump any conflicting wishes of the deceased.[16-19] It is maintained that the dead cannot have rights and that although the dead can be said to have interests (for example, respect for their life achievements), these do not carry the same weight as they would in life. For the purposes of saving lives, such arguments conclude that the removal of organs ought to be legalised, irrespective of the deceased's wishes or the emotional distress that this might cause relatives.

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PHILIP MOULD/BRIDGEMAN

The hunter and the hunted. Joshua Reynolds's portrait of John Hunter, with Byrne's skeleton hanging at the top right

Others have adopted a contrary stance.[20-24] The authors of one paper argue that compulsory organ donation might cause significant harm to living people and that there is no easy way to balance this against the fact that others' lives might be saved.[20] Liberal societies place great value on respect for the autonomy of individuals. Significant harm might be caused by forcing people to live with the prospect that, despite their wishes, their bodies will be used for medical purposes. Moreover, such harm may extend after death to the physical and emotional wellbeing of living relatives.

People may decline to be organ donors in the belief that this will negatively influence their afterlife. (Indeed, historically one of these people may well have been Charles Byrne!) If donation was enforced by law, people and their relatives with shared beliefs would have to live with this prospect. Some supporters of compulsory donations argue that refusal to donate organs, say on religious grounds, must be irrational.[16 17] However, irrationality of this kind cannot be demonstrated without making disputable presumptions about the meaning of rationality itself—for example, that evidential justification trumps justification based on a belief in divine revelation, provided that both are internally logically consistent.[25]

In short, since it is known that lives will be at risk if people explicitly refuse to donate organs or other tissue, one school of argument maintains that the duty of rescue always trumps respect for such choices. Another school places priority on the duty to respect autonomous wishes of decedents and relatives about the medical use of bodies. Where no such known risk exists, however, we suspect that these otherwise disputing authors would agree that the prior wishes of the deceased about the disposal of his or her body should be respected in death as far as is practically possible. Where there is such agreement about respect for choice, its moral foundation is more or less the same as it was in Byrne's time.

The implications of this debate for Byrne's skeleton

We agree with those who argue that, all things being equal, everyone should carry donor cards and do their best to ensure that this is respected by their relatives. Indeed we accept that consent to donate should be implied in the absence of explicit refusals to do so.[26] The fact is that Hunter knew of Byrne's terror of him and ignored his wishes for the disposal of his body. What has been done cannot be undone but it can be morally rectified. Surely it is time to respect the memory and reputation of Byrne: the narrative of his life, including the circumstances surrounding his death.

The Hunterian Museum and the Royal College of Surgeons' possession of Byrne's skeleton may have led to beneficial medical outcomes. However, as a justification for not burying his skeleton, that case is no longer tenable. Past research on Byrne did not require the display of his skeleton; merely medical access to it. Moreover, now that Byrne's DNA has been extracted, it can be used in further research. Equally, it is likely that if given the opportunity to make an informed choice, living people with acromegaly will leave their bodies to research or participate in it while alive, or both. Finally, for the purposes of public education, a synthetic archetypical model of an acromegalic skeleton could be made and displayed. Indeed, such skeletons are now used in medical education throughout the world.

It follows then that our arguments and those of others make the case for the removal and burial of Byrne's skeleton.[27-31] As Soren Holm, the first bioethicist to raise this issue, originally stated: "we have clear evidence of the desires of the deceased with regard to a dignified treatment after death, and there seems to be no present countervailing scientific or other gain to achieve by not following the wishes of Charles Byrne."[4]

Last rites

As a sign of respect for Byrne's original desires, his skeleton should be buried at sea as part of a ceremony commemorating his life. We recommend that the Hunterian Museum and the Royal College of Surgeons organise this burial, along with a conference on related legal and ethical issues. At the very least, we suggest that more complete information is provided about the background of the acquisition and display of Byrne's skeleton so that visitors can make a more informed judgment about the moral implications and appropriateness of its continued display.

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References are in the version on bmj.com

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HUNTERIAN MUSEUM RCS OF ENGLAND

bmj.com/video

The authors discuss the fate of the skeleton in a 15-minute video about acromegaly and Charles Byrne's life.

bmj.com poll

Do you think that Charles Byrne's skeleton
a)should now be buried at sea
b)should be taken off display and stored in private for research purposes?
c)should remain where it is on public display?

Vote on bmj.com

Death without the sting

The first dead person I saw was in 1956 on entering the dissecting room at Bristol Medical School. After the initial distaste was overcome, delicately cutting up a dead body became a pleasurable collegiate exercise with chat to fellows on the other side of the lead covered table, forming friendships that have been sustained lifelong.

Each Thursday, we had a viva on the previous week's dissection, and I mostly got As and Bs. However, on Thursday 26 July 1956 I was rewarded with an E, as the day before I had joined a student demonstration in the centre of Bristol and was involved in setting fire to a Union flag as a protest against the impending British invasion of Suez. For this misdemeanour, I spent the night in Bridewell's historic cells and was released without charge the next day in time to sit the viva. At the end of this course, I was awarded an anatomy prize and eventually became a surgeon.

DUNCAN SMITH

Now aged 75 and in gratitude for my anatomical training all those years ago, I have decided to leave my own body for dissection purposes to Bristol Medical School. For this to be arranged one needs to write to the Bequest Office in Southwell Street, Bristol BS2 8EJ, and complete a simple form detailing one's decision.

Squaring the decision with my family proved a little delicate, and a discussion ensued with the local vicar as there would be no body available for a funeral service. He assured me that that was no problem: a memorial service could be held, followed by an internment when the body was returned. It was pointed out that this would be three to five years' later and that there might only be a few parts, as I had allowed any organs to be retained for future study.

After dissection is complete, the largest pieces left for burial are the 2 × 18 inch long femurs, so a much smaller coffin and burial plot can be used. The cleric was not amused by my request for a half price funeral at the appropriate time. Medical schools offer cremation, but this would produce carbon dioxide and dioxins, and I have no wish to contribute any more to climate change.

Although I am a militant Dawkins atheist, I wish to be buried in the parish where I have lived in the former rectory for more than 40 years. Instructions have been given that my coffin should also contain a radio tuned to Radio 4 with a spare set of batteries (just in case). My wife refuses to erect a tombstone as I am not a believer, but suggests a small attractive tree for the churchyard, or a plaque on the church wall.

Lastly, abdominal surgeons and anatomists will tell you that the one thing that makes their work much more difficult is an excess of fat. So I have decided to diet towards my death, probably the first time this dietary regimen has been proclaimed.

John McGarry retired surgeon, gynaecologist, and obstetrician, Barnstaple, UK
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