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# Medieval Monastic Mortality: Hazard Analysis of Mortality Differences Between Monastic and Nonmonastic Cemeteries in England

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*ABSTRACT* Scholarship on life in medieval European monasteries has revealed a variety of factors that potentially affected mortality in these communities. Though there is some evidence based on age-at-death distributions from England that monastic males lived longer than members of the general public, what is missing from the literature is an explicit examination of how the risks of mortality within medieval monastic settings differed from those within contemporaneous lay populations. This study examines differences in the hazard of mortality for adult males between monastic cemeteries ($n$ = 528) and non-monastic cemeteries ($n$ = 368) from London, all of which date to between AD 1050 and 1540. Age-at-death data from all cemeteries are pooled to estimate the Gompertz hazard of mortality, and "monastic" (i.e., buried in a monastic cemetery) is modeled as a covariate affecting this baseline hazard. The estimated effect of the monastic covariate is negative, suggesting that individuals in the monastic communities faced reduced risks of dying compared to their peers in the lay communities. These results suggest better diets, the positive health benefits of religious behavior, better living conditions in general in monasteries, or selective recruitment of healthy or higher socioeconomic status individuals. Am J Phys Anthropol 152:322–332, 2013. 

Monasteries were an important part of the social, political, and economic landscapes of medieval Europe, for in addition to their more obvious role in religious life, they served as landowning corporations, landlords, employers (of domestic servants, craftspeople, physicians, and others), and centers of education (Lawrence, 1989). Given its prominent role in shaping medieval society, monasticism has long drawn the attention of historians and bioarchaeologists. There is a rich literature on monastic diet, housing conditions, activity patterns, and other aspects of life in medieval monastic communities that potentially affected both morbidity and mortality among monastery inhabitants. Scholars have identified numerous differences in the experiences of people living in monastic versus nonmonastic (i.e., secular) settings, as outlined below. These differences, in turn, could have created variation in the patterns of health and mortality between the two subpopulations within medieval Europe.

Previous studies of monastic communities have found evidence of both survival advantages and disadvantages compared to lay populations. For example, Sullivan (2004) found, based on skeletal data, that male religious members at St. Andrew's Fishergate lived longer than their lay contemporaries in medieval York. Hatcher (1986) used parish registers and family reconstitution data and found that the expectation of life for monks in Christ Church Canterbury (*c*. 1395–1505) was lower than that for the lay population *circa* 1541 to 1871. Hatcher et al. (2006) also found lower life expectancy for monks in Durham Priory. However, both of these studies compared late medieval monastic populations to early modern lay populations, and the authors caution that we lack detailed knowledge about mortality in the late-medieval population at large. Analyses of relatively recent monastic populations (*c*. 1900–1994) in Germany and the Netherlands have revealed temporal variation in mortality patterns, with higher mortality for monks compared to the general population before the mid-20th century, but lower mortality and higher life expectancy for monks in the latter half of the century (Gouw et al., 1995; Luy, 2003).

Many aspects of medieval monasticism potentially conferred health benefits and might have acted to reduce risks of mortality among monastery inhabitants compared to the general public. As described in the Discussion, over the course of the Middle Ages, diets in many monasteries became increasingly similar to those of wealthy households, and even when monastic diets were not particularly rich, they were at the very least adequate (Lawrence, 1989; Harvey, 1993); the same, however, was probably not true for all members of the lay population. Beyond eating relatively well, inhabitants in many monasteries enjoyed good housing, clothing, sanitation, hygiene, and medical care, and they were generally freed from demanding physical labor and therefore likely faced relatively low risks of serious injury or accidental death from work-related causes (Hatcher, 1986; Sullivan, 2004; Hatcher et al., 2006).

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Some researchers have argued that the standard of living in many monasteries was similar to that of the nobility or other elite households (Harvey, 1993).

In addition to the extrinsic factors that could have benefited health in monasteries, there is evidence from living populations that meditation, prayer, and other types of religious behavior can have positive effects on immune function and other health factors (Woods et al., 1999; Koenig et al., 2001; Sephton et al., 2001; Davidson et al., 2003; Newberg et al., 2003; Robinson et al., 2003; Carlson et al., 2007; Tang et al., 2007; Ferguson et al., 2010). In medieval Europe, lay people who engaged in religious activities could have benefitted from the positive health effects thereof, but monastic inhabitants would have benefited to a greater degree given their more frequent involvement and greater degree of training in such activities.

There were also factors associated with life in a monastic community that might have elevated risks of mortality. Some monastic orders engaged in ministry and service to the public, either inviting the public to worship in their churches or leaving the monastery to engage in pastoral work. Further, monastery infirmaries were among the best sources of medical care in medieval England, serving both monastic inhabitants and lay individuals (Rawcliffe, 2002; Dyson et al., 2011). Contact with the general public, particularly those in poor health in infirmaries, possibly increased the exposure of monastic inhabitants to infectious diseases relative to a typical layperson. The communal living characteristic of many monasteries (e.g., sleeping in common dormitories) might also have negatively affected health by promoting the spread of infectious disease (Harvey and Oeppen, 2001; Hatcher et al., 2006); though medieval secular households were also characterized by shared sleeping chambers, there were typically fewer individuals in a single room in such households compared to monasteries. The rich diets available in monasteries might actually have been detrimental, particularly if combined with a lack of exercise (Hatcher et al., 2006); for example, in the Merton Priory cemetery, Waldron (1985) found a relatively high frequency of diffuse idiopathic skeletal hyperostosis (DISH), a pathological condition that might be associated with obesity and late onset diabetes.

In addition to differences in the monastic and nonmonastic ways of life, variation existed between medieval monastic houses in their engagement in particular religious behaviors. Bermondsey Abbey, which is used in this study, was a Cluniac monastery (one branch of the Benedictines). The Cluniac ideal was a complete renouncement of the world, silence, and highly complex, continual prayer (Lawrence, 1989), and monks in these houses typically spent a large part of their day engaged in vocal prayer, often exceeding what was prescribed in the Rule of St. Benedict (Dickinson, 1962; Lawrence, 1989; Kerr, 2008). Our second monastic sample comes from Merton Priory, an Augustinian monastery; beginning in the 12th century, Augustinian canons engaged in active pastoral work and visited villages and towns to preach, a practice that was not embraced by Benedictines in general (Dickinson, 1962; Lawrence, 1989). Augustinians engaged in less protracted periods of prayer than typical Benedictines (Butler and Given-Wilson, 1979). These variations in religious practices potentially led to differences in the associated health effects between the two monasteries.

Furthermore, the two monasteries examined in this study were located in different environments. Merton Priory was located in the rural area of Surrey, approximately seven miles from the City of London. Bermondsey Abbey, however, was much closer to the City of London, just half a mile south of the River Thames and the Tower of London. The close proximity of Bermondsey Abbey to the City might have meant that the monks there were subject to the negative health effects associated with the extraordinarily crowded conditions of London (Roberts and Cox, 2003). On the other hand, the Augustinians had more contact with the outside world, and Merton Priory was an important center of education (Butler and Given-Wilson, 1979). It is thus possible that Bermondsey Abbey monks experienced less exposure to disease because of less protracted interaction with the lay community compared to Merton Priory.

No study to date has explicitly examined how the risks of mortality within medieval monastic settings differed from those within contemporaneous and geographically proximate lay populations and how such differences in mortality reflect the effects of the distinctive monastic way of life (Mays, 2006). This study examines mortality patterns within and between several monastic and nonmonastic cemeteries from medieval London (*circa* 1050–1540 AD) to test the hypothesis that the monastic way of life conferred health benefits that resulted in lower risks of mortality. Further, given the differences in setting and behavior between Merton Priory and Bermondsey Abbey, we also compare mortality patterns between the two monasteries.

## MATERIALS AND METHODS

This study uses a combined sample of 528 individuals from two medieval monastic cemeteries and 368 individuals from four medieval non-monastic cemeteries from London to assess differences between the two types of communities in the risks of adult mortality. We also examine variation in risk of mortality between the two monastic communities that might be associated with differences in location and the religious activities emphasized in the associated orders. The samples for this study are all from medieval London cemeteries and are curated by the Center for Human Bioarchaeology at the Museum of London (WORD database 2012). Females make up a small proportion of the monastic cemeteries; no females for whom age was estimated were excavated from Bermondsey Abbey, and only 12% of adults with age estimates in Merton Priory were female. However, females comprise a much larger proportion of the nonmonastic cemeteries (e.g., one-third of adults of estimable sex in St. Mary Graces were female). Such a discrepancy in the number of females in the monastic and nonmonastic samples means that any estimated differences in mortality between the two communities using samples with both sexes could reflect the effect of sex in the nonmonastic samples more than the effect of non-monastic life. That is, the inclusion of both sexes in our samples would make it difficult to infer the effects of living in monastic vs. non-monastic communities. Therefore, analyses for this study are restricted to the males from all cemeteries. Similarly, subadults (individuals below the age of 18) made up a very small proportion of the monastic cemeteries; only one individual of the over 200 interred in Bermondsey Abbey was a subadult, and fewer than 5 percent of those buried in Merton Priory

were subadults. Subadults comprise much larger proportions of the non-monastic cemeteries. To control for the potential effects of such sample bias on estimates of mortality, including the difficulty (or impossibility) of fitting a juvenile hazard of mortality with insufficient data, mortality hazards are fit only to adult age data from all cemeteries for this study.

## Skeletal samples: monastic cemeteries

***Merton Priory (c. 1117–1538).*** The Augustinian Priory of St. Mary Merton, Surrey was established in *c.* 1114–1117 in a rural area in the valley of the River Wandle and remained in use until the Reformation in 1538 (Miller and Saxby, 2007). Excavations by the Museum of London Archaeology Service (MoLAS) ultimately revealed 736 burials in the external cemetery, church, cloister, chapter house, and infirmary complex (Miller and Saxby, 2007). Merton Priory differs from the other cemeteries used in this study because of its more rural setting. The potential implications of this difference are addressed both in our analyses and in the Discussion. This study uses a sample of 399 adult males from Merton Priory; this sample comprises all of the excavated adult males from Merton Priory who were preserved well enough to provide sufficient data on age (using the method described below).

***Bermondsey Abbey (c. 1066–1540).*** The Cluniac Priory of St. Saviour Bermondsey, Surrey was established in the 1080s. The exact timing of the foundation of the monastery is unclear, but the first monks arrived from France in 1089. Bermondsey Abbey was located south of the River Thames, opposite the Tower of London. The MoLAS excavated the site from 1984 until 1995, recovering 202 burials dating between 1066 and 1538. Seven of the burials were recovered from inside the chapel, with the remainder excavated from a cemetery located between the chapel and the church. The demographic profile of the burials (overwhelmingly adult males) is consistent with Merton Priory and other monastic sites in London (WORD database 2012). This study uses a sample of 129 adult males from Bermondsey Abbey.

The cemeteries associated with Merton Priory and Bermondsey Abbey, though primarily monastic, may contain lay individuals. Many medieval monasteries allowed burial of lay people in their cemeteries. However, such burials were usually allowed in exchange for bequests of land or money, which would generally only be possible for better-off individuals and thus exclude poor people from the monastic samples (Gilchrist and Sloane, 2005; Mays, 2006). Lay individuals are likely to comprise a minority of the monastic sample; indeed, the demographic profiles of Bermondsey Abbey and Merton Priory are mostly male and adult, which clearly differentiates them from the non-monastic cemeteries described below. However, the effect that the inclusion of individuals who did not live in the monastic communities but were nonetheless buried in the monastery cemeteries could have on the results of this study must be considered and is addressed in the Discussion.

## Skeletal samples: Nonmonastic cemeteries

***Guildhall Yard (c. 1050–1350).*** The Guildhall Yard site is located in central London. It was the site of the lay cemetery for St. Lawrence Jewry, and the MoLAS conducted excavations there between 1992 and 1997. A total of 68 individuals, all of whom date to the late 11th century, were analyzed from these excavations, and 17 adult males are used in this study (WORD database 2012).

***St. Benet Sherehog (c. 1250–1500).*** The site of St. Benet Sherehog consists of a parish church and cemetery located near the center of London. The church was built in the 11th century and remained in use until 1666, when it was destroyed by the Great Fire of London (Miles et al., 2008). Following the fire, the church was not rebuilt, though the site continued to be used as a burial ground for the parish. St. Benet Sherehog was a small but comparatively affluent parish. It was regularly a contributor to poor relief, and average rents within the parish were quite high compared to the city average (Miles et al., 2008). Excavations took place at the site between 1994 and 1996. Of the 274 burials recovered during these excavations, 39 were dated to the medieval period (WORD database 2012). This study includes eight adult males from this period.

***St. Mary Graces (c. 1350–1538).*** The Cistercian Abbey of St. Mary Graces was established in east London, near the Tower of London, just after the Black Death ended in London in 1350 and was in use until the Reformation in 1538 (Grainger and Hawkins, 1988; Grainger et al., 2008). Lay individuals (with the exception of some higher status people) were interred in a cemetery associated with the Abbey, and monks and important lay people were buried within the Abbey's church and chapels (Grainger and Hawkins, 1988; Rogers and Waldron, 2001; Grainger and Phillpotts, 2011). Excavation of St. Mary Graces in the 1980s by MoLAS revealed several hundred skeletons within the Abbey church and chapels and from the larger lay cemetery (Grainger and Hawkins, 1988; Grainger and Phillpotts, 2011). The St. Mary Graces cemetery contains individuals of all ages, both sexes, and both higher and lower socioeconomic statuses (WORD database 2013). This study uses a sample of 122 adult males from the St. Mary Graces cemetery.

***St. Mary Spital (c. 1120–1250).*** The hospital and priory of St. Mary Spital was situated outside the eastern walls of the City, close to Bishopsgate. They were founded by a group of wealthy London merchants in 1197 in response to the City's increasing population and growing need to provide charity for the deserving poor (Connell et al., 2012). The first hospital at the site had an associated cemetery (Spital Square) that was exclusively used by the infirmary from 1197 to 1280, but it is not included in this analysis (Thomas et al., 1997). The hospital was refounded in 1235 on a plot of land that included another cemetery that was already in use. It is suggested that this cemetery was not used to bury those who died in the infirmary until after 1280 (given that the infirmary used the Spital Square cemetery described above until that time) (Connell et al., 2012); that is, in the St. Mary Spital cemetery, burials that pre-date 1280 do not likely represent infirmary patients. In addition to lay burials, the cemetery also might have been used for members of the priory (i.e., canons, lay staff, residents

and benefactors) beginning in 1235. However, it is considered to primarily be a secular cemetery (Connell et al., 2012). The greater portion of the site was excavated between 1998 and 2001 by MoLAS (Connell et al., 2012). A total of 10,516 individuals were excavated, of which 5387 were recorded onto WORD. The cemetery has been divided into four periods using Bayesian radiocarbon dating: 14 (*c*. 1120–1200), 15 (*c*. 1200–1250), 16 (*c*. 1250–1400), and 17 (*c*. 1400–1539), and there are both single and multiple burials in each period (Connell et al., 2012). Our study includes only single inhumations (burial type A) of adult males from periods 14 and 15, both of which are believed to pre-date the use of the cemetery for infirmary burials. This provides a sample of 221 (106 from period 14, and 115 from period 15).

Just as the monastic cemetery samples may include lay individuals, the lay cemeteries, e.g., St. Mary Graces, contain monks and other religious status individuals, though the majority of burials represent non-monastic individuals (Grainger and Phillpotts, 2011). The possible effects of the inclusion of monastic individuals in the non-monastic cemeteries on the results of this study are addressed in the Discussion.

## Age and sex estimation

***Age estimation.*** The age estimates used in this study were obtained from the Museum of London Wellcome Osteological Research Database (WORD database 2012). Adult ages (i.e., ages 18 years or older) were estimated based on tooth wear (Brothwell, 1981), and age-related changes of the pubic symphysis (Brooks and Suchey, 1990), iliac auricular surface (Lovejoy et al., 1985), and sternal rib ends (İşcan et al., 1984; İşcan et al., 1985; Powers, 2012). The age estimates from WORD are provided as interval estimates: 18–25, 26–35, 36–45, and 46+. For these analyses, we use the midpoints of the interval estimates for individuals assigned to the first three intervals, i.e., 21.5, 30.5, 40.5; the terminal age category (46+) is open-ended, and thus has no true midpoint, so we used an age of 50.5 for this interval in our analyses. We note that the inclusion of the earliest age interval (18–25) is not likely to result in severe left-censored data for the monastic samples, given that men entered monasteries at young ages during the medieval period. According to Hatcher (1986), at the Benedictine Priory of Christ Church, Canterbury in the 15th century, the mean age at profession of monks was 16.8 years, and all were professed between the ages of 15 and 21. Similarly, in Durham Priory, the "great majority" of monks were professed in their late teens or early twenties (Hatcher, 1986). In Westminster Abbey, monks were professed at age 21 from 1390–1469, and at age 18 from 1470 until the dissolution of monasteries (mid-1500s) (Harvey, 1993). Age at profession, however, is not necessarily the same as age at entry. According to Harvey (1993), the period between being "clothed" (i.e., taking on the monastic garments) and professed in Benedictine monasteries ranged from a few weeks to a year. In some monasteries, during the Middle Ages, the vast majority of monastery novices were clothed between the ages of 18 and 20, and clothing at age 15 was common (Harvey, 1993). However, given the possibility that some individuals in our monastic samples entered the monasteries at later adult ages, we restricted one set of analyses to individuals above age 26 for comparative purposes, as described below

***Sex estimation.*** Sex estimates were also obtained from the WORD database. Sex was estimated using standard methods based on sexually dimorphic features of the skull and pelvis (Phenice, 1969; Brothwell, 1981; Bass, 1987; Buikstra and Ubelaker, 1994). Sex estimates were used to exclude females from all cemetery samples for this study.

## Statistical analyses

***Kolmogorov–Smirnov.*** The age at death distributions from the pooled monastic and non-monastic cemetery samples are compared using a Kolmogorov–Smirnov (SPSS version 20) test to identify differences between the two distributions that suggest survival advantages or disadvantages associated with monasticism.

## Hazard models

***Monastic vs. non-monastic.*** To assess the differences in risks of mortality between the monastic and non-monastic communities, age-at-death data from all cemeteries are pooled to estimate a baseline hazard of mortality and "monastic" (i.e., burial in a monastic cemetery and thus presumed residence in a monastic community) is modeled as a covariate affecting that baseline hazard. The baseline hazard is modeled as the Gompertz model of adult mortality:

$$h(a)=\alpha e^{\beta a}$$

where $a$ is age, and $\alpha e^{\beta a}$ is an exponentially increasing risk of mortality (Gage, 1988). Because the Gompertz model requires the estimation of just two parameters, it can be applied to relatively small samples, and it smoothes the random variation usually present in mortality data from these samples without imposing any particular age pattern on the data (Gage, 1988; Wood et al., 2002). Further, parametric models, such as the Siler model, are suitable for use with datasets such as ours that include imprecise age estimates, including open-ended terminal age categories (Milner et al., 2008). Parametric models are particularly useful when working with open-ended terminal categories as they allow for assessment of patterns at later adult ages that would otherwise be "unaccessible" (Milner et al., 2008: p 585).

For this study, burial in a monastic cemetery is modeled as a covariate acting upon the parameters of the Gompertz model using a proportional hazard specification:

$$h(a|x_i\rho)=h(a)e^{x_i\rho}$$

where the baseline hazard $h$(a) is the Gompertz hazard, $x_i$ is the monastic covariate (0 = buried in a non-monastic cemetery, 1 = buried in a monastic cemetery), and $\rho$ is the parameter representing the effect of the monastic covariate on the baseline hazard. Parameters are estimated using maximum likelihood analysis with the program *mle* (Holman, 2005). A negative estimate for the parameter representing the effect of the monastic covariate on the hazard would suggest that people who lived in monastic communities were at a decreased risk of death compared to individuals who lived in lay communities. For most of our analyses, we included all individuals above the age of 18 to maximize our sample sizes. However, because of the possibility that men entered the monasteries at later adult ages, and thus that there is left censoring in our monastic samples, we

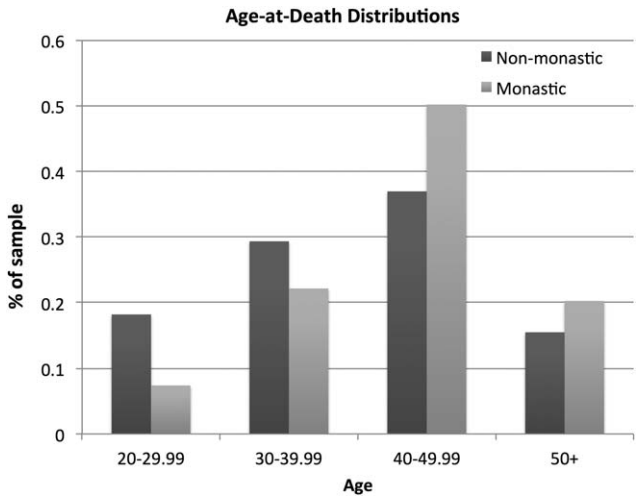


**Fig. 1.** Age-at-death distributions from the monastic and non-monastic samples.

also assessed mortality differentials using samples that excluded individuals in the 18–25 age interval to verify that our results using all age categories reflect real patterns and are not simply an artifact of biased samples. It should be noted that we use age estimates without their associated errors to estimate the parameters of the models, and thus, the reported standard errors for the parameter estimates are likely underestimated to an unknown degree; readers should therefore view the standard error estimates with caution.

A likelihood ratio test (LRT) is used to assess the fit of the full model compared to a reduced model in which the value of the parameter representing the monastic covariate was set equal to 0 ($H_0$: effect of living in a monastic community = 0). The LRT tests the null hypothesis that monasticism had no effect on risk of mortality. The LRT was computed as follows: $\text{LRT} = -2[\ln(L_{reduced}) - \ln(L_{full})]$, where LRT approximates a $\chi^2$ distribution with $df = 1$. Though we are wary of reporting statistical significance, given recommendations by major epidemiological and medical journals to avoid doing so (Lang et al., 1998; Rothman, 1998; Goodman, 1999; Cohen, 2011), we consider $P$ values $<0.10$ to be suggestive of a real effect.

As described above, Merton Priory differs from Bermondsey Abbey and all the non-monastic cemeteries by being located in a rural, rather than urban setting. Because of this, observed differences in risks of mortality between the pooled monastic and the non-monastic samples could, at least partly, reflect differences in rural vs. urban conditions rather than differences in monastic and non-monastic ways of life. Therefore, we also compare patterns in the non-monastic cemeteries to those in just the Bermondsey Abbey sample; i.e., we restrict the analysis to the urban cemeteries to verify that the results of our monastic vs. non-monastic comparison are not an artifact of using the rural Merton Priory sample. The comparison of risks of mortality in Bermondsey Abbey and the pooled non-monastic samples uses the same analytical approach as that described above, save for excluding the Merton Priory sample. We also compare mortality patterns between just Merton Priory and the non-monastic samples to confirm whether mortality differences between monastic and non-monastic communities were consistent across the two monastic cemeteries.

***Urban vs. rural monastic.*** Given the differences in location and religious activities between Merton Priory and Bermondsey Abbey described above, which might have created variation between the two monasteries in exposure to numerous factors that influenced health and survival, we also compare mortality risks between them. This analysis provides a means of determining whether there is a pan-monastic pattern of mortality associated with the distinctive monastic way of life that potentially differs from the pattern existing in non-monastic communities, or if variation in mortality existed between monastic communities. To assess differences in mortality between Merton Priory and Bermondsey Abbey, the data from both monastic cemeteries are pooled to estimate the baseline risk of mortality, modeled again as a Gompertz function, and burial in Merton Priory is modeled as a covariate affecting that baseline hazard. A likelihood ratio test, which tests the null hypothesis that residence in Merton Priory had no effect on risks of death, was performed as described above.

Given the close proximity of all the non-monastic cemeteries within London and the small samples sizes from each cemetery, comparison of the mortality patterns among the non-monastic cemeteries was not done for this study.

This study, like most paleodemographic studies, makes the assumption that the population under investigation was stationary, i.e., closed to migration and having constant age-specific fertility and mortality rates, a stable age distribution, and a growth rate of zero (Wood et al. 1992; Milner et al. 2008). Such an assumption allows paleodemographers to use skeletal age-at-death distributions to estimate mortality rates and other demographic patterns. However, this assumption, if violated, means that our estimates might be biased. This likely does not present a major limitation for our study given that we are looking at a relatively long time period, during which perturbations in fertility and mortality should tend to average out, and we are comparing subpopulations within a larger population rather than comparing two separate populations. However, ideally, we would use a model that allows for estimation of the population growth rate, and thus make the less stringent assumption that our population was stable (a state that most populations tend towards) (Wood et al., 2002; Milner et al., 2008), but that is beyond the scope of this article.

## RESULTS

The age-at-death distributions from the monastic and non-monastic cemeteries are shown in Figure 1. Based on the results of the Kolmogorov–Smirnov test, the two distributions are significantly different ($P < 0.05$). Compared to the non-monastic cemeteries, the proportion of individuals between the ages of 20 and 39.99 is lower in the monastic cemeteries, but the proportion of individuals above the age of 40 is higher in the monastic cemeteries.

Table 1 provides the estimated values of the parameter representing the effect of the monastic covariate on the adult risk of mortality and the associated likelihood

*TABLE 1. Maximum likelihood estimates (with standard error) of the effect of the covariates on adult mortality and results of the likelihood ratio tests*

| Covariate | Effect of covariate (s.e.) | −2LLR |
|---|---|---|
| Monastic (Bermondsey Abbey and Merton Priory) | −0.24 (0.07) | 12.1 ($P$ = 0.0005) |
| Monastic (Bermondsey Abbey and Merton Priory) Ages 26+ | −0.16 (0.08) | 4.49 ($P$ = 0.03) |
| Monastic (Bermondsey Abbey) | −0.33 (0.1) | 10.7 ($P$ = 0.001) |
| Monastic (Merton Priory) | −0.20 (0.07) | 8.03 ($P$ = 0.004) |
| Merton Priory | 0.19 (0.1) | 3.46 ($P$ = 0.06) |

ratio tests from analyses that use data from both monastic cemeteries, just Bermondsey Abbey, and just Merton Priory, respectively. Also included in Table 1 is the estimated value of the parameter representing the effect of residence in Merton Priory compared to Bermondsey Abbey and the associated likelihood ratio test. The negative estimated value of the parameter using the pooled monastic sample of males above the age of 18 indicates that in the medieval population of London, people who lived in monasteries were at reduced risks of mortality compared to their peers who lived in non-monastic settings. The result of the likelihood ratio test further suggests that monastic life was associated with relatively reduced risks of mortality, as it indicates that including the monastic covariate improved the fit of the model. The results using just individuals above the age of 26 also indicate reduced risks of mortality for the monastic individuals. The negative estimated values of the parameter representing the effect of the monastic covariate using just the Bermondsey Abbey and just the Merton Priory data are consistent with the results from using the pooled monastic data; i.e., for both monasteries, the estimated effect of the covariate effect is negative, indicating reduced risks of mortality for residents of Bermondsey Abbey and Merton Priory compared to their lay peers. The estimated value of the parameter representing the effect of residence in Merton Priory, compared to Bermondsey Abbey, is positive, suggesting that risks of mortality were elevated in Merton Priory compared to Bermondsey Abbey.

## DISCUSSION

### Monastic vs. non-monastic

The age-at-death distributions from the monastic and non-monastic cemeteries suggest that there were reduced risks of adult mortality and thus enhanced survival to later adult ages in the monastic communities compared to the lay communities, as there is a significantly higher proportion of older adults (above the age of 40) in monastic cemeteries. The results of hazard analyses using both the pooled monastic sample and each monastic sample separately also indicate that monasticism was associated with reduced risks of mortality. The results using just individuals above the age of 26 also indicate reduced risks of mortality for the monastic individuals, and suggest that the observed mortality differentials are not an artifact of biased age distributions resulting from late age of entry into monasteries.

As mentioned above, it is possible that the monastic cemeteries include lay burials and the non-monastic cemeteries include burials of religious individuals, i.e., that the two samples do not reflect monastic or non-monastic mortality patterns exclusively. The inclusion of lay individuals in the monastic cemeteries, and vice versa (i.e., "non-exclusivity") would lead to underestimation of the magnitude of the differences in mortality patterns between the two samples. Given that our results indicate significant differences in mortality between the monastic and non-monastic communities, the potential for nonexclusivity in the cemeteries means that if anything, the true difference in mortality between the two was possibly even stronger than observed here. Thus, the potential for nonexclusivity in these samples does not affect our interpretation of the results.

One possible reason for the lower estimated risk of mortality in the monastic sample is the dietary differences between monastic and lay households. During the Middle Ages, grains (primarily wheat, rye, and barley) in the forms of bread, ale, and pottage, provided the largest component of the diet for individuals of all status levels; however, the diets of wealthy individuals included much higher proportions of animal protein than those of peasants (Dyer, 1983). While the Rule of St. Benedict, which provided the standard model for medieval monastic behavior, prescribed moderate quantities of food, mostly bread and vegetables, and forbade meat to all but the sick, there was variation among monasteries in adherence to the Rule and temporal changes in interpretations thereof (Lawrence, 1989). Exceptions were frequently made, and over time choice foods were increasingly added to typical monastic diets (Waldron, 1985; Murray et al., 2004; Harvey, 2006). By the end of the 15th century, monastic diets in some cases more closely resembled those of the nobility and wealthy elites than those of peasants (Harvey, 1993; Yoder, 2012). Given that nutritional status can strongly influence immune competence, better nourished monastic inhabitants would have been less likely to die from a variety of infectious diseases compared to the general public (Floud et al., 1990; Scrimshaw, 2003; Calder et al., 2006; Hughes and Kelly, 2006; Fernandes, 2008; Wolowczuk et al., 2008; Jones et al., 2010).

Further, the generally good living conditions found in monasteries, such as relatively good housing, hygiene, and medical care, all could have positively affected health and survival in Merton Priory and Bermondsey Abbey. The monastic inhabitants were also less likely than members of the general publish to engage in activities or jobs that exposed them to injury and violent death. According to Hatcher (1986), monks at Christ Church, Canterbury engaged in very little manual labor, and thus their risks of suffering accidental death or serious injuries were likely substantially lower than those of the general population. Mays (1999) found from analysis of the cross-sectional properties of humeri, that the canons of St. Andrew Fishergate would have had lower diaphyseal strength compared to contemporary lay people, indicating that the canons were involved in less heavy physical activity. A study of inhabitants of Bavarian cloisters from 1946 to 2005 found that nuns experienced significantly lower mortality from external causes

(accidents, injuries, homicides, and suicides) than women in the general population, which indicates that cloistered environments have a protective effect against such causes of death, at least for women (Luy. 2009). The external cause mortality for priests did not differ significantly from that of men in the general population; however, much of the external-cause mortality for priests in that study was the result of car accidents, a phenomenon clearly not present in medieval populations.

The close living quarters typical of monasteries might have promoted the transmission of certain infectious diseases, such as tuberculosis, and thus elevated the risk of death from such diseases in the monasteries, as has been observed in more recent populations (Luy, 2003). However, the results of the hazard analysis suggest that if this were the case, it did not elevate overall mortality of the monastic inhabitants above that of the lay community.

Lastly, as mentioned above, numerous studies in living populations have found important health benefits associated with meditation and prayer (Koenig et al., 2001). For example, Davidson et al. (2003) found that individuals who engaged in meditation experienced significantly greater increases in antibody titers in response to influenza vaccines compared to controls. Woods et al. (1999) found that religious behaviors, such as prayer, were significantly positively associated with T-helper-inducer cell (CD4+) counts among HIV-infected men. Carlson et al. (2007) found that cancer patients who participated in a meditation program experienced significant reductions in blood pressure over time. Several studies have also found that meditation reduces cortisol levels, high levels of which can have myriad negative effects on health, such as immunosuppression, insulin resistance, cardiovascular disease, and neuron atrophy (Koenig et al., 2001; Carlson et al., 2007; Tang et al., 2007). Frequent or regular attendance at religious services is associated with reduced blood pressure (Sørensen et al., 2011), lower prevalence of coronary heart disease (Banerjee et al., 2012), lower risk of stroke (Obisesan et al., 2006), and lower overall mortality risks (Gillum et al., 2008). The disease contexts of medieval populations and the living populations in which most studies of health and religion are conducted are certainly quite different, with higher infectious disease mortality in the former. However, given the demonstrated effects of meditation and prayer on cell-mediated immunity (Koenig et al., 2001), religious behaviors might have benefitted health in the medieval period similarly to its observed effects today. There is evidence that at the very least people believed in the healing power of prayer during the Middle Ages (Finucane, 1995; Metzler, 2006). Diseases and physical impairment were considered to have a spiritual cause, and therefore it was believed that undertaking penances and engaging in other religious behaviors were means of healing. More frequent participation in religious behaviors by the monks and canons of Merton Priory and Bermondsey Abbey might have conferred health benefits to a greater extent than that experienced by the general public. Further, Luhrmann et al. (2010) argue that effective spiritual practice involves a dimension of skill. The monks and canons of Merton Priory and Bermondsey Abbey were trained to engage in religious behaviors, such as prayer, and given the higher proportion of older adults in the monastery samples, they had more years to hone these skills compared to the lay population. That is, the monastic inhabitants might have benefitted more highly from the positive effects of prayer and other religious activities not just because they spent more time doing them, but also because they were more skilled at them.

In addition to living in conditions and performing activities that differed from those of the general lay population, the monastic inhabitants themselves, rather than representing the population at large, were likely selected from the higher social strata. There is evidence that recruitment of monks during the Middle Ages was biased towards relatively well-off individuals, as new entrants were expected to pay for their clothing (Lawrence, 1989; Harvey and Oeppen, 2001). Recruits to most Benedictine houses were also expected to provide an endowment to the houses, and even if an endowment was small, this requirement would exclude the poor and, according to Lawrence (1989) restrict admission to landowners and better-off townspeople. Monasteries also had educational requirements, which also would have tended to favor people of higher socioeconomic status (Lawrence, 1989; Harvey and Oeppen, 2001). In living populations, there is an inverse relationship between education level and risk of mortality, i.e., people with higher levels of education face lower risks of mortality (Kitagawa and Hauser, 1973; Kunst and Mackenbach, 1994; Shkolnikov et al., 1998; Hummer and Lariscy, 2011; Montez et al., 2012). Education level is a major component of socioeconomic status, along with occupation, income, and wealth, and as such is associated with beneficial resources including higher income, stable jobs, good social ties, and safe neighborhoods (Montez and Zajacova, 2013). The correlation between education and health, however, persists even when controlling for other measures of socioeconomic status, such as income; this seemingly causal relationship between education and mortality in living populations might indicate that better educated people have crucial critical thinking skills that allow for better management of chronic conditions, better compliance with medical advice and other behaviors that benefit health (Lleras-Muney, 2005). It is possible that some of these factors were also at work in medieval populations. Given the likely exclusion of poor people from admission to medieval monasteries, even if monasticism itself did not confer health and survival advantages, the individuals who comprised the monastic community might have been healthier than the population at large given their relatively advantaged upbringings. Furthermore, Benedictine novices underwent a medical examination before being admitted to the order and had to swear they were free from infection; such practices might also have served to create a relatively healthy monastic population (Hatcher, 1986).

This study examines a relatively long time period. The limitation of this approach is that it masks temporal variation that might have existed in mortality differentials between monastic and non-monastic communities. However, the benefit of using these cemeteries is that they provide a sample that is large enough for estimation of the parameters of the hazard models described below. Given that the monastic and the combined non-monastic cemeteries span a period of time that includes the Black Death (1347–1351), it is possible that patterns within and differences between these samples were affected by the catastrophic mortality of the epidemic. Both lay and monastic communities were affected by the Black Death (Wood et al., 2003), and some have

suggested that clergy might have been affected even more severely than the lay community because their duties, such as administering last rites, might have increased their risk of exposure to the disease (Hatcher, 1977). If this were the case, the mortality differential between the two communities might have lessened during the period of the Black Death, and thus our results potentially underestimate the true differential that existed before or after the epidemic. If, however, the lay community suffered higher mortality during the Black Death, this would be consistent with our findings that mortality was elevated in the lay community. According to some scholars, the massive depopulation caused by the Black Death had an effect on who entered the monasteries (Putnam, 1915; Aberth, 1995). For example, the high mortality suffered by clergy and the resulting shortage thereof led to lowered standards of admission to monasteries, such as the minimum age and education requirements (Putnam, 1915). Such changes in admissions standards perhaps meant less selective recruitment of higher status and healthy individuals; if this were the case, it might have served to lessen differences in mortality between the monastic and non-monastic communities in the post–Black Death period.

One potential limitation of this study is that it does not account for the considerable variation that existed within the lay community (Dyer, 1989; Keene, 1989; Hanawalt, 1993; Barron, 2004; Thomas, 2004; Connell et al., 2012). As in any urban center, the population of London included a mix of people who were native to the City and long- and short-term migrants (e.g., people bringing their goods to market from the surrounding region, those on pilgrimages, merchants and also members of the army). The livelihoods of people in medieval London were quite diverse. Many people were employed in various trades (medieval records from London list over 180 different trades) or as servants, although some were classed as either the "deserving" or "undeserving" poor, reliant on charity for survival (Connell et al., 2012). Diets varied according to social status, particularly access to exotic imported foodstuffs, such as spices and oils (Dyer, 1983; Woolgar et al., 2006). In London, the population was reliant on imported foods, with animals, vegetables, and cereals being brought to the City from all regions of Britain; however, evidence also shows that the suburbs of London supported many market gardens (Dyer, 2006). Housing also varied considerably according to socioeconomic status. Lower status people typically lived in houses constructed of timber with wattle and daub and earth or mortar floors at ground level, whereas wealthy people could afford stone houses with paved floors (Schofield and Vince, 2003; Connell et al., 2012). Given the tremendous diversity in so many facets of life in medieval London, it is possible that there was also variation in morbidity and mortality among the lay population, and thus that mortality differentials between monastic and the lay community varied accordingly; examination of such variation is, however, beyond the scope of this article.

***Differences between Merton Priory and Bermondsey Abbey.*** There are important differences between Merton Priory and Bermondsey Abbey, and the results of this study suggest that these influenced health and mortality in the two communities. We should emphasize that given that the $P$ value of the likelihood ratio test associated with the analysis of differentials between the two monasteries ($P = 0.06$) does not meet the conventional criterion of 0.05, our results are suggestive of an effect, but warrant further study with larger sample sizes using additional monastic samples. Nonetheless, our results do suggest a trend, one that is consistent with behavioral differences between the monasteries. Given their more rural setting, the inhabitants of Merton Priory experienced less crowded conditions, and had easy access to clean water and more consistent supplies of and a wider variety of foods than did people living in London (Miller and Saxby, 2007). Given the Augustinian rule regarding providing food (as well as shelter and medical care) to people outside the priory (Miller and Saxby, 2007), those living near Merton Priory might have been less likely to suffer from malnutrition compared to people living in the City of London, and thus any lay people buried in Merton Priory were likely healthier than lay people interred in cemeteries within London proper. The close proximity of Bermondsey Abbey to the City would have meant that the health of the monks there was more likely to have suffered from the negative effects associated with the crowded conditions of London (Roberts and Cox, 2003). On the basis of the urban setting of Bermondsey Abbey alone, we could reasonably expect mortality to be higher in that cemetery compared to Merton Priory, but the results of this study indicate that the opposite is true. This could be due to differences between the monasteries in contact with the lay population. Augustinians, in general, engaged in much more active pastoral work, such as visiting communities to preach and sharing their parish churches with parishioners, compared to other monastic orders like the Cluniacs (Dickinson, 1962; Butler and Given-Wilson, 1979; Lawrence, 1989). Augustinians had more freedom of movement outside the walls of the house compared to other monastic orders that more closely followed the Rule of St. Benedict (Butler and Given-Wilson, 1979). Merton Priory was also an important center of education. It is thus possible that mortality was lower in Bermondsey Abbey because the monks there experienced less exposure to disease because of greater social isolation and less protracted interaction with the lay community compared to Merton Priory (Lee and Newberg, 2005).

Differences in health and mortality between Merton Priory and Bermondsey Abbey might also have resulted from differences between the Benedictines (particularly Cluniacs) and Augustinians, in general, in the relative importance of and proportion of time spent in prayer, with Augustinians engaged in less protracted periods of prayer than typical Benedictines (Dickinson, 1962; Butler and Given-Wilson, 1979; Lawrence, 1989; Kerr, 2008). Given that Bermondsey Abbey monks likely spent more time in prayer than the canons of Merton Priory, and given the demonstrated benefits of prayer and religious behavior in living populations, inhabitants of Bermondsey Abbey apparently benefitted more from the positive health effects of prayer than their contemporaries in Merton Priory.

Differences in wealth, and thus standards of living, could have produced variation in health between the two monasteries. However, both were, in general, wealthy houses (Malden, 1967b; Malden, 1967a). Bermondsey Abbey was richly endowed by William Rufus (King William the III) in the 11th century and other royals and nobles thereafter, and Merton Priory, which was founded

by Henry I's Sheriff of Surrey, Gilbert in 1114, was a "great" house and did not struggle to survive like some contemporaneous Augustinian houses (Butler and Given-Wilson, 1979). While Bermondsey Abbey began and ended as a wealthy house, a series of misfortunes in the mid-13th century led to economic hardships through the remainder of the century (Dyson et al., 2011). Repeated local flooding in the 1230s resulted in damage to the Priory's buildings and surrounding fields. These natural disasters were exacerbated by extensive leasing of monastic lands, poor management of priory funds and lands, and a significant decrease in donations and benefactors. During this period, the number of monks residing at the priory was greatly reduced compared to other monasteries of its size. Such a reduction in the resident population might have acted to reduce the dangers associated with communal living, such as disease transmission. Recovery from this economic downturn began in the early 1300s, and by the first decade of the 1400s the monastery had returned to its former glory (Dyson et al., 2011).

The differences in mortality patterns between the two monasteries might also reflect a greater proportion of lay burials in Merton Priory compared to Bermondsey Abbey, which is suggested by the higher proportion of subadults and females buried in Merton Priory as described above. That is, the higher estimated risk of mortality in Merton Priory could be an artifact of including more lay individuals, rather than reflecting truly higher risks of mortality within Merton priory itself.

## CONCLUSION

The results of this study suggest that in the medieval population of London, monasticism conferred mortality advantages, and such advantages might have resulted from a number of factors, such as good diets, medical care, or more frequent participation in health-promoting religious behaviors in monastic settings. The results might also reflect recruitment of predominantly wealthy, highly educated, and relatively healthy individuals as monks and canons. This study also suggests differences between the mortality patterns of the two monastic samples, which might indicate that there was variation in the conditions that influenced health and mortality among medieval monastic communities.

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