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Letters to the Editor

Longevity of popes and artists between the 13th and the 19th century

From MARIA PATRIZIA CARRIERI[1] and DIEGO SERRAINO[2]*†

Longevity has increased steadily through history. Life expectancy at birth was a brief 25 years during the Roman Empire, it reached 33 years by the Middle Ages and raised up to 55 years in the early 1900s.[1] In the Middle Ages, the average life span of males born in landholding families in England was 31.3 years and the biggest danger was surviving childhood.[2] Once children reached the age of 10, their life expectancy was 32.2 years, and for those who survived to 25, the remaining life expectancy was 23.3 years. Such estimates reflected the life expectancy of adult males from the higher ranks of English society in the Middle Ages,[3] and were similar to that computed for monks of the Christ Church in Canterbury during the 15th century.[4]

Similar to landholders and monks, members of the Vatican were also likely, in the past centuries, to be better fed, clothed and sheltered, and to had better medical care and to survive longer than most of their contemporary people. Several steps were required before a cardinal could enter the Conclave, making longevity a necessary condition for being elected Pope. Bearing in mind this consideration, we aimed at investigating whether longevity of Popes was longer than that of other population groups of contemporary people, after having taken into account that Popes had to have reached a certain age before being elected to papacy.

In the past, artists were often on duty for the Vatican and could have shared with the members of the Vatican a better access to food and shelter than other people. However, artists were also more likely than Popes to suffer material deprivation and were characterised by social instability and risky behaviours (e.g. travels, sexual promiscuity). In our opinion, artists (e.g. painters, sculptors) constituted one of the suitable population groups for comparison with Popes with regard to longevity because (i) they were a well-defined population group that maintained its particularity across centuries, (ii) the individual information necessary for the aim of the study (i.e. gender, date of birth, area of birth, date of death) were easily available.

We thus carried on a statistical analysis based on historical data on Popes and on male Italian artists who lived between 1200 and 1900. We choose the 13th to 19th century period because the 13th century marks the beginning of artistical activity and the 19th century roughly marks the end of the pre-antibiotic era. For each Pope elected after 1200, calendar year at birth, calendar year at starting pontificate and calendar year at death were searched for in books[5] and in the Web. Information was thereafter computerized by means of a standard package. For the same period, we collected the date of birth and the date of death of all Italian male artists who were listed in '*Storia dell'Arte Italiana*', an exhaustive opus on the history of art in Italy.[6]

To make the survival of the two groups comparable, we restricted our analysis to artists who were alive at the ages their contemporary Popes had when elected at the throne of Peter. The study period was divided in two parts to classify Popes by calendar year at death (1200–1599 or 1600–1900). For each period, the minimum age at starting pontificate was used to exclude artists who died before reaching that age (39 and 38 years, respectively). We chose to censor the analysis at 70 years of age because such cut-off represented—over the centuries—a reasonable indicator of longevity (e.g. 75 years as a cut-off would not be a reasonable choice in the first study period because of the very short life expectancy, whereas 60 years could not be a reasonable one in the last period). The Kaplan–Meyer method was used to compute the cumulative survival probability, and the Cox model was used to compute hazard ratios (HRs) and 95% confidence intervals (95% CIs) of death before age 70 of artists, as compared with Popes.[7] The HR were adjusted for century of death (i.e. a proxy of the improvement in survival across centuries).

We found and analysed relevant information on 80 out of 81 Popes (the date of birth of Celestino IV is unknown) elected between 1200 and who died as of 1900 (actually, 1903 —when Pope Leone XIII died), and on 426 male artists selected according to the above mentioned criteria.

Between 1200–1599 and 1600–1900, the median age of Popes at starting pontificate increased from 60.0 to 65.5 years, while the median duration of pontificate raised from 6.5 to 11.0 years, respectively (Table 1). The median age at death of both groups increased in the study period, from 66 to 77 years for Popes, and from 63 to 70 years for artists (Table 1).

Figure 1 shows the probability that Popes and artists had of reaching 70 years of age during the study period. Longevity of Popes was significantly longer than that of artists ($P = 0.02$), and through the Cox model we estimated that, after adjustment for century of death, artists had a 1.5-fold higher risk of death before 70 years of age with respect to Popes (HR = 1.53; 95% CI: 1.08–2.16) (data not shown in tables).

In conducting this statistical analysis we had to make some assumptions, which could have had implications on the study findings. In particular, artists cannot be considered representative of the other people who were contemporary of the Popes. Furthermore, we have taken into consideration the necessary condition of being old to start pontificate, but our statistical approach might not have fully addressed such a noteworthy bias.

[1] INSERM U 379, Marseilles, France.
[2] Unit of Epidemiology and Biostatistics, IRCCS CRO Aviano, Italy.
† Formerly at the Dept of Epidemiology, INMI ''L. Spallanzani'' IRCCS, Rome, Italy.
* Corresponding author. Servizio di Epidemiologia and Biostatistica, INT CRO, IRCCS, Via Pedemontana Occ 12, 33081Aviano, Italy.
E-mail: serrainod@cro.it

Table 1 Age at starting and duration of pontificate and age at death of Popes and artists, according to study period

Period	Years (interquartile range)			
	Median age at starting pontificate	Duration of pontificate	Median age at death	
			Popes	Artists
1200–1599	60.0 (51.5–67.0)	6.5 (2.0–10.3)	66.0 (59.0–72.0)	63.0 (51.8–71.3)
1600–1900	65.5 (57.5–70.0)	11.0 (4.5–18.8)	77.0 (69.0–82.5)	70.0 (60.0–79.0)

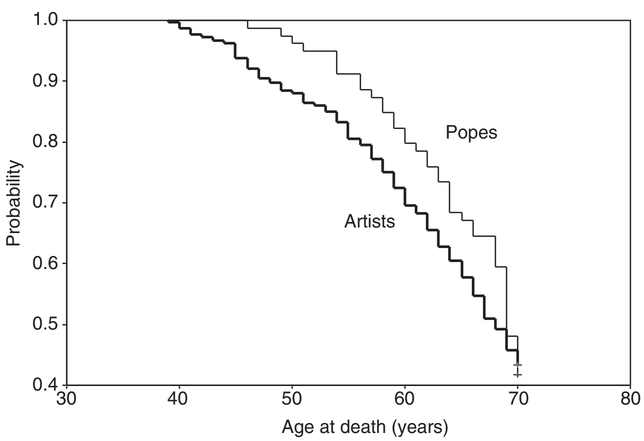

Figure 1 Probability of Popes and artists to survive up to 70 years of age

In conclusion, the findings of this analysis suggest that Popes had higher chances of survive up to 70 years than their contemporary artists, even when the effect of age at starting pontificate was taken into consideration. Bearing in mind the above mentioned study limitations, several hypotheses may constitute likely explanations of this finding. Among others, it is likely that Popes represented in the past centuries a very privileged population group with regard to care and that artists—because of their lifestyle—were probably more at risk than Popes of diseases (like infectious diseases) that could be fatal in the pre-antibiotic era.

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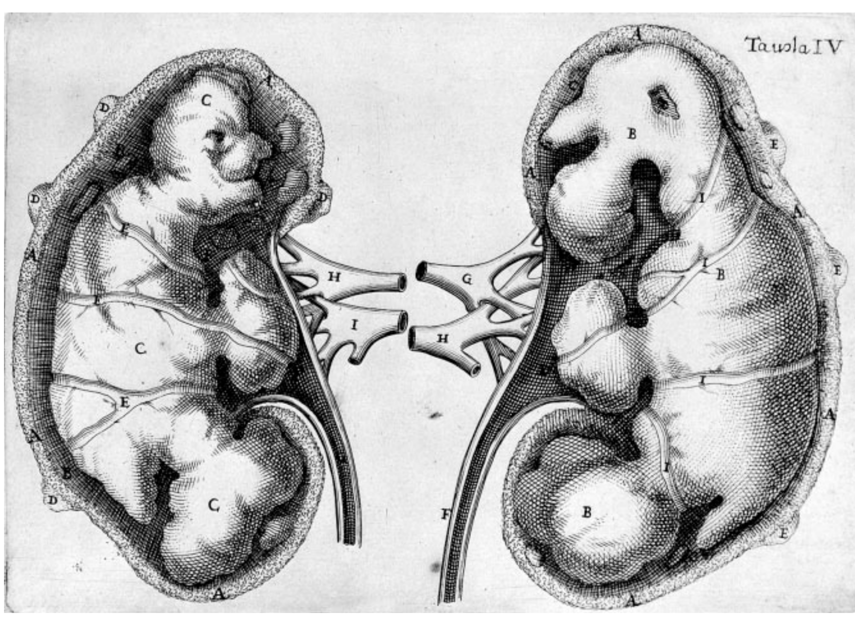

Pope Innocent X1's kidneys containing massive stones (Wellcome Library London). Born in 1611 Pope Innocent XI lived to the ripe old age of 78, having survived primitive surgery to remove his kidney stones. He was said to be ''loved by all on account of his deep piety, charity and devotion to duty''. (The Catholic Encyclopedia online: http://www.newadvent.org/cathen/08021a.htm)

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EDITOR'S CHOICE

Equal, but different? Ecological, individual and instrumental approaches to understanding determinants of health

Editing a journal, even a relatively minor one like the *International Journal of Epidemiology*, can be hard work, but some things make it very rewarding. The chance to reprint a report from the first Framingham study—a community based prospective investigation of tuberculosis control, initiated in 1917[1]—and commentaries from George Comstock about the study itself,[2] Meryvn Susser and Zena Stein about Donald Armstrong, the instigator of the study,[3] and William Kannel and Daniel Levy, relating it to the better known Framingham heart disease study initiated a generation later[4]—is an example of one of these rewards. In the case of the transition from Framingham I (TB) to Framingham II (coronary heart disease) the move was certainly from the community to the individual, perhaps in line with the general tendency of epidemiological thinking over this period.

A second example of the joys of editing is the ability to host an extended debate on an important topic, as exemplified by the exchange initiated by Jose Tapia Granados' analysis of the effect of short-term economic growth on health.[5] To cut a long story short, this exchange[6–12] relates to the use of data on secular trends in health outcomes (mainly mortality) in relation to economic indicators to estimate whether short-term economic growth improves or harms health. As Tapia Granados and other commentators point out, formal analytical interest in this issue has existed since the first decades of the 20th century, and while the methods have improved greatly, some of the interpretive issues are similar to those raised in an exchange between Joseph Eyer[13] (one of whose papers 'Prosperity as a cause of death' admirably adopted a title that summarised its content[14]) and Richard Cooper[15] a quarter of a century ago. The continued focus on this is completely justified, as these are important issues about population health. They are also issues than can ultimately only be addressed by the use of aggregate data.

Analyses of population aggregates—either through secular trend data or through the comparison of health outcomes between areas—are basic epidemiological approaches to understanding the determinants of population health, and ones exemplified in pioneering texts such as the first edition of Jerry Morris' 'Uses of Epidemiology'[16] 50 years ago. In recent years such ecological analyses played an important role in the development of the fetal origins of adult disease hypothesis, as discussed in the cohort profile for the Hertfordshire cohort study, which was set up to follow up on the findings from these aggregate analyses.[17] Our second cohort profile also starts with a discussion of ecological analyses of cause-specific death rates within China, which identified clear and important environmental influences on disease risk that are now being investigated in a large-scale cohort study involving half a million people.[18] A different scale of aggregate experience is illustrated in our Photoessay,[19] which considers how social fragmentation is reflected in very specific features of place.

Ecological studies have other advantages, one of which is that they provide estimates of causal effects that are not attenuated by measurement error (which is discussed in another context by Frost and White in this issue).[20] However, they are subject to confounding, as Yoav Ben-Shlomo[21] discusses in his editorial. An approach that can help here is the use of instrumental variables (discussed in different contexts in our pages several times in recent years[22,23]), which have even been applied to such seemingly difficult issues as the one tackled by Houweling *et al*.[24] regarding the association between wealth and child mortality.[25] Classical epidemiological designs such as using information on the company providing water supply as an index of water quality (as utilized by John Snow) are, essentially, applications of this approach, a fact that links the instrumental variable and ecological analyses.

A final use of aggregates in this issue of the *International Journal of Epidemiology* is the entertaining comparison of longevity of popes and artists by Carrieri and Serraino.[26] These authors suggest that the longer life expectancy of popes reflects the lives characterized by social instability, high-risk behaviours and geographical mobility (and thus infection risk) of the artists. Certainly the life of one of the artists in Carrieri and Serriano's sample—Michelangelo Merisi, better known as Caravaggio, illustrates these threats to longevity. He often lived in poverty, who was fond of alcohol (see his self-portrait as the god of wine—known as 'sick little Bacchus', reproduced here, Figure 1), left the protection and comfort of the house of one patron because he was fed up with the (healthy) diet of salad, travelled constantly, engaged in frequent fights (one leading to murder), was sexually reckless, and who ultimately 'died as wretchedly as he lived'aged 39.[27] However, the assumption of better behaviour by the popes is perhaps unjustified. Of the 41 popes who succeeded Pope John VIII in 872 when his attendants beat him to death, a third had unnatural deaths, some at the hands of their successors.[28] The incessant copulator John XII was accused 'of homicide, perjury, sacrilege, [and] incest with your relatives, including two of your sisters'. No wonder it was popularly considered that the antichrist would first appear as a pope. While painting the ceiling of the Sistine chapel in the early 1500s Michelangelo despaired of his patron, the syphilitic father of (at least) three, Pope Julius II, in verse:

> Of chalices they make helmet and sword
> And sell by the bucket the blood of the Lord
> His cross, his thorns are blades in poison dipped
> And even Christ himself is of patience stripped[27]

Clearly Michelangelo would have recognized the dangers of assuming that certain aggregate groups, such as popes, were free from the vices of other aggregate groups, such as artists.

GEORGE DAVEY SMITH

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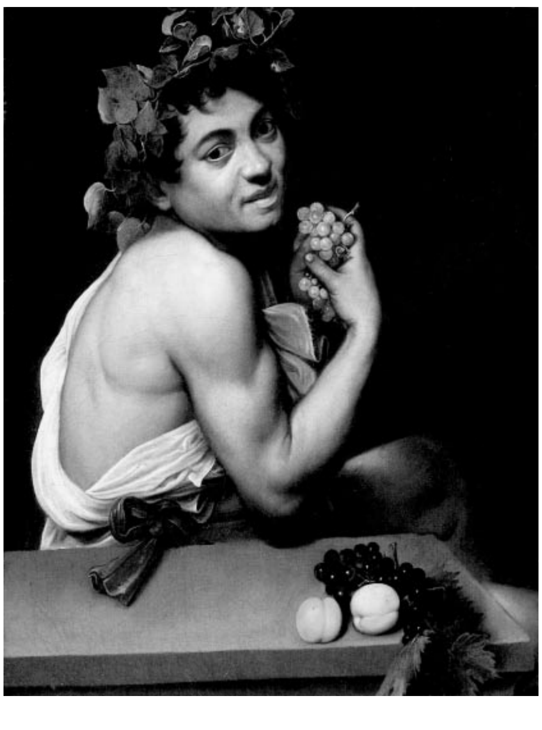

Sick Bacchus by Caravaggio. Reproduced with permission from Archivio fotografica Soprintendenza Speciale per il Polo Museale Roma, Italy

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Letter to the Editor

Statistical fallibility and the longevity of popes: William Farr meets Wilhelm Lexis

From JAMES A HANLEY,[1]* MARIA PATRIZIA CARRIERI[2] and DIEGO SERRAINO[3]

We write to follow up on the editorial[1] on the use of statistical aggregates. We focus on the reaction, in it, to the letter from two of us (MPC and DS) in the same issue suggesting that the 'longer (average) life expectancy of popes relative to artists[2] reflects the lives characterized by social instability, high-risk behaviours and geographical mobility (and thus infection risk) of the artists.' The Editorial presented evidence that the 'assumption of better behaviour by the popes is perhaps unjustified'. We have now looked behind the summary longevity statistics, and present individualized data showing that the initial, but tentative, conclusion about their longer life expectancy should be reversed. Even if the assumption of better behaviour 'on average' of popes is justified, these behaviours were not—*even on average*—accompanied by longer life expectancy.

We now show the longevity data in Figure 1, using the Lexis diagram,[3] a device sadly neglected by modern epidemiologists. It plots advancing age on the vertical, and calendar time on the horizontal, axis. The 'pope-years' (i.e. *after* they were elected) are shown in black and the artist-years (*all* of them) in grey. In the initial report, the statistics, aggregated over centuries, suggested that popes had a longevity *advantage* of several years. However, if we proceed papacy by papacy, the inter-ocular traumatic test[4] (IOTT)—another under-used analytic device—applied to Figure 1 reveals that *among those who were alive at the age at which each papacy commenced*, the average remaining life of the popes was *shorter* than that of the corresponding peer artists—at least up until 1750 or so, after which the distributions became more similar.

The principal cause of this reversal is the phenomenon that the first analysis of this dataset sought to remove, namely that 'Popes had to have reached a certain age before being elected to the papacy'. In that analysis, the statistical approach did not fully address this constraint. Ideally, for each papacy-specific 'longevity competition', the time-clock should start when the pope is elected, and the competition should include the pope, and those artists born the same year as he, who were still alive when he was elected. However, for several papacies, such detailed matching is not possible. Instead, for each of the 1200–1599 papacies, the previous analysis effectively 'started the clock' at age 39—the age at which the *youngest* pope in that era was elected—by excluding artists who died before reaching that age. For the 1600–1900 papacies, it was started at age 38.

Unfortunately, under this broad scheme, as is clear from Figure 1, several artists included in that analysis died before 'their' (and several other) pope(s) were even elected. This inbuilt survival advantage[5,6] for the popes is an example of what is today called 'immortal time bias'.[7] William Farr described this fallacy in 1843.[8] He noted that the average age at death of bishops is greater than that of curates, and thus—concerned for the underprivileged—suggested that curates should be promoted to bishops, and at an early age, 'for the sake of their health.'

Rather than match perfectly on year of birth and age at entry to *each* longevity competition, one could for example proceed half century by half-century, and determine the youngest age ($A_{\min}$) at which a pope born (or elected) in that half-century was elected, and compare the post-$A_{\min}$ survival of these popes and the corresponding artists. However, these half-century (or even narrower) strata would still contain at least one other pope elected at an age older than $A_{\min}$, after several artists would already have died, and so the competition would continue to be unfair.

In our new analysis, we circumvented this by creating a separate contest (stratum) for each papacy. We started the clock at the age at which the specific pope was elected. We used as a comparison group those artists, born within 25 years of when the pope was, who had reached that same age. For example, in Figure 2, consider the papacy that began at 1335, when the pope, born in 1280, was 55. Five 'nearby' artists, born in 1260, 1266, 1280, 1284, and 1290, all of whom lived until at least 55, serve as a comparison group. The pope died in 1342, at age 62, after 7 years as pope. His five 'peers' died in 1318, 1337, 1348, 1344 and 1348, respectively, at ages 58, 71, 68, 60, and 58. Thus, their 'post-55' survival times were 3, 16, 13, 5, and 3 years, respectively, so that two lived longer than the pope, by +9 and +6 years, and three lived a shorter amount, i.e. the (artist minus pope) differences were −4, −2 and −4 years. In this approach, some artists serve in several comparisons: for example the artist who lived from 1280 to 1348 competes again in the next papacy, but against a younger pope. One can correct for this 're-use' of some artists, by using robust standard errors, from say a GEE analysis.

Figure 3 plots the (artist minus pope) differences. There are too few artists to serve as comparators for 13th century papacies. From the 14th up until the 18th century, the IOTT confirms that the artists tended to outlive the popes. We heed the editorial warning about the dangers of aggregation (in this case, over *time* rather than people), and thus refrain from giving an overall average; we merely note that the average difference in Figure 3 is positive—statistically so, even when we correct

[1] Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montreal, Canada.
[2] INSERM U379/ORS PACA, Marseilles, France.
[3] Unit of Epidemiology and Biostatistics, IRCCS CRO Aviano, Italy.
* Corresponding author. Department of Epidemiology, Biostatistics and Occupational Health, McGill University, 1020 Pine Avenue West, Montreal, PQ, Canada H3A 1A2. E-mail: James.Hanley@McGill.ca

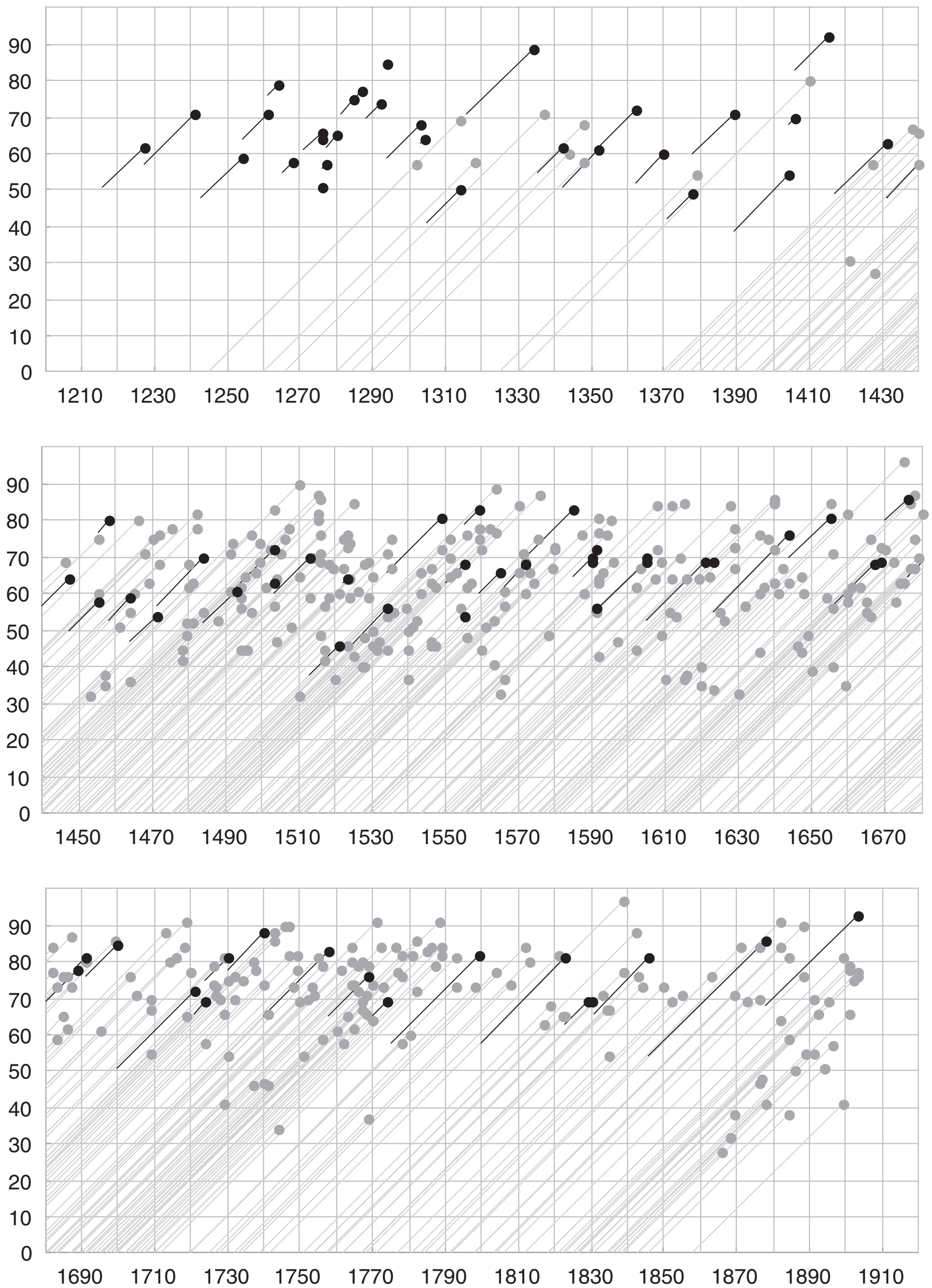

Figure 1 Lexis diagram, with age on vertical, and calendar time on the horizontal, axis. Pope-years (i.e. those post election) shown as black lines and artist-years as grey lines. Age of/year at death indicated by circle

for the 're-use' of some artists. Readers who are not convinced by IOTT's, and who insist on translating the differences into cold hazard ratios (HRs), are asked to estimate the overall and the calendar-time-specific HRs by eye. In the earlier analysis, with popes as the reference category, and observations censored at age 70, the HR for artists was 1.50; here, the average HR is decidedly <1. The ratio varies considerably: it was ~0.3 in 1300 and 1.0 in 1800. Narrower windows give similar results.

Like the Editor, we too believe that Michelangelo would have recognized the dangers of 'assuming that certain aggregate groups, such as popes, were free from the vices of other aggregate groups, such as artists' or—in this instance—of aggregating over time. Michelangelo would also have liked Aaron Levenstein's (http://politicalgraveyard.com/) quip about statistics: 'what they reveal is suggestive, but what they conceal is vital.' He might also have admired Lexis' 2-D epi-geometry, and Farr's illustration of statistical fallibility ('bias', nowadays), in relation to (im)mortality and religious careers.

For some situations, even the sharpest and best-designed statistical analysis may fail to uncover the truth. Just as

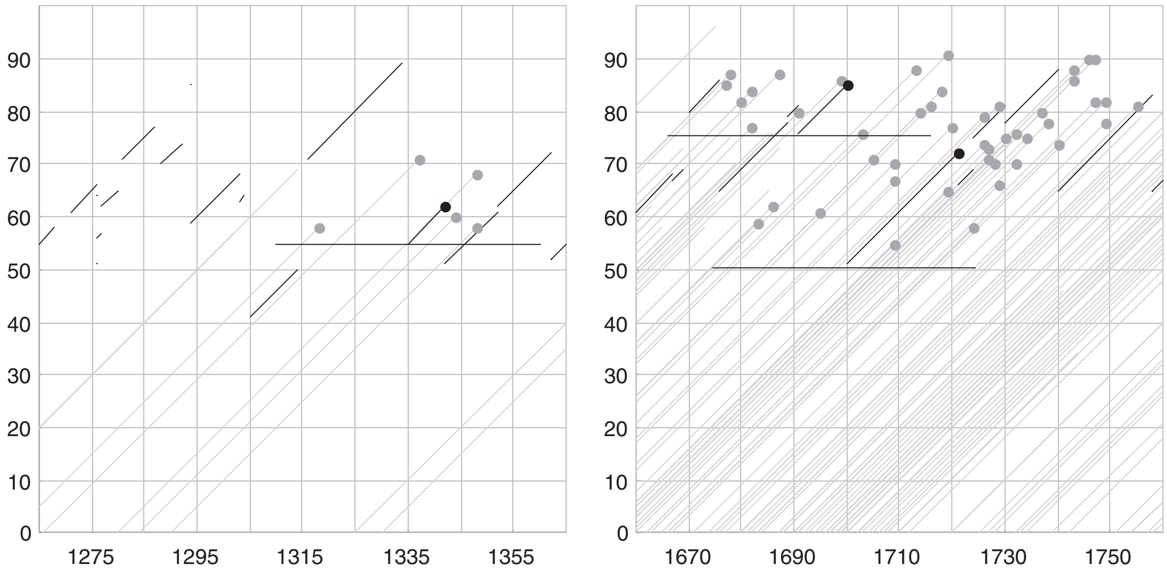

Figure 2 Mini-cohorts based on specific papacies. Left: papacy that began in 1335, when the Pope, born in 1280, was 55, along with (diagonally above and to right of horizontal black line) the five artists, born within 25 years of when the Pope's birth, who reached that same age Right: papacies that began at 1691 at age 76, and 1700, at age 51

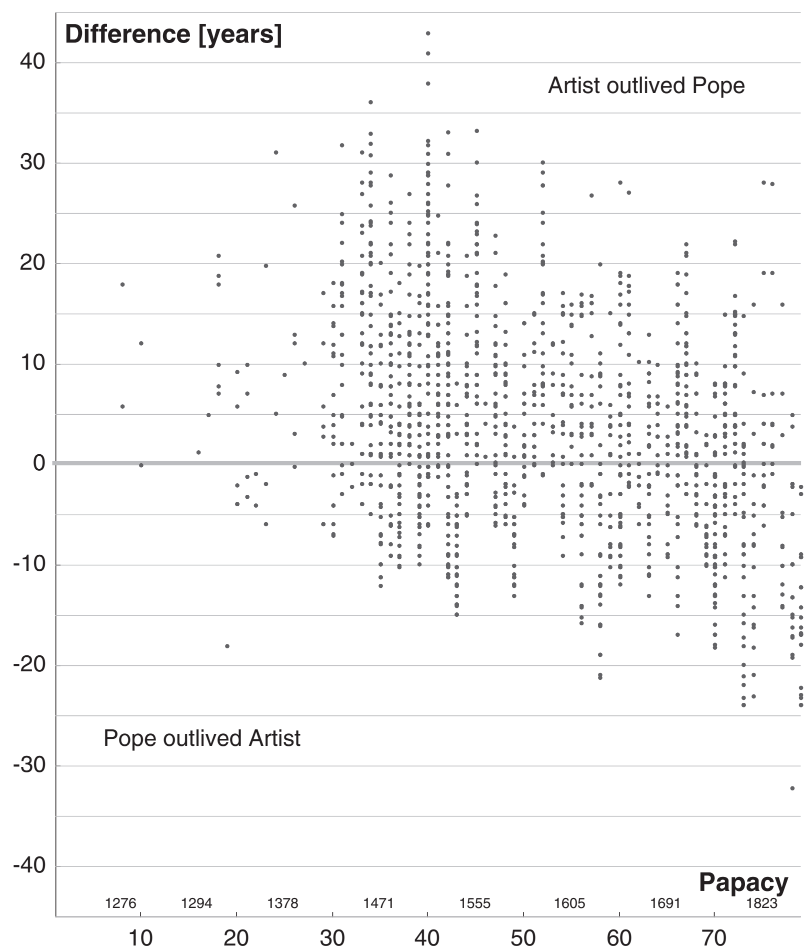

Figure 3 The numbers of years by which artists, who had reached the same age as the Pope was when elected, outlived (positive differences, vertical axis), or were outlived by (negative differences), the Pope

'confounding by indication' is a near-impossible challenge in non-experimental studies of drug efficacy, a similar phenomenon may have been at play here. It is possible that in some periods cardinals prefer to choose healthier or less healthy popes (depending on political circumstances) to try to influence how long they will be in power. We do not statistically investigate the existence of such 'guided' individualized choices, preferring instead to let the data in Figures 1 (after Lexis) and 2 and 3 (dedicated to Farr) speak for themselves.

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