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Status and Health in Roman Dorset: The Effect of Status on Risk of Mortality in Post-Conquest Populations

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ABSTRACT The Roman conquest of Britain was previously shown to have negatively impacted health, particularly for children, older adults, and men. We build upon this previous research by investigating the effect that status had on risks of mortality within the Roman Britain populations of Dorset. This study incorporates a sample of 291 individuals excavated from several cemeteries in the county of Dorset dating between the first to early fifth centuries AD. To assess the effect of status on risks of mortality, burial type was used as a proxy for status and modeled as a covariate affecting the Siler and Gompertz–Makeham models of mortality. The results of these analyses indicate that high-status individuals, particularly children, had a lower mortality risk compared to lower-status groups; and for those buried in urban cemeteries, higher-status individuals of all age-groups had a lower mortality risk. As with our previous study (Redfern and DeWitte: Am J Phys Anthropol 144 (2011) 269–285), we found that male mortality risk was higher than females, which we consider to reflect underlying sex-differences in immunity and disease response. Am J Phys Anthropol 146:197–208, 2011.

The Roman conquest of Britain by the Emperor Claudius in 43 AD resulted in considerable changes to the landscape, economy, and indigenous culture and incorporated Britain into an Empire, which at the height of its powers (third century BC to fifth century AD), united communities in the Arab World, North Africa, and Europe (Wells, 1992). This process is known as "Romanization," a term which has recently undergone significant changes to move away from its imperialist and colonial past (e.g., Hingley, 2005; Gosden, 2006) and, instead, is now used as "a convenient denomination covering the events involved in the creation of Roman [Britain], with no cultural implications taken for granted" (Terrenato, 1998: 20). Work by the authors (Redfern and DeWitte, 2011) has demonstrated that this process had significant biological repercussions, because it negatively impacted health in all age-groups and both sexes, particularly for subadults and adult males. This finding was unexpected, as the Roman world was male orientated (Garnsey, 1968; Rawson, 1986b; Wiedemann, 1989). Our research suggests that underlying biological differences between the sexes allowed females to better buffer risk, probably through immunological advantages, despite them being perceived as having a lower status than males in this period (Stinson, 1985; Flemming, 2000; Langley, 2003). We believe that these risks were created by the introduction of urban settlements and increased population migration and the adoption of "Romanized" life-styles, particularly how children were cared for [see also Gowland and Redfern (2010)]. The research presented here expands upon our previous findings by focusing on the relationship between social status, age, and sex, as these factors were highly influential in the Roman world (Harlow and Laurence, 2002).

The important relationship between health and social status has been explored by numerous bioarchaeological studies at the population scale of analysis (e.g., Steckel and Rose, 2002; Cardoso, 2007) and was also recognized in the ancient world, as evidenced in medical texts (e.g., Hippocrates—airs, waters, and places). Society and culture can influence a person's health, because they permeate and often determine the entire life course (Rousham and Humphrey, 2002). People who are disadvantaged socially and economically have a higher risk of developing a serious illness and have a shorter life expectancy (Nettle, 2010). The disadvantaged have higher morbidity and mortality risk because of the cumulative effects of inadequate diet and poor living conditions. It is now well established that health status during childhood directly affects an individual's long-term health outcomes, such as the development of metabolic and infectious diseases because of living conditions and poor diet (McElroy and Townsend, 1996; Wilkinson and Marmot, 2003).

To further investigate the results of our previous study, we used the Siler and Gompertz–Makeham models of mortality to investigate the relationship between age, sex, and status by testing the hypothesis that higher status, as evidenced by the type of coffin used for burial, was associated with lower mortality risk in Roman Britain. By examining how risk of mortality

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varied with social status, we hope to reveal a factor that contributed to heretofore "hidden" heterogeneity in frailty (Vaupel and Yashin, 1985; Wood et al., 1992) in the population of Roman Britain.

SOCIAL STATUS IN THE ROMAN WORLD

An individual's status in the Roman world was negotiated according to their biological sex, age, and socioeconomic status. During this period, Roman society viewed the adult male body as the ideal physiology, above those of women and children who were regarded as being incomplete and, therefore, of less value (Foxhall and Salmon, 1998; Flemming, 2000). The emphasis on adulthood is crucial, as children were seen as incomplete beings that were transformed through the life course into adult beings by various social and religious rituals (Rawson, 1986b, 1991). These social notions were reinforced by legal proscriptions, which dictated ages of responsibility in terms of property ownership and voting rights (Garnsey, 1968; Harlow and Laurence, 2002). Recent research taking a gender or life course approach has demonstrated that these social proscriptions were subject to regional and temporal variation within the Empire, reflecting local traditions, and show that a uniform way of life did not exist (Gowland and Redfern, 2010; Revell, 2005; Carroll, 2006). Within the Empire, a wide variety of status groups existed from slaves to ruling elites, and it was possible over an individual's life course to move between groups because of factors such as forced slavery and manumission, marriage, and migration (Adkins and Adkins, 1998).

In Roman Britain, a range of status groups has been identified using a wide range of archaeological evidence, including funerary and epigraphic data. At the most fundamental level, the greatest distinction was between the enslaved and the free. Slaves lived in both urban and rural settlements, and these individuals could have been transported from all areas of the Empire and also from marginal territories (Scheidel, 1997; Joshel, 2010). Other social and status groups in Britain included the military, merchants and traders, skilled craftspeople, unskilled and agricultural workers, and government officials (Birley, 1964, 1979). The population of Roman Britain has been shown by stable isotope and ancestry studies to be very diverse, with people from the Mediterranean, other areas of Europe, and Africa (Evans et al., 2006; Leach et al., 2010). In Dorset, the population appears to have been formed of locals and migrants from the Northern Mediterranean—populations that show very little genetic differentiation (Richards et al., 1998; Lao et al., 2008; Redfern et al., 2010). The majority are believed to have participated in agricultural activities, but the material culture evidence shows that the town of Dorchester (*Durnovaria*) must have been inhabited by skilled craftspeople, merchants, and traders; some military personnel appear to have lived in the region, although a permanent fort has not been found (Woodward et al., 1993; Putnam, 2007). The region was governed by an elite formed of native and newcomers, who were responsible for keeping order and administrating the province.

The walled urban settlement of *Durnovaria* was built in the Roman style, with rectangular buildings made of stone, wood, or a mixture of the two, with homes often having plumbing and latrines, under-floor heating (hypocaust), and private bathhouses (Putnam, 2007). The town also had a large public bathhouse, an aqueduct servicing a public fountain and a forum. Excavations have revealed evidence for industrial activities, such as metal working, and it is suggested that the environs were managed (Woodward et al., 1993). Outside the town, the extent to which settlements were "Romanized" did not depend on their distance to the principle center, but, instead, it was more complex, involving a broad range of variables (Putnam, 2007). For example, in rural areas, villa settlements were the epitome of Roman living as they were high-status settlements that incorporated luxury styles of living (Putnam, 2007). Other rural settlements were more comparable to their preceding late Iron Age counterparts, consisting of wattle and daub roundhouses (Hingley, 1989).

SOCIAL AND FUNERARY STATUS IN THE ROMAN PERIOD

In archaeology, an individual's status and identity are most frequently investigated using available funerary evidence (e.g., Buzon and Judd, 2008). Hope's (2009) review of Roman death shows that the relationship between social and funerary statuses can be reliably established, and we are fortunate to have a wide range of evidence relating to funerals and cemeteries from the Roman period (Toynbee, 1996). Written evidence, including prices and amounts to be set aside for burial, can provide important information about status and burial practice (Toynbee, 1996). However, these sources are not without bias in terms of geographic and temporal distribution in the Empire, and we should question how representative they are of the community from which they derive, as we do not know whether complex high-status funerals described in texts from Rome occurred elsewhere in the Empire (Hope, 2009). Evidence from legal texts shows that people often bought land in the suburbs and built tombs during their lifetime; funeral clubs were also popular in the Empire and were joined by slaves, freedmen, and the less prosperous to ensure that their bodies were buried. The lowest status and cheapest burials just placed the body in the ground, while more expensive coffins were made of wood, terracotta, stone, and lead (Toynbee, 1996; Hope, 2009). However, variations within each type existed, and, as Esmonde Cleary (1987) highlights, a stone coffin at source may have cost as much as a quality wooden one elsewhere. The wealthy also used decorated or plain sarcophagi made of marble, stone, or lead to "house" a coffin. Those who could not afford to save (e.g., slaves, the poor, and noncitizens) received basic disposal, in mass-burial pits, from the local authorities or none at all and were left exposed to the elements and scavenging animals (Toynbee, 1996; Hope, 2009).

BURIAL PRACTICES IN ROMAN BRITAIN

One of the most significant impacts of the Roman invasion of Britain in 43 AD was the introduction of organized urban settlements, which created a new physical and conceptual geography for the inhabitants (Esmonde Cleary, 1987; Mattingly, 2006). Burial of the dead played an influential role in this new landscape, as the towns were surrounded by cemeteries, with graves visible on either side of the roads linking the town to other settlements (Esmonde Cleary, 1985, 2000). Cemeteries in Roman Britain are more common in towns compared to settlements in the countryside. The majority dates from the third to early fifth centuries, and because

TABLE 1. Sample used in the study presented by site, location and numbers of individuals

References	Site name	Location	Male	Female	Ambiguous sex	Undetermined sex	Subadult	Total
Woodward et al., 1993	Albert Road	Urban	6	1	–	1	10	18
Davies et al., 2002	Alington Avenue	Rural	22	13	5	–	11	51
Smith, 1993	County Hall	Urban	–	–	–	–	2	2
Green et al., 1981	Crown Building	Urban	1	–	–	–	–	1
Smith et al., 1997	Dorchester Bypass	Rural	11	8	1	–	13	33
Startin, 1982	Fordington Old Vicarage	Urban	5	1	–	–	6	12
Smith, 1993	Greyhound Yard	Urban	–	–	–	–	8	8
Wainwright, 1979	Gussage All Saints	Rural	1	–	–	–	–	1
Dinwiddy, 2009	Little Keep	Urban/rural	17	9	–	–	3	29
Putnam, 1998	Littlewood Farm	Urban/rural	1	–	–	–	–	1
Farwell and Molleson, 1993	Poundbury Camp	Urban/rural	33	23	3	–	54	113
Davies and Grieve (1986)	Poundbury Pipeline	Urban/rural	–	3	1	–	1	5
Davies and Thompson, 1987	Southfield House	Urban	–	1	–	–	–	1
Graham et al., 2007	Tarrant Hinton	Rural	–	–	–	–	8	8
Hearne et al., 1999	Tolpuddle Bypass	Rural	2	2	–	–	1	5
Leonard, 2008	Wyke Regis	Rural	–	2	–	1	–	3
		Total	99	63	10	2	117	291

of biases in historical urban development, most have been identified in the southeast of England but have not been excavated in their entirety. In the countryside, burial areas have been identified in environs of villas, associated with small settlements or military establishments (Cleary, 1987, 2000; Pearce, 2008). In Roman Britain, cremation and inhumation burials have been identified, but it seems that inhumation was more typical in this province of the Empire (Philpott, 1991). According to Philpott (1991), the majority of individuals were buried in a container in an extended position, often accompanied by grave-goods. He observes that although the range and type of grave-goods are subject to intense regional and temporal variation, which in its simplest terms reflects variation in population origin and beliefs, different status groups are evident based on the type of burial container (Philpott, 1991). According to Struck (2000), in Britain (*Britannia*), burial status appears to differ according to cemetery type. Struck's (2000) research has shown that only 3% of all first to third century AD graves show elite characteristics, the majority (2.5%) of which were discovered at city cemeteries, with smaller towns accounting for just 0.5% of the total. Her analysis also demonstrates that children and females were not excluded from high status burials because of their own rank and wealth or association with elite individuals (Struck, 2000).

Many studies of Romano-British cemeteries report sex and age differences in the samples available for study. Urban cemeteries appear to have a paucity of female burials (Davison, 2000; Crowe, 2001), but many of these cemeteries were strongly associated with the military (e.g., Colchester, Essex), and, therefore, a higher number of male burials should not be unexpected. The low recovery of infant burials ($\leq$3 years old) from formal cemeteries is believed to have been caused by age-related trends in funerary practices, whereby these individuals were preferentially buried in settlements (Scott, 1999). The burial of infants also displays temporal variation, with greater numbers being buried in cemeteries during the third and fourth centuries AD (Pearce, 2001). The cemetery populations available for study are also influenced by the geographic and temporal biases outlined earlier (Esmonde Cleary, 2000; Pearce, 2008), in addition to limitations placed on the bioarchaeologist's ability to determine age and sex because of preservation factors, burial truncation, and skeletal completeness, which affect the demographic results obtained (Walker, 1995; Bello et al., 2006). The limitations identified by Pearce (2008) above have influenced the samples available from this region [see Redfern and DeWitte (2011)]. The majority of individuals have been excavated from the environs of Dorchester, in response to road building and expansion of the town in later periods. As Table 1 shows, the majority of cemeteries have a rural character, and there are intersite differences in the age and sex of the extant population. Demographic analysis of the sample shows, however, that it conforms to an attritional profile as there are a greater number of young subadults, middle, and older adult individuals (see Figure 1), and the male-to-female ratio of 1.5:1 is within normal limits (Chamberlain, 2006).

Formal burial grounds were quickly adopted around the major settlement *Durnovaria*, in the Dorset region of southwest England (Esmonde Cleary, 1987). Individuals were buried in extended "supine" positions, although prone and decapitation rites were also practiced (Leech, 1980). The majority of individuals were buried in coffins made of wood, lead, and stone, and a small number of individuals were also placed in other sarcophagi and/or interred in a frescoed mausoleum (e.g., Poundbury Camp) (Leech, 1980; Smith et al., 1997). Toller's (1977) study of lead coffins in Britain shows that their distribution conforms to the distribution of wealth in *Britannia*, with the majority uncovered at urban centers, with *Durnovaria* having the second highest number of lead coffins excavated from its cemeteries.

In the Romano-British period, people were buried with a range of grave-goods (e.g., pottery), but the range of items expanded over time (Hamlin, 2007). Hamlin's (2007) review of funerary evidence from the region shows that gender was not the determining factor in whether a person received grave-goods in their burial, but intercemetery differences in the number of grave-goods given to either sex were observed, as was intrasex variation in the number of grave-goods. Interestingly, no gendered artifact classes (e.g., currency and personal ornament) were present in this period, but a number of items were specific to males/females (Hamlin, 2007). Hamlin's (2007) research has also shown that there is a

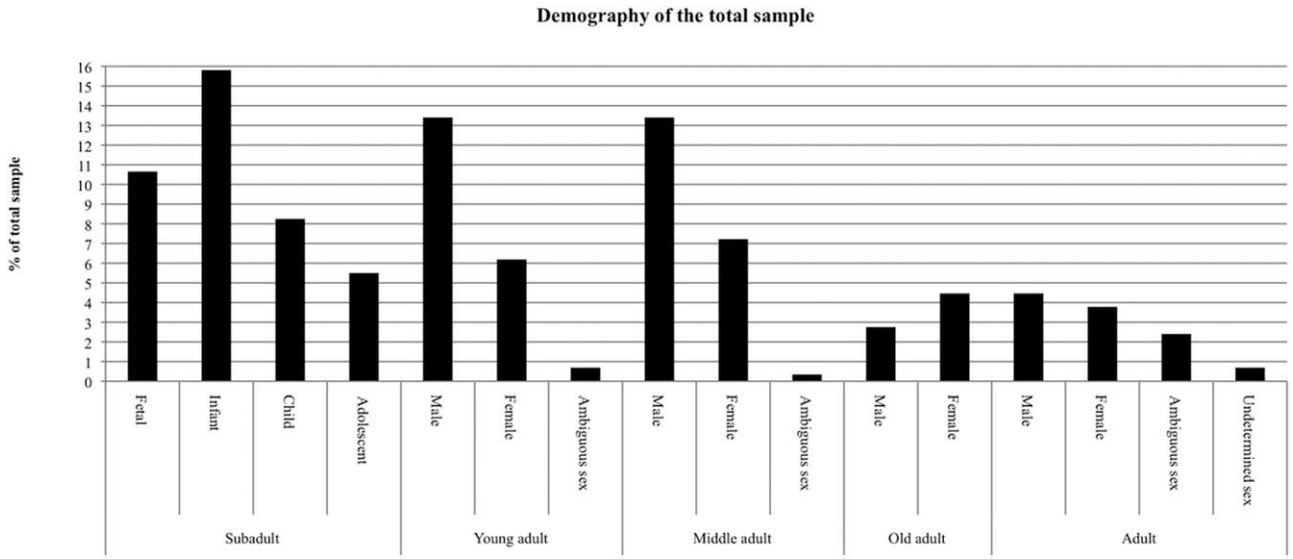

Fig. 1. Demography of the sample used in the study by age and sex group.

strong age-related (subadult/adult) trend in the disposition of grave-goods, which is proposed to relate to concepts of the Roman life course. In the Romano-British period, coffin burials were the most frequent choice for males and females (92.6% of the 737 burials in Hamlin's study). Age-related differences in coffin use were observed, with adults more likely to receive a coffin burial than subadults; unlined wooden coffins were the most frequently used type in Dorset, with a few individuals buried in lead-lined wood, stone, and stone with wood. Interestingly, there was no statistically significant difference in the use of unlined wooden coffins for subadult or adult internments, indicating that coffin type was not related to the age of the deceased (Hamlin, 2007; Table 2).

MATERIALS AND METHODS

The individuals included in this present study date from the first to early fifth centuries AD and are predominantly derived from the environs of Dorchester [see figures presented in Redfern and DeWitte (2011)]. The cemetery samples reflect a long history of excavation work in the county, from the Victorian period to the present-day, and therefore it is not possible to break the sample down into more discrete time periods (Redfern, 2006, 2007, 2008, 2010). Using the sample previously published by the authors (Redfern and DeWitte, 2011), a total of 291 individuals were selected for the current study based on the availability of reliable archaeological information about burial type and that their skeletons were in articulation at the time of excavation: 116 subadults (<20 years old), 98 adult males, 63 adult females, 10 ambiguous sex, and 2 indeterminate individuals. All these individuals were between stages zero (excellent) to three (weathered compact bone) of preservation (Buikstra and Ubelaker, 1994; Tables 1 and 2).

The use of coffins in Roman Dorset has been described earlier, and, in this study, we used the following divisions based on the work of Hamlin (2007) as a gauge of status: no coffin, wood coffin, lead-lined wood coffin, and lead coffin; the highest status burials were within mausoleums with people being interred in coffin type unknown, no coffin, wood coffin, lead-lined wood coffin, lead coffin, and stone coffin.

Age and sex estimation

Subadults ($\leq$20 years) were aged using a combination of dental eruption, diaphyseal length, and epiphyseal fusion methodologies (Ubelaker, 1989; Scheuer and Black, 2000). When both dental and skeletal estimates were available, dental age was used, because this has the strongest correlation to chronological age and provides the most reliable estimates (Lewis and Garn, 1960). Age-at-death in adults was determined using degeneration of the pubic symphysis and iliac auricular surfaces and sternal rib end morphology (İşçan and Loth, 1986a,b; Buikstra and Ubelaker, 1994). Sex was estimated using morphology of the skull and pelvis (Buikstra and Ubelaker, 1994), and the sex and age-group divisions devised by Buikstra and Ubelaker (1994) were used.

Effect of burial type on risk of mortality

To determine the effect of status on risk of mortality across the lifespan, burial type was used as a proxy for status and modeled as a covariate affecting the parameters of the Siler model of mortality. The Siler model is a parsimonious five-parameter model of mortality that fits a wide range of human mortality patterns (Siler, 1979; Gage, 1988).

$$h(a) = \alpha_1 e^{-\beta_1 a} + \alpha_2 + \alpha_3 e^{\beta_3 a}$$

The first component of the Siler model, $\alpha_1 e^{-\beta 1 a}$, represents juvenile mortality, which typically is very high at birth and then decreases rapidly with age; the α_1 parameter specifies the risk associated with infant and childhood causes of death, and β_1 specifies the rate at which this risk changes with age. The second component of the model, α_2, is an age-independent component that is associated with causes of death that are unrelated to an individual's age (e.g., accidental causes of death). The last component of the Siler model, $\alpha_3 e^{\beta 3 a}$, represents the

TABLE 2. Variation in skeletal preservation (stages 0–3) displayed by coffin type, age group, and sex

Coffin variable	Age group	Sex	0	1	2	3
No coffin	Fetal	–	31	–	–	–
	Infant	–	13	7	1	–
	Child	–	3	1	–	–
	Adolescent	–	2	–	–	–
	Young adult	Male	7	–	–	–
		Female	2	–	–	–
		Ambiguous sex	1	–	–	–
	Middle adult	Male	12	1	1	–
		Female	7	–	–	–
	Old adult	Male	5	–	–	–
		Female	5	–	–	–
	Adult	Male	3	–	–	–
		Female	1	–	–	–
		Ambiguous sex	–	1	–	–
		Undetermined sex	–	1	–	–
Wood	Infant	–	12	8	–	–
	Child	–	13	4	1	–
	Adolescent	–	12	2	–	–
	Young adult	Male	17	5	4	2
		Female	11	3	1	–
		Ambiguous sex	1	–	–	–
	Middle adult	Male	18	3	–	–
		Female	10	2	–	–
		Ambiguous sex	1	–	–	–
	Old adult	Male	2	–	1	–
		Female	5	–	–	–
	Adult	Male	3	1	3	3
		Female	3	5	1	–
		Ambiguous sex	1	1	3	–
		Undetermined sex	–	1	–	–
Lead	Middle adult	Male	1	–	–	–
Lead-lined wood	Child	–	1	–	–	–
Mausoleum: no coffin	Infant	–	2	–	–	–
Mausoleum: wood	Child	–	1	–	–	–
	Young adult	Male	2	–	–	–
	Middle adult	Male	2	–	–	–
		Female	1	–	–	–
	Old adult	Female	1	–	–	–
Mausoleum: lead	Young adult	Male	–	1	–	–
		Female	1	–	–	–
	Middle adult	Male	–	1	–	–
Mausoleum: coffin unknown	Infant	–	2	–	–	–
Mausoleum: lead-lined wood	Infant	–	–	1	–	–
Mausoleum: stone	Young adult	Male	1	–	–	–
	Middle adult	Female	–	–	1	–

typical senescent pattern of mortality, which is low at birth and younger ages, but increases with adult age; α_3 specifies the risk associated with senescent causes of death, and β_3 specifies the rate at which this risk changes with age. The three components of the Siler model are independent of one another, and so surviving one component has no influence on risk of mortality during another component (Wood et al., 2002).

Burial type was modeled as a covariate affecting the Siler model in two ways. The first approach was to model burial type as a covariate affecting the entire Siler model (i.e., burial type was modeled as proportional to the entire hazard, independent of age). However, the effects of status on risks of mortality might not be uniformly distributed across all ages, and the aggregate pattern may mask important subpopulation differences in risks of mortality (Vaupel and Yashin, 1985; Wood et al., 1992). Therefore, we also modeled burial type as a covariate affecting the juvenile and senescent components of the Siler model independently to allow for some variation with age in the effect of status on risk of mortality. Given that slaves were often buried in the mausolea of their owners (Toynbee, 1996), it is possible that the high-status burial sample includes some low status people; the potential effect of this is discussed below.

Given our previous findings that the risk of mortality was elevated for males compared to females in *Britannia* and results from a recent study indicating sex differentials in the effects of physiological stress on mortality risk in an archaeological sample from Britain (DeWitte, 2010), we also examined sex differences in the effect of status on risks of death for this study. We first confirmed that sex did, in fact, affect risk of mortality in this particular sample (as the sample composition differs slightly from that used in our previous study) by modeling sex as a covariate affecting the Gompertz–Makeham model of mortality (males were scored as 1 and females were scored as 0 for this analysis). Then, to assess sex differences in the effect of status on risk of death, we modeled burial type as a covariate affecting the Gompertz–Makeham model and compared the results for males versus females. The Gompertz–Makeham model includes the

TABLE 3. The effect of the burial type covariate on the entire Siler hazard of mortality and on the juvenile and senescent components of the Siler model for the total Romano-British sample

Siler hazard	Juvenile mortality	Senescent mortality
−0.098 (−0.36, 0.14)	−1.47 (−2.45, −0.87)	0.13 (−0.20, 0.36)

The 95% confidence intervals are shown in parentheses.

TABLE 4. The effect of the burial type covariate on the Gompertz–Makeham hazard of mortality for men and women in the total Romano-British sample

Men	Women
−0.32 (−0.72, 0.11)	−0.19 (−0.72, 0.35)

The 95% confidence intervals are shown in parentheses.

second and third components (i.e., the age-independent and senescent components) of the Siler model shown above (Wood et al., 2002):

$$h(a) = \alpha_1 + \alpha_2 e^{\beta a}$$

For all of the analyses described earlier, individuals who were not buried in coffins were assigned a value of 0, and individuals buried in any type of coffin or in mausoleums were assigned a value of 1. Parameters were estimated using maximum likelihood analysis with the program *mle* (Holman, 2005). A significant negative estimate for the parameter representing the effect of the burial type covariate would indicate that the risk for people buried in coffins was lower than that for people without coffins.

As shown in Table 1, the cemetery sample from Dorset used in this study includes urban and rural cemeteries and those that have both urban and rural characteristics (urban/rural). Because of this variation in cemetery contexts, we assessed the effect of status on the risk of mortality not only for the combined sample (i.e., all cemeteries shown in Table 1), but also separately for the urban, rural, and urban/rural subsamples to determine if there were any differences among the three. Comparison of the effects of status on mortality for males and females was limited to the combined sample with all contexts included, as there were insufficient sample sizes from any of the subsamples to assess the difference between the sexes within each subsample.

One major advantage of the Gompertz–Makeham and Siler models is that they require the estimation of a small number of parameters and thus can be applied to small samples, as they smooth the random variation in mortality data that is an artifact of small samples without imposing any particular age pattern on the data (Gage, 1988). However, this efficient use of small sample sizes has the drawback of potentially masking underlying heterogeneity in risks of death. By including covariates in our models, we can examine the effects of some potential causes of heterogeneity (i.e., social status and sex). It is possible that there are other sources of heterogeneity in risks of mortality (e.g., nutritional status and geographic origin) that we are not capturing. Analysis of such factors is beyond the scope of the current study, as the addition of more covariates necessitates a larger sample size than is currently available.

RESULTS

The estimated values and 95% confidence intervals of the parameters representing the effect of the burial-type covariate on the entire Siler model, independent of age, and on the juvenile and senescent components of the model for the total Romano-British sample are shown in Table 3. For the model with burial type specified as a covariate affecting the entire Siler hazard independent of age, the estimated value of the parameter representing the effect of the burial type covariate is not significantly different from zero. This suggests that status had no significant effect on the risk of mortality when all ages are assessed simultaneously. However, when modeled as a covariate affecting the juvenile and senescent components of the hazard independently, the estimated value of the burial type covariate effect on juvenile mortality is significantly less than zero, but the estimated effect on senescent mortality is not significantly different from zero. These results suggest that status had a significant effect on childhood mortality (i.e., higher status was associated with lower risks of mortality for infants and young children), but not senescent mortality.

Analysis of the effect of the sex covariate on risk of mortality indicated that males were at higher risks of death than females, similar to our previous findings (the estimated effect of the sex covariate was 0.44, with a 95% confidence interval of 0.09–0.77). Table 4 shows the estimates of the effect of burial type on risk of mortality for males and females in the total sample. For both sexes, the estimated values of the effect of the burial type covariate are not significantly different from zero; these results are consistent with the result for all adults combined and suggest that status did not significantly affect the risk of mortality for males or females in this sample.

The results for the urban, rural, and urban/rural cemeteries are shown in Table 5. The results from the rural and urban/rural sites are consistent with those from the total sample, that is, burial type has no significant effect on risk of mortality when it is modeled independent of age nor does it have a significant effect on the senescent component; however, coffin/mausoleum burial is associated with significantly reduced risks of mortality in childhood. The results from the urban subsample differ from those observed in the other subsamples and from the total sample. For the urban subsample, the esti-

TABLE 5. The effect of the burial type covariate on the entire Siler hazard of mortality and on the juvenile and senescent components of the Siler model in the urban, rural, and urban/rural subsamples

Location	Siler hazard	Juvenile mortality	Senescent mortality
Urban	−1.94 (−2.82, −1.25)	−2.51 (−3.39, −1.83)	−1.42 (−2.33, −0.73)
Rural	0.08 (−0.40, 0.50)	−1.59 (−10, −0.33)	−0.07 (−0.55, 0.34)
Urban/Rural	0.32 (−0.04, 0.64)	−0.87 (−1.65, −0.12)	0.24 (−0.11, 0.56)

The 95% confidence intervals are shown in parentheses.

mated value of the parameter representing the burial type covariate is significantly lower than zero when burial type is modeled on the Siler hazard independent of age and when it is modeled as a covariate affecting juvenile and senescent mortality separately. These results suggest that in the urban populations, higher status was associated with significantly reduced risks of death across all ages and not just among children as in the other subsamples.

DISCUSSION

The findings of this study challenge many current interpretations about status and funerary treatment in *Britannia*. It is considered that the discrepancy between these and other findings arises from bioarchaeological data, and, in particular, mortality modeling, being excluded from funerary and status studies, because they are deemed unreliable or of no value (Gowland, 2006). Our findings show that there may be disparities between what is "read" from the funerary context and the remains of the person contained within, particularly with respect to a lack of intrastatus differences in each sex. We accept that this result may reflect our choice of coffin type as an indicator of status and the widespread use of unlined wooden coffins in Roman Dorset. Nevertheless, the result indicating that burial type had no significant effect on risk of death for both sexes does conform to the funerary evidence that shows considerable overlap in practices between males and females and the lack of gendered artifact grave-good classes. Consequentially, our results support Hamlin's (2007) findings, but also those in funerary research more generally, in that the grave context is a not a true reflection of the deceased, because it is a sociocultural construction (e.g., Pearce, 2010). This finding is also important, because, in part, it lends weight to Struck's (2000) hypothesis that the number of elites in Roman Britain was very small.

These new findings also support the results of our previous study that Romanization increased male mortality risk compared to females. As discussed in Redfern and DeWitte (2011), this result is contrary to the increased cultural buffering afforded by having a male body in the Roman world (Foxhall and Salmon, 1998). We believe that this cultural advantage may not have been sufficient protection from environmental stressors associated with employment, particularly for nonelite males, and conclude that underlying sex-differences account for this finding.

The estimated values of the parameter representing the effect of the burial type covariate shown above suggest that in this region of *Britannia*, in general, and in the rural and urban/rural contexts, in particular, status had significant effects on the risks of mortality for infants and children, but it did not significantly affect risks of mortality for adults. Higher status seems to have been associated with lower risks of mortality for children throughout Roman Dorset, but in the rural and urban/rural areas, status did not apparently strongly affect the risk of death for adults. The pattern from the urban cemeteries differs from that observed in the rural and urban/rural subsamples, as higher status appears to have been associated with significantly lower risks of mortality for adults in addition to children in urban areas. As mentioned earlier, it is possible that there are some low status people buried in mausolea; if so, we might have underestimated the effect of status on risk of mortality, and the true difference in risk of death between high and low status individuals might be even greater (in favor of high status people) than our estimates reveal.

The significantly reduced risk of death associated with coffin/mausoleum burial for juveniles, but not for adults in the rural and urban/rural samples might reflect the effects of strong selective mortality during childhood in those populations. Mortality tends to be selective and target individuals with higher frailty, which is an individual's relative risk of dying compared to other people in the same population (Vaupel et al., 1979). In all contexts, in Romano-British Dorset, high status likely exerted strong protective effects on children, such that higher status children had lower frailty compared to their lower status peers. If mortality was strongly selective with respect to frailty in childhood in these populations, the individuals who survived to older ages would have had lower average frailty than the original cohort exposed to childhood mortality. By selecting out of the population those individuals with highest frailty, a large proportion of which would likely have been among the lower statuses, selective mortality could have resulted in reduced apparent differences in the risks of mortality between high and lower status people during adulthood. That is, during childhood, there might have been significant differences in frailty between people of high and low status, but strong selection against low status children with high frailty could have resulted in reduced differences in frailty between high and low status adults in these populations.

Status as a buffer for child mortality provides a more nuanced understanding of our previous findings, which indicated that subadults had a higher mortality risk in Dorset during this period (Redfern and DeWitte, 2011). Storey's (1992) analysis of preindustrial health in Mexico found that compared to rural groups, urban populations had higher mortality rates in infant and child age-groups, particularly for lower socioeconomic groups. Therefore, the role of status in buffering is not unexpected (Panter-Brick, 1998), particularly as the funerary evidence shows that although coffin type was not related to age, adults unlike subadults were more likely to be buried in a coffin (Hamlin, 2007). Our new findings support studies in other archaeological populations that have demonstrated that high-status samples have lower subadult mortality (Cowie et al., 2008); however, this is the first to do so in the Roman Empire. The survival of subadults is determined by their immediate environment and care-givers (Saunders and Barrans, 1999; Lewis, 2007), and in higher-status environments, several buffers may have afforded them better protection. In higher-status homes, environmental hazards may have been reduced because of plumbing and the use of latrines, which would have made living conditions more sanitary (Scobie, 1986; Jackson, 2000), although we can never be certain about standards of hygiene. Many of these homes also had water delivered from the aqueduct, which would have reduced the risk of contamination (Howe, 1997) compared to lower-status homes, which relied on well water, as garbage pits were often dug near wells (Jackson, 2000).

Stable isotope data show that migrants, particularly from the Mediterranean (including one child who lived in *Durnovaria*), and different food-ways and dietary practices were present in the region (Richards et al., 1998; Redfern et al., 2010). Richards et al.'s (1998) study

of Poundbury Camp found that individuals buried in high status burials (lead coffins and mausoleums) consumed more marine products compared to those in wooden coffins. However, this finding has not been observed in other cemeteries in Dorset (Redfern, unpublished data) and, therefore, the role of diet as a status buffer is not as clear. Archaeobotanical records from Roman Britain show that there is no clear correlation between location of a settlement (i.e., rural vs. urban in character) and the types of food consumed and that access to new foods in rural sites and small towns was not limited to high-status groups (van der Veen et al., 2008).

Stable isotope analysis of subadult diet and weaning in Dorset shows that, as with other areas of the Empire, children were weaned by the ages of 2–3 years (e.g., Dupras and Tocheri, 2007; Prowse et al., 2008; Redfern et al., in review). Other evidence for subadult diets is present, including feeding bottles (Fildes, 1985), and, from excavations in *Durnovaria*, we know that a wet nurse lived in the *civitas*, as a flagon, has the inscription "NUTRICIS"–property of *Nutrix* (Tomlin, 1993: 284). Roman medical texts, such as Soranus and Celsus, recommended that weaning took place between the ages of 3 months and 3 years (Rawson, 2003: 7–30, 126). Weaning is a risky process that had a high morbidity risk in past populations, because the immunity and protection of breast milk are removed as new foods are introduced that may have been made with contaminated water or were of insufficient nutritional quality (Katzenberg et al., 1996; Herring et al., 1998). Roman medical texts recommended that children were fed cereals—which is attested isotopically (Prowse et al., 2005, 2008)—but this may have increased their risk of developing metabolic diseases, because such foods may not have been supplemented with sources of vitamins C and D. In Roman Dorset, rickets and scurvy have been observed in these age groups, and examination of their funerary contexts shows that the majority was buried in coffins and one in a mausoleum, indicating that they were of high status (Redfern, 2007). Consequentially, we can conclude that although status did afford some protection, it was not absolute.

As Roman Britain contained a diverse population, it is very unlikely that one style of child-rearing was practiced, and, therefore, there may have been differences in this form of cultural buffering (Schell and Ulijaszek, 1999). Woolf's (2005) research into family life in the northwest provinces of the Empire has shown that little epigraphic evidence is available, but suggests that the nature of the family and its relationship to wider kinship and power networks would have been subject to considerable regional differences, in addition to variation in the adoption/adaptation of Roman culture and concepts of family life (Rawson, 1986a, 2003; Revell, 2005). The Roman medical texts recommended a range of child-rearing practices, which were aimed at high-status groups in the Mediterranean (Rawson, 2003; Bradley, 2005). As many inhabitants of *Durnovaria* were from this area, we must allow for the possibility that such practices were followed in *Britannia* [see Gowland and Redfern (2010)]. Unfortunately, the information in these texts did not make for the best health outcomes, as they recommended the withholding of colostrum (Celsus, 1935; Holman, 1998). These practices would have increased morbidity and the risk of developing metabolic diseases—indeed, this was recognized by Roman doctors, but fault was assigned to the mother for behaving badly and or neglecting her child (Bradley, 2005). The results of this study show that although high-status living was not without its problems, for the majority of subadults, it was of some benefit.

The differences observed between the urban subsample and the rural and urban/rural subsamples (i.e., status affected risk of mortality for all ages in urban areas, but only for children in other locations) might indicate that people in towns were, in general, better buffered against physiological stress, at least during childhood, than people living in rural areas. In other words, the observed differences in the effect of status on mortality risk for adults suggest that mortality was not as strongly selective during childhood in urban areas as it was in rural areas. A reduction in the strength of selective mortality might have allowed more urban, low-status individuals with high frailty to survive to adulthood than they would have had they lived in rural areas. This, in turn, might have resulted in the maintenance of greater variation in frailty throughout the lifespan in urban areas compared to rural areas and thus the maintenance of significant differences in risks of mortality between high and low status people from childhood through adulthood in urban areas. To a certain extent, this challenges conventional wisdom, as preindustrial urban populations are considered to have had poor health (Storey, 1992; Paine and Storey, 2006; Scheidel, 2009, 2010), and there is a overlap in the range and type of pathogens and types of disease (e.g., tuberculosis, rickets, and scurvy) occurring in both rural and urban settlements (Lewis, 2003).

In Roman Britain, an earlier study by Redfern and Roberts (2005) found that urban populations had higher rates of infectious and metabolic diseases. Therefore, we must suppose that in Dorset, the buffering was cultural rather than environmental. The benefits of living in *Durnovaria* compared to rural areas may have been from the amenities offered in the town, such as the aqueduct and access to a bathhouse (Putnam, 2007). Additionally, life in rural areas carries the risks of diseases and injury from agricultural work, such as becoming infected by pathogens in the soil or from animals, the often debilitating effects of heavy manual labor, and accidents sustained in animal husbandry or from agricultural tools (El Batawi, 2003; Lewis, 2003). Unfortunately, very little is known about rural life in Roman Britain, particularly about the people themselves. This arises from very few rural cemeteries being excavated in Britain (Pearce, 2008) and the majority of research focusing on economic and settlement activities (Taylor, 2001). The possibly higher mortality risk of rural populations is considered to reflect two outcomes; first, it is generally proposed that the majority of rural dwellers in this period were more likely to be indigenous (Birley, 1964, 1979; Mattingly, 2006), and, therefore, their interactions with newcomers may have increased their risk of being exposed to new pathogens; additionally, recent environmental archaeological suggests that livestock was being imported (Albarella et al., 2008), which may have brought with them diseases hitherto not encountered. Stable isotope analysis of rural populations from Dorset shows that they are more diverse than previously expected, as different food-ways are present (Redfern et al., 2010). This may reflect villa owners importing slaves to work the land, whose health status may have been compromised by migration and their social status.

We must also consider the possibility that the differences observed between the urban subsample and the rural and urban/rural subsamples reflect stronger mortality among adults in urban cemeteries than in rural areas, because there were causes of death in urban areas that did not exist in rural areas, which would have targeted adults and selected out low-status individuals (Harrison and Gibson, 1978). Low-status people may have had increased risk, because their living conditions were more unsanitary, as they could not afford measures such as drainage. Their employment may have also led to health problems, such as exposure to pathogens during butchery, pollution from metalworking, and being used in occupations that would have increased their risk of disease (Lewis, 2003), such as working as a cleaner in a bathhouse. Furthermore, the likely greater number of migrants in urban areas (Birley, 1979; Evans et al., 2006) might have resulted in a greater proportion of frail adults in urban versus rural areas. Migrants from the Mediterranean into urban areas, for example, may have been at increased mortality risk, because they were exposed to pathogens in Roman Dorset to which they lacked immunity and their biological and immunological adaptations may have been made to environmental conditions very different from those in Britain. However, the cultural buffering associated with high status would presumably have benefitted high-status migrants as it did high-status native inhabitants.

CONCLUSION

Our study of the relationship between status and mortality risk of a region in Roman Britain reveals that high-status individuals, particularly children, had a lower mortality risk compared to lower-status people; and for those buried in urban cemeteries, higher-status individuals of all age-groups had a lower mortality risk. These results provide further insights into our earlier findings, which reveal that Romanization had a deleterious effect on health because of the introduction of urbanism and increased population migration.

We propose that the cultural buffering afforded by being of high-status enabled people to more effectively deal with urban environments and migration, with lower-status individuals having greater risk because of their forms of employment and living conditions. Our findings about the relationship between urban living and mortality risk are not clear, because urbanism is known to be a risk to health (Schell, 1997; Fotso, 2006; O'Reilly et al., 2007), but it appears to have conferred an advantage in Roman Dorset. The reasons for this are not clear, as access to healthcare and sanitation was likely to be status-related. It is hoped that future studies in other Roman locales will be able to help clarify this finding.

Overall, our research has demonstrated that a bioarchaeological examination of funerary status shows that the relationship between the burial evidence and the body is more nuanced and complex than previously thought, and it provides new insights into life in Roman Britain.

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