Old age, height and nutrition:

Common misconceptions about medieval England

Felinah Memo Hazara Khan-ad-Din
Caidan Pentathlon, March 2003

I. Introduction: The benefit of the original records.

Just as introspection enriches our life experience and our personal relationships, examining history enriches our understanding of society and how people have responded to common challenges under many different circumstances. Expanding historical study to visualize the everyday lives of the individuals involved enhances these benefits greatly, but reveals the complexity of such study. Understanding any complex subject requires simplification, and medieval history is no exception. Therefore, it is natural to use personal experience to help create a mental model of medieval everyday life. The relative dearth of written records in medieval England, especially prior to the 14th century, only strengthens the tendency to fill out the medieval life experience by analogy to the better-documented 18th and 19th centuries, or even to our modern experience.

While generalization and analogy provide a necessary starting point for any student of medieval history, recourse to the actual records provides an essential "reality check". For contrary to a common subconscious bias, historical trends do not progress steadily over time, and many correlations valid during the better-documented periods cannot be accurately projected back into the medieval period. Such study of the medieval record often reveals fascinating misconceptions concerning the medieval experience, and this paper explores three such misconceptions.

The first concerns the perception of life span. Surrounded by facts and measurements in modern society, most people know that today, on average, babies born in the United States or Great Britain will live 70 to 80 years. This reflects the statistical calculation that half of the babies born in a particular year will live into their later eighth decade; *i.e.,* the *statistical average life span from birth* today is between 75 and 80. When an adult is asked how long he or she expects to live, the answer will typically center on this statistical average. So an adult of 30 years would commonly answer that he or she expected to live another 40 to 50 years. Although the definition of "old age" tends to vary with the age of the individual being questioned, most

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adult residents of the United States or Britain would also agree that 70 to 80 is definitely "old", although 60 is questionable.

In medieval England, the statistical average life span from birth was between 20 and 25 years[1], yet a medieval Englishman of 30 years expected to live into his or her early 50s. Some students of history, aware of the statistical average life span, assume that medieval Englishmen considered 40 to be old. In fact, a medieval English adult most probably considered 50 years about the beginning of "old age".

The second misconception concerns average adult height in medieval England. Certainly the 17th century swashbuckler and the Victorian gentleman were a few inches shorter than their modern descendents. This period of English history also saw mortality (death) rates about twice the modern level, supporting the evidence of poor nutrition and harsh living conditions presented by the short average adult height[2]. Since medieval mortality rates were even higher than those in 17th through 19th century England, logic indicates an even shorter stature for medieval Englishmen[3]. But, despite a very short statistical average life span from birth, medieval English men and women were only about an inch shorter than those measured in 1984 (see Table 2 and Figure 2 below), indicating that nutritional status was sufficient for near-modern height.

This leads to the third misconception investigated in this paper — the connection between nutritional status and mortality rates. The greatest killer in all pre-modern societies has always been infectious disease[4], and poor nutritional status increased the death rate from diseases prevalent in 18th and 19th century England[5], so the short stature of the 18th century Englishmen predicted his relatively short life span. Yet in medieval England, the epidemic diseases most responsible for mortality were unaffected by nutritional status[6], disconnecting high mortality rates from stature and living conditions.

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II. Old age — how long did a medieval English adult expect to live?

What determines how long a person expects to live? The modern American or British answer to "How long do you expect you'll live?" equates roughly with the statistical average life span from birth. Similarly, ages above this figure are included in the category of "elderly", although some argue about the starting point for that category. Based on statistical analysis of medieval records, the average life span of medieval English babies was only 20 to 25 years. Yet several lines of evidence indicate that an adult medieval English landowner *expected* to live to more than twice that age — into his sixth decade. Perception of expected life span, not statistics, defines "old age", so people in medieval England did not consider those under 50 years as "old" and would not have been surprised by "elderly" colleagues living into their 60s. Since medieval Englishmen had no idea of their statistical average life span from birth, what created these expectations?

Due to limits in the available documentation, discussion of expected life span in medieval England must focus on men of the landowning classes. Medieval records examined in such discussions emphasized the land-holding class and, with the exception of the Domesday report of 1086, did not exist in significant detail prior to the mid-13th century. Few manorial and monastery accounts (extents) and church benefices were recorded prior to late 13th century, while inquisitions post mortem for land-owners were first recorded in the mid-13th century. Increasing numbers of genealogies and wills, as well as the poll tax of the laity of 1377 enrich the records for 14th century. By the end of the 16th century, parish records recorded deaths caused by plague and other vague categories of disease along with their other records for all classes of society. The highly detailed records of deaths categorized by cause begin in the mid-19th century[7].

From these data, statistical analysis can provide average and age-specific mortality rates. *Average mortality rates* measure the number of deaths/1000 of the mid-year population. But knowing that four to five times as many medieval individuals died per 1000 population in a year versus modern Britain[8] does little to personalize medieval life. Such data require

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calculation of *age-specific mortality rates*, or the number of deaths in a year/1000 of the individuals *of that age* in that year. *Infant mortality* specifically refers to the mortality rate from birth to one year. Although not traditional in demographic articles, mortality rates in this paper will be expressed as percentages (deaths per 100 individuals), to increase recognition and comparison of such rates.

The statistical manipulations of age-specific mortality rates that generate the *average life span from birth*, or average life span from a specific age are explained in Appendix A. Russell[9] provides the best analysis of medieval mortality and life spans in his study of medieval male landowners from the 1200s to 1450. Rosenthal[10] analyzed records of medieval peers summoned to court from 1300-1500, while other authors have studied specific monastery and village records encompassing different segments of the medieval period. For comparison, Ascadi and Nemeskeri[11] have provided a detailed analysis of early medieval eastern European life spans.

As shown in Table 1 on the following page, the average life spans of medieval British adults reaching age 30 are remarkably consistent between several studies. Throughout the medieval period, 30-year-old men from different segments of the population lived on average to about 52 years.

Figure 1 on the following page compares the statistical average life spans from birth and for adults reaching age 30 over the past several centuries. Appendix B details the data sources and calculations used to provide the figures in Table 1 for each study and for each time period in Figure 1.

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TABLE 1: Average adult life spans				
	Ave. life span from:			
Time Period	20	30	60	Population studied
MEDIEVAL EASTERN EUROPE				
900-1200	47.5	51.1	67.4	Primarily Hungary (Ascadi and Nemeskeri)[11]
MEDIEVAL ENGLAND				
1250 - 1450	44.9	52.3	68	Male landowners (Russell)[9]
1350-1500	46.1	51.7	69	Peers summoned to court (Rosenthal)[10]
1242-1478	46.7	51.5	69	Men who remarried in Lincolnshire villages (Hallam)[12]
1270-1348	47.4	52.3	69	Villagers in Halesowen (Razi)[12]
1400-1500	48	52.8	69.5	Monks of Christ Church (Hatcher)[13]
MODERN ENGLAND				
1980	≈71	≈72	76	Male population of England[14]

Figure 1: Average life span from 1200 to 1980
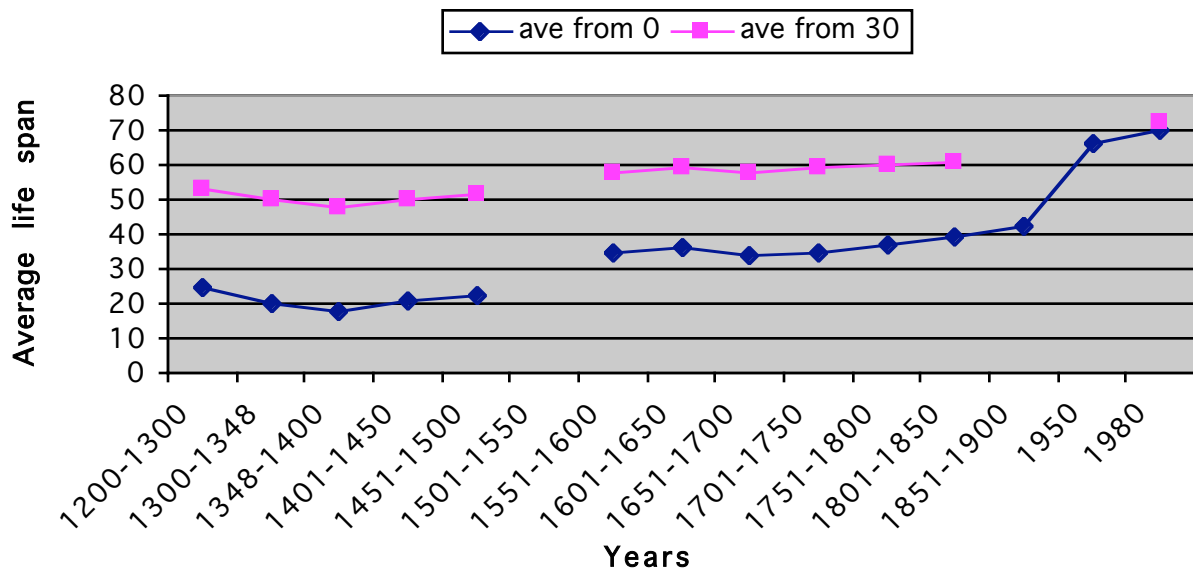
The medieval life spans in Figure 1 are derived from Russell[15], who is the only demographer to provide detailed data for each quarter century of the medieval period. The post-medieval data through the mid-19th century were derived from the demographic study of Wrigley and Schoefield[16]. Interestingly, no specific demographic data has been published for the period from

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1450 to 1550. Detailed mortality records originated in the mid-19th century, and the Registrar General of England and Wales provide data from this period through modern times.

The difference between average life span from birth and average life span from 30 years in each time period in Figure 1 is due primarily to infant and early childhood mortality. As average life spans increased over the centuries, the reduction in this early mortality brought the average life span from birth much closer to the average life span of an adult at age 30.

Recent medieval demographers have questioned the accuracy of any age-specific mortality rates for infants and young children, but agree that the first decade of life in medieval England had by far the highest mortality rate. Probably about 25% of all babies born died in the first year, and about another 20% of children and adolescents died before age 20.[17] This high childhood mortality is reflected in the average life span from birth during the medieval period, currently estimated between 20 and 25 years[18]. Living through childhood and adolescence meant that the individual had already outlived many of those sharing his or her birth year, so half of the adults reaching 30 years lived into their sixth decade. Appendix A explains the concerns of recent demographers with medieval childhood mortality rates.

Figure 1 indicates that a baby born in England in 1980 will live on average to 73 years old. An individual at age 30 will live on average to about 75, and one living to 60 years will live on average to 77.5 years of age. Current English infant mortality is only 1.6%, childhood mortality remains very low, and the highest death rate averaged over a 10-year period occurs from 65 to 74 years of age[19]. An adult of 30 years in modern England or America knows that about half of his or her parents' acquaintances live into their seventies. So in modern England, the statistical average life span from birth is a reasonable indicator of the *expected* life span of an adult.

Since medieval Englishmen did not calculate a statistical average life span from birth, how long did medieval people really *expect* to live? Three lines of evidence support the proposition that medieval English adults viewed 50 to 55 as a "normal" average life span.

The first line of evidence concerns how and when children learn the length of a "typical" lifespan — how long they will expect to live. Children first develop the ability for abstract

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thought at about age 7[20]. Children learn the length of a "typical" lifespan from their parents after this age, both by hearing discussion and observing their parents' response to deaths around them. A medieval woman of the landholding class in 1300 married at an average age of 24[21], and so might expect her first child by age 26. So a medieval child began learning the length of an expected lifespan from parents who were typically in their 30s[a]. At that age the parents' expectations, established by observing about half of *their* parents' acquaintances living into their sixth decade, would center on 50 to 55 years.

A second line of evidence drawn from statistical analysis of ages at death in early medieval Hungary supports the first line. The average mortality rate for Hungary during this early medieval period is close to that of England, and the average life span of adults reaching age 30 is very similar to those in medieval England in non-plague years[22]. Using skeletal evidence, the authors calculated the death rate for each year of life in that time period. In this study, the age-specific death rate fell from a maximum of 20% during the first year of life to below 2% per year by age 5[b], and never exceeded 2% per year again. The largest increase in death rate per year after age 5 occurred between ages 50 and 55. This age would correlate to the most common age of death observed by adults, supporting the first line of evidence. The authors explain that statistically, this largest increase in mortality in adults represents the "normal" length of life of adults[23].

The third line of evidence is drawn from the writings of an early medieval author. Bishop Isadore of 7th century Spain outlined six ages of man in his "Etymologies", a manuscript widely read during the medieval period. He defined "infancy" from birth to age 7, "childhood" from age 7 to 14, "adolescence" from age 14 to 28, "youth" from age 28 to 50, "seniority" from age 50 to 70, and "old age" over 70[24]. Although modern categories might redefine the Bishop's

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[a] Average marriage ages of daughters of medieval land-holding Englishmen from 1272-1307: 24 years; 1307-1327: 22 years; 1327-1377: 20 years; mid-1400s: 18 years; 1485-1509: 15 years. Russell, JC, 1948, p. 157, and Russell, JC, 1984, p. 207 (for mid 1400s). Russell estimates that these ages are somewhat lower than for average medieval marriage.

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"youth" as "adult" and the Bishop's "seniority" as "mature adult", the age groups are surprisingly familiar to modern readers. It hardly seems likely that the Bishop would define the age to which he expected to live as "youth". Most probably, he would have included the expected life span within "seniority". Even allowing for the longer average life span in early medieval Iberia, Bishop Isadore's writing supports an estimate of at least 50 to 55 as the expected life span in medieval Europe.

Bishop Isadore's manuscript also provides insight into what age was considered "old" in the medieval period. Although Bishop Isadore began "senilis" or "old age" at 70 years, it is likely that in medieval Britain with its shorter average life spans, "elderly" began somewhat earlier. Since approximately 20% of the young adult population (age 20) survived to age 60[25] in medieval England, adults surviving to 60 years would not be surprising. And Table 1 indicates that half of the adults living to 60 years could expect to live almost to 70 years. So medieval Englishmen were unlikely to consider 40 years, as "old"; this category most likely began about 50, with Bishop Isadore's "seniority".

Of course, differences in medieval mortality created several other contrasts to the modern life experience. Today, in both the United States and in Great Britain, women commonly live between 5 and 8 years longer than men, and both in the United States and in England, the largest segment of the population, the "baby-boomers", are mostly in their 50s. In contrast, at least half the medieval English population was under 20 years old[26] and medieval men typically lived 2 to 3 years longer than women[27].

The statistical average life span from birth in late 20th century England and Wales was 76 for a woman, compared to 70 years for a man[28], which reflects a slightly greater mortality among men compared to women and results in a small excess of women compared to men in the population[29]. In medieval Europe, female mortality exceeded male mortality from birth through the fifth decade, so men outlived women by a few years on average, and men outnumbered

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[b]Although the specific figures calculated for infant and early childhood mortality may be questionable, as discussed in Appendix A, they undoubtedly represent the highest age-specific death

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women by a few percent in the population.[30] The increased female mortality arose from a combination of higher rates of female infanticide and an increased death associated with childbearing.[31]

Infanticide has been a relatively common method for controlling overpopulation, especially in earlier periods, and the climate of medieval England provided a simple method through exposure and hypothermia.[32] Repeated bans on infanticide by the medieval English Church demonstrate infanticide was a recurring problem, and the increased sex ratios of pre-pubertal boys to girls can not be reasonably explained through other means.[33]

Some skeletal evidence, specifically infants buried with women, supports an increased mortality in women due to complications of child bearing, but examination of skeletal remains tends to underestimate the problem. In many cases, the mother lived long enough that the infant was buried separately, and infant burials are more difficult to detect than adult burials. The best evidence for increased mortality due to childbearing stems from the difference in average life spans between women and men during the reproductive years:[34]

Medieval English girls, like their modern counterparts, began menstruating between ages 12 and 14, and became fertile about a year after their first menstrual cycle[35]. But the typical reproductive years in medieval women extended from ages 20 to 40. The average marriage age of a medieval woman occurred in her early 20s, ensuring that reproductive age typically began about 20. And like her modern counterpart, fertility in a medieval woman began to drop sharply in the late 30s[36].

A 20-year-old medieval woman in England[37], Hungary[38] or Sweden[39] lived on average about two years *less* than her male counterpart. This difference held true until age 40 in medieval English women, after which the difference became negligible. In 16th to 17th century Germany, similar maternal mortality rates indicated that 11.3% of fertile women died from childbearing[40]. While about 13.5% of 20-year-old men reached 60 in medieval Europe, about 12.9% of women

rates, and do not change the age-specific adult mortality rates, or the conclusion drawn from them.

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did so[41]. In England, the reversal to greater longevity in women did not occur until the early 1800s[42].

III. Height — how tall were adults in medieval England?

Although adults in medieval England lived on average about 5 – 8 years less than their early 17th century counterparts (see Figure 1, above), skeletal evidence indicates that medieval Englishmen were at least 2″ taller on average than Englishmen in the 17th century, and only about 1″ shorter than their counterparts in 1984. As usual, less data is available for women, but medieval Englishwomen averaged about 1.25″ less in stature than their modern counterparts.

The first detailed historical records of height began with military recruitment records kept from the beginning of the 18th century.[43] Stature data prior to 1700 relies on skeletal evidence,[44] which presents several difficulties. Correctly identifying the time period represented by burials in a particular cemetery creates the first hurdle, which is compounded by casual abuse of skeletal remains prior to 1960.[45] Once the historical time period of the skeletal remains has been narrowed as much as possible, the skeletal evidence itself can be addressed. The sex of skeletons can be determined with high accuracy from as little as a pelvis or skull and use of multiple determinants can give quite accurate results for the age at death.[46] Several statistical models have been developed to accurately predict height from individual limb bones, or averages of several limb bones. The currently accepted model for accurately estimating height was developed by Trotter and Gleser using specifically measurements from femur (thigh bone) and tibia (larger lower leg bone), and most of the data cited used this method. A brief discussion of the Trotter and Gleser model is presented in Appendix C.

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Table 2 provides a summary of the medieval skeletal evidence[a]. The heights have been converted from centimeters and rounded to the nearest quarter inch. The number of cases per study, when available, is included in parentheses after the stature data within the cells of the table.

Table 2: Skeletal evidence for medieval stature (covering from about 1200-1500 AD)			
Location	Male height	Female height	Reference
Scotland (3 sites)	5′ 7″ (15)	5′ 2″ (16)	Spalding, RN, *et al.,* 1996[47]
Yorkshire	5′ 7″ (>250)	5′ 2″ (>110)	Brothwell, DR, 1994 (excluding Jewbury data)[48]
York	5′ 7.75″	5′ 2 ″	Daniell, C, 1997[49]
Cambridge	5′ 6.5″ (37)	5′ 2.25″ (18)	Brothwell, DR, 1994 (excluding Jewbury data)[48]
Midlands	5′ 7.25″ (174)	No data	Huber, N, 1968, p. 93 [50]
Hampshire	5′ 7.25″ (21)	5′ 2.5″ (6)	Brothwell, DR, 1994 (excluding Jewbury data)[48]
Taunton	5′ 7″	5 ′ 1.5″	Daniell, C, 1997[49]
London	5′ 7.5″	5′ 3″	Werner, A, 1998, p. 108[51]
Medival English	**5′ 7.5″**	**5′ 2.25″**	See discussion in text below
Modern English	**5′ 8.5″**	**5′ 3.5″**	Knight, I, 1984[52]

The different studies agree to a remarkable extent on an average male height of 5′ 7.5″ and an average female height of 5′ 2.25″. Average male heights range from 5′ 6 1/2″ in a Cambridge cemetery to 5′ 7 3/4″ in a cemetery in York, and the specific values listed in Table 2 generate an unweighted average height of 5′ 7.25″. However, Daniell[49] and Huber[50] each cite average English male height of 5′ 7.5″ after including a variety of unlisted sites, and this average agrees with Werner's[51] estimate of the height of male Londoners. This additional evidence supported

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[a]The sex of a skeleton can be determined most accurately from the pelvis and skull (97-8%), and is slightly less accurate with just the pelvis, or the skull alone; the long bones alone give an accuracy of 80-5%.
Different factors are used to determine a skeleton's age at death:
    Tooth eruption (best for estimates from 4 to 12 years)
    Tooth attrition (best for estimates in mature adults, but can be affected by changes in diet)
    Fusion of epiphyseal "growth" plates at ends of limb bones (best from about ages 12 to 24 years)
    Shape changes in the pubic symphysis (best for adults in later decades)
    Changes in the sternal ends of rib bones and the surface of the ileum (best in mature adults)
Age estimates made from single determinants, as done in earlier studies, tend to underestimate the true age of the individual at death. Age estimates from multiple determinants are quite accurate.
(Daniell, C, 1997, p. 129-132; Kunitz, SJ, 1987, p. 271)

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an average medieval English male height of 5′ 7.5″. Spalding[47] found that medieval Scottish men were slightly shorter at 5′ 7″.

The average height for medieval adult women in Table 1 was derived from English averages of 5′ 2″ (Daniell) and 5′ 2.25″ (Brothwell), with 5′ 3″ for Londoners (Werner). Again, Spalding found that Scottish women were slightly shorter at 5′ 2″.
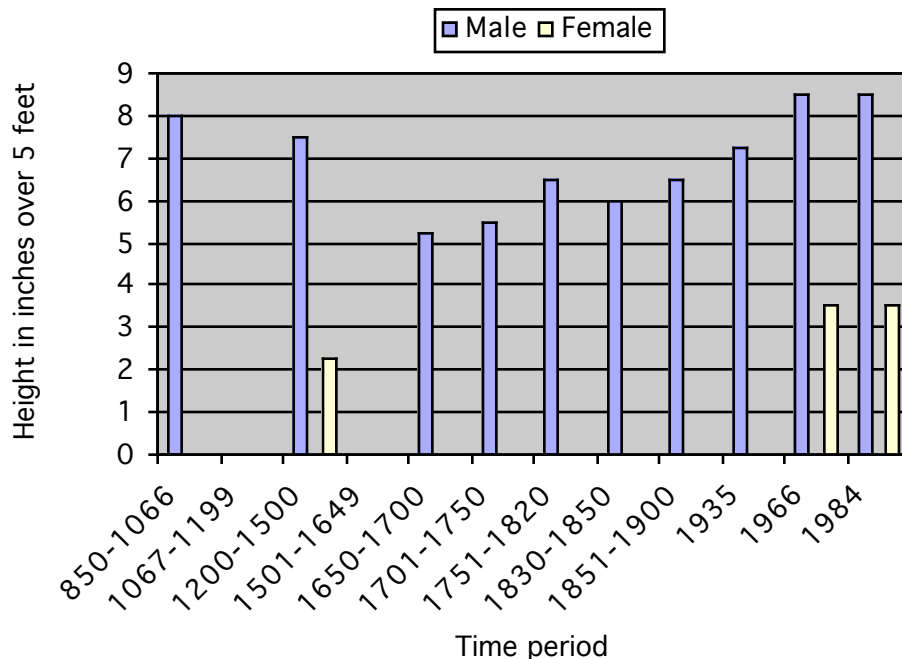
The medieval average heights for men and women are surprisingly similar to the average heights of men and women in Great Britain in the 1980s, at which time British men averaged 5′ 8.5″, while British women averaged 5′ 3.5″[52]. Details of the data sources for both Table 2 and Figure 2 are provided in Appendix C. Appendix C also discusses how the data in Table 2 were selected to avoid or minimize certain complications in stature data, such as height loss with advancing age and the need to focus solely on the Caucasian subpopulation of modern Britain when comparing stature data. The question of the small but continuing increase in average British (and American) stature over the past 20 years is also addressed briefly, explaining why the most recent stature data is less likely to provide the best comparison with medieval stature.

Examination of the heights of some of the medieval English kings and their description by medieval writers provides an interesting side note about height, its perception and its impact. As noted by one author in his introduction[53], "Height matters to humans," and is "… one of our primary means of identification." In a similar vein, Russell[54] explains that, "Human height assumes an unreal importance because our eyes are near the top of our bodies, and thus they detect easily relatively slight differences in stature. Today a few inches seem to confer some advantage in securing positions of leadership…." Russell goes on to compare the actual heights of medieval English kings with their descriptions in contemporary manuscripts. Although much of his evidence is derived from tomb and effigy sizes, which are only sporadically accurate, the available skeletal evidence supports his contention that 5′ 9″ was an expected ordinary height (often described as "just") for English kings. Henry VI (reigned 1422-71) was described in this fashion, and a recent historian identified his height as between 5′ 9″ and 5′ 10″; Henry III (reigned 1216-1272) was similarly described, and his tomb indicates a height of 5′ 9″, at a time

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when tombs commonly portrayed correct height. Henry's father John (reigned 1199-1216) was described as one of Henry II's "short" sons, and both John's skeleton and effigy agree on a height between 5′ 5″ and 5′ 6″. If Richard I's (reigned 1189-99) tomb is as accurate in height as that of his brother John, then he justified his "noble" and "very grand" descriptions by standing about 6′. In contrast, skeletons are available for both Edward I (reigned 1272-1307), who at 6′ 2″ was described as standing "head and shoulders above common folk", and Edward IV (reigned 1461-83), who at 6′ 3″ was described as "exceeding all in height"[55]. So, not surprisingly, the contemporary writers expected an "ordinary" king to be 1″ to 2″ taller than an average medieval subject.

Figure 2 surveys average height in Great Britain from early medieval to modern times; the details of the data sources for each period are discussed in Appendix C.

Figure 2: Changes in British stature

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No specific stature data were available between 1066-1200. Huber identifies heights based on skeletons specifically from 1200-1400, and most of the other "medieval" cemeteries discussed above were in use from the 12th or 13th centuries through the 15th century. Therefore, the average medieval English height from Table 2 is used for the period from 1200-1500. No stature data specific to the 16th or early 17th century has been found in the literature at this time. At some point between the late 1400s and the end of the 17th century, average male stature decreased by about two inches. This may account, at least in part, for a common observation that some of the existing suits of full armor appear to be made for smaller men[56]. Since many of these ornate suits date from the mid-16th century, the decrease in British male stature may have already begun. From the late 17th century, British men slowly increased their height, with a small regression in the second quarter of the 19th century, but didn't regain their medieval average until after 1935.

IV: The nutritional connection — what can explain tall medieval Englishmen with short life spans?

What of the nutritional connection between average height and mortality? The average height of a population is an accepted index of its general nutritional status[57], and poor nutritional status increases the mortality rates from some diseases[58]. Both the average stature of Englishmen and the average English life span were rising in the early 18th century, emphasizing the effect of nutritional status on mortality, as well. What can explain the taller medieval Englishman with a shorter average life span?

Adult height results from a genetic potential modified by infant and childhood environmental influences, including diet, living conditions and frequent disease, often grouped under the heading of "nutritional status"[59]. Although the heights of an individual's relatives provide some guide to the genetic height potential of an individual, the genetic variation built into sexual reproduction precludes knowing (yet) the genetic height potential of any individual[60]. But genetic influences average out in a stable population, and genetic potential does not change significantly in the span of even several hundred years. So in a stable

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population over time, genetic factors are constant, leaving only average nutritional status of children and adolescents as the variable that significantly affects the average adult height of the population. This is true for the medieval English population, and still holds reasonably well for the Caucasian subpopulation in England through the last quarter of the 20th century (see discussion in Appendix C).[61]

The exact statistical relationship between measurable changes in nutritional status and average population stature remains uncertain, however. Children's early growth is easily slowed by inadequate nutrition or frequent bouts of disease because of the large energy demands placed on their body by continued growth. And a few years after puberty, the growth plates (epiphyses) on the long bones fuse, preventing further increase in stature. In fact, within a decade or less of achieving full adult stature, individuals begin to lose height slowly[62]. However, intermittent childhood periods of malnutrition or disease[63] frequently have little effect on decreasing final adult stature because of the opportunity for "catch-up" growth. After a period of growth retardation in childhood resulting from poor nutritional status, accelerated growth during the adolescent growth spurt often compensates to bring the adult height back towards its normal value. Additionally, malnutrition or disease severe enough to retard growth often delays puberty as well, allowing another opportunity for catch-up growth to return the individual to his or her normal adult height.

Clearly, the average height of the medieval English population indicates a quite reasonable nutritional status, despite comparatively harsh living conditions[64]. The typical medieval English landowners' diet emphasized bread, beer and meat, but medieval nobility minimized their consumption of vegetables and fresh fruit. In fact, even consumption of significant milk and cheese was avoided, unless as part of pies or deserts, since this form of "white meat" was considered fit primarily for peasants. The peasant diet featured less meat, but more dairy products and somewhat more vegetables[65]. No modern dietician would recommend any medieval diet as nutritionally balanced, and periodic harvest failures ensured frequent spring and early summer hunger, with occasional episodes of starvation due to outright famine. But

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both of these diets must have allowed substantial catch-up growth to help compensate for periodic harvest failures and bouts of childhood disease[66]. Additionally, this nutritional pattern, even with the harvest failures and occasional starvation, did not produce the severe malnutrition we associate with famine in underdeveloped countries in the 20th century. Unlike severe malnutrition, the moderately low nutritional status typical of the medieval period has little, if any connection with increased mortality from epidemic disease[67], and medieval famines were typically short-lived enough not to permanently stunt growth.

The additional environmental factors contributing to nutritional status must have allowed this catch-up growth as well. This argues that medieval housing was adequate to protect people reasonably well from English winters, and that chronic or wasting, but non-fatal childhood diseases were not frequent enough to permanently stunt growth. The small decrease in average English male height between 850 – 1066 period and the period spanning 1200 – 1500s, if it is significant, probably occurred during the late 1200s or early 1300s. During this time, increased demand for taxes and increasing population pushed villages into marginal land and decreased fallowing of land. These factors combined with some climactic cooling to decrease crop yields[68] and strain winter housing. The resulting drop in average nutritional status may have sufficed to decrease average male height about a half an inch, but medieval men still stood only about an inch shorter than their modern counterparts.

So why didn't this reasonable nutritional status increase the average life span of the medieval Englishman, particularly that of the landowners with their better living conditions and more protein-rich diet? By far the most predominant cause of mortality in medieval England was epidemic disease. Violent death accounted for only about 5% of total deaths per year among medieval English males, although male English peers suffered about twice that many violent deaths per year[69]. After 1348, plague constantly dominated the medieval mortality figures, accompanied by less severe epidemics of "sweating sickness"[a,70], epidemic typhus, and

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[a]"Sweating sickness" (Sudor Anglicus) appeared in English records in 1485 and disappeared again in the 1550s. Although often equated with outbreaks of influenza, this disease differs from influenza and has

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influenza, imposed on a lower background mortality from dysentery, epidemic typhoid fever, malaria, smallpox and tuberculosis[71]. Nutritional status has virtually no effect on the probability of infection by epidemic diseases, nor on the mortality rates due to the plague, malaria, or "sweating sickness". Nutritional status has only a very equivocal effect on the mortality rates due to smallpox, influenza and epidemic typhus, although it is closely correlated to mortality from tuberculosis and dysentery.[72] So although nutritionally-sensitive diseases were present in medieval England, the relatively good nutritional status indicated by average adult height did not significantly protect the people from the predominant causes of mortality. Although medieval famines did typically correlate with outbreaks of pestilence, the connection was not through depressed nutritional status. Instead, the pestilence during famine most probably resulted from the infected population moving to escape hunger and spreading a small local outbreak into an epidemic[73].

This situation held through the late medieval period, even as the post-plague English population began to increase once again during the late 15th century. Indeed, the poorer growth and greater evidence of disease observed in urban children vs. their rural cousins in industrialized England are not seen in late medieval England, although contemporary accounts complain of air pollution and poor living conditions. So even in relatively crowded 15th century English cities, children's health did not suffer significantly compared to their rural contemporaries[74].

At some point between the 15th century and the late 17th century, average English male height dropped by at least two inches, as shown in Figure 2. The significant decrease in nutritional status causing this decrease probably resulted from increased urbanization, increasing population and decreased real wages (adjusted for cost of living)[75]. Interestingly, the "little ice age" in Europe began in the 1500s[76], about the same time as increasing population began to stress agricultural productivity[77]. Although both height and life span began rising about 1700,

not yet been definitely identified. Similarities to Hantavirus and an unidentified arbovirus have both been explored.

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(Figures 1 and 2), the period from about 1700 to 1900 was characterized by relatively short English stature and mortality rates still at least twice the modern level[78]. By the mid-1700s, the pattern of mortality changed from a "crisis mortality" pattern dominated by regional or national epidemics to a steadier "background mortality" pattern with fewer epidemics[79]. Specifically, this was the period during which tuberculosis emerged as the predominant killer, accompanied by cholera, smallpox and infantile diarrhea[80]. During this same period, the mortality of the peerage began to fall significantly below the mortality of the general populace for the first time[81]. Since the nutritional status of the peerage always exceeded that of the general population, this supports a change in the dominant causes of mortality to diseases correlated with nutritional status. So, unlike the their taller medieval forefathers, members of the shorter Georgian and Victorian population found poor living conditions clearly related to a shorter life span.

V: Conclusion.

Certainly medieval living conditions and the demography of the medieval population ensured that the medieval life experience differed greatly from ours. Death was a common companion for medieval Englishmen, and the probability of a baby living past 25 years was less than 50%. Even prior to the plague, villages grew slowly by modern standards, adding slightly over two new individuals a year to a village of 300 people in the 13th century, in the absence of migration[82]. But any population growth in the face of such high mortality rates required an even higher fertility rate, ensuring that medieval Englishmen lived within a young population. The dangers of childbirth predicted that men often outlived their wives. Living conditions were clearly harsh and diet unbalanced by modern standards.

Modern experience, as well as that of the better-documented 18th and 19th century, would seem to predict that such a short average life span from birth would indicate poor nutritional status and "old age" starting by at least 35 or 40 years; the poor nutritional status would correlate with a short average stature in the population. Not surprisingly, this is a common view of medieval England. Yet investigation of the actual medieval record surprises the student

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of history with the reality that medieval individuals considered 50 to 55 to be a "typical" life span, that nutritional status was good enough to allow near-modern height, but that that nutritional status was unrelated to the high mortality rate. Such tantalizing insights into the many common misconceptions of medieval life can only emphasize the rewards awaiting those willing to delve further into the medieval record.

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APPENDIX A: Expectation of life and the concern over older demographic statistics.

In the literature, mortality data are used to generate life tables listing "expectation of life" values[83], which give the average number of years that an individual would live *beyond* the listed age. *Expectation of life* ($e_x°$) is defined as the number of years *beyond* a given age (x) that 50% of individuals born in a particular time period can expect to live. The *expected age of death*, or **average life span,** is defined as the age to which 50% of the individuals of any particular age will live; therefore, average life span equals the actual age plus the expectation of life for that age (average life span at age $x = x + e_x°$). The *expectation of life from birth* ($e_0°$) is defined as the number of years that 50% of all babies born in a particular year or period will live, which is also the **average life span from birth**.

In this paper, the statistical average life span must be distinguished from the *expected* life span. The expected life span is defined here as the age to which a person reasonably *believes* he or she will live, based on the average life span of his or her contemporaries or other beliefs learned from his or her parents. Therefore, in this paper, the "expectation of life" data have been converted into *average life spans* for clarity, and the term "expected" always refers to a person's beliefs or perception.

With regard to the calculation of life tables for medieval England, more recent demographers have questioned two areas of earlier medieval demographic studies: the ability to accurately calculate medieval infant and child mortality rates and the statistics used to calculate expectation of life tables from age-specific mortality figures.

Infant and child burials are so unreliable in medieval cemeteries, and the records so poorly kept, that more recent statisticians believe accurate infant and *age-specific* child mortality rates are impossible to calculate. Most authors estimate medieval infant and child mortality between 25 and 35%, which is greater than that estimated by Russell in his medieval English data. This calls into question the accuracy of Russell's expectation of life from birth figures, since these figures are significantly influenced by child and infant mortality rates.

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In addition, the statistics used to generate the age-specific expectation of life data of earlier life tables have been questioned by more recent demographers. Coale and Demeny have constructed a large series of life tables based on combinations of populations from the 19th and 20th centuries showing similar patterns of age-specific mortality.[84] Identifying the table with the closest match to particular mortality data provides demographers with more accurate pattern of age-specific expectation of life data. The more recent medieval demographers agree that the level 1 or level 2 West model tables of Coale and Demeny best estimate adult medieval English life spans.[85]

The best estimates of medieval infant and child mortality do not appear to correlate accurately with the any of the West model tables of Coale and Demeny, which at level 1 or 2 would estimate even higher infant mortality rates of 35-40%.[86] Therefore, the best estimate of expectation of life from birth values for medieval populations should fall between those estimated by Russell and those listed in the West model tables. In agreement with this, Hollingsworth estimates the expectation of life from birth in medieval England to have averaged between 20 and 25[87]. The calculations used to estimate expectation of life from birth values, or average life spans from birth, for specific medieval periods from Russell's data modified by Coale and Demeny's tables are detailed in Appendix B.

The concern with inaccurate infant and child mortality rates distorting expectation of life data diminishes with age, so that expectations of life at 30 and at 60 were virtually the same in the original data of Russell and Ascadi and Nemeskeri as those calculated from the newer model West tables.

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APPENDIX B: Sources of life span data for Table 1 and Figure 1.

Table 1 provides average life spans from 20 years, 30 years and 60 years for a variety of different medieval populations. The average life spans in this table have been calculated from expectation of life data as explained in Appendix A. The average life span figures for each study were derived either directly from the articles cited, or by consultation with the Coale and Demeny model West level cited by each author as appropriate for that specific data.

Time period	Source of data
900-1200	Ascadi and Nemeskeri[88] provided detailed data from Hungary. At adult ages, the newer statistical concerns explained in Appendix A do not significantly bias the data.
1250 – 1450	Calculated as an average of Russell's medieval data[89]. At adult ages, the newer statistical concerns explained in Appendix A do not significantly bias the data.
1350 – 1500	Average life span from 20 was calculated by the author[90]; remaining values were derived from model West table, level 1.
1242 – 1478	Average life span from 30 was calculated by author[91]; remaining values were derived from model West table, level 1.
1270 – 1348	Average life span from 20 was estimated from an average of model West table levels 1 and 2, as suggested by author[92]; remaining values were derived from model West table, average of levels 1 and 2.
1400 – 1500	Average life span from 20 was calculated by the author[93]; remaining values were derived from model West table, level 2.
1980	Average life span from 60 was calculated by the author[94], who also provided an accurate average life span from birth. The average life spans from age 20 and 30 are estimated from the knowledge that infant mortality is currently about 1.6% in England, and child mortality is similarly low; the highest decades of mortality are between 50 and 70.

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Figure 1 provides average life span from birth and from 30 years from the 1200s through 1980.

Time period   Source of data

1250 – 1450:   Russell's figures[95] for average life span from 30 are averaged for each time period. Russell reported his data for the cohort *born* in the indicated period; on average, the people aged 30 in one 25-year period were born in the previous quarter century. Therefore, the average life spans from 30 are reported for the quarter century that a particular cohort would have been *alive*, to correctly time the effect of major mortality crises, such as the plague. This applies Russell's data through 1500.

Average life spans from birth are estimated for each time period by comparing Russell's data with the Coale and Demeny model West tables, calculating the deviation from the closest Coale and Demeny model West level, and applying that deviation to Russell's value for expectation of life from birth.

The model West table levels used in the medieval periods shown on the graph are: 1200 – 1300: level 2.5; 1300 – 1348: level 1 less 2.2 years; 1348 – 1400: level 1 less 4 years; 1401 – 1450: level 1 less 1.7 years; 1451 – 1500: level 1.

1550 – 1850: The data from Wrigley and Schoefield (provided in Kunitz, SJ, 1997) was used for the average life span from birth. The average life span from 30 was calculated by applying the appropriate model West table levels cited in Loschky and Childers, p. 92.

1850 – 1900: The data from Lancaster was used for the average life span from birth. Since the Coale and Demeny model tables do not apply well to modern populations, the average life span from 30 was omitted in the 1850 – 1900 and 1950 periods. An estimate of 73 years was used for 1980, as explained for Table 1.

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APPENDIX C: Sources of adult stature data for Table 2 and Figure 2.

The sources of data for the medieval English stature data in **Table 2** are cited in the table.

Ironically, an excess of data, rather than a deficiency, complicates modern stature data presented in Table 2. Although Werner cites an average height in the UK of 5' 9" for men and 5' 3 3/4" for women by 1998, the slightly shorter 1984 data from Knight were used for a modern comparison. Modern stature data is complicated both by increased immigration into England in last century, and by stature data provided for specific age groups. Werner does not specify either the ethnic group or the age group covered by his data, while Knight's data specifically represent the average height of the "white" subpopulation from age 20 to 64.

Immigration in England has created an ethnically mixed population in the last century, confusing the genetic contribution to average adult stature. Focusing on the "white" subpopulation data in Knight's 1984 study minimizes this difficulty, since most Caucasian immigrants come from a similar genetic pool.

As a second complication in stature data, adults begin to lose height several years after they finish growing, so the average height of British men from ages 20 to 60 is an inch less than the average height of British men at 21 or 22 years. British women show a similar, but smaller difference with age.[96] Since skeletons of all adult ages available at each medieval cemetery were used in the skeletal evidence, the average male and female heights from ages 20 to 60 provide the best comparison.

Although several studies indicate that average stature in Great Britain has continued to increase over the last 15 to 20 years, this recent increase is most likely the result of increased infant health care technology, rather than significant improvements in diet or living conditions. This makes the more recent increase in stature much less applicable to comparison with the medieval experience, supporting the use of Knight's 1984 data in Table 2.

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Graph 2: The sources of the average adult stature data for each time period, male and female, are listed below.

Time period	Source of data
850-1066	Huber, N, 1968, p. 94.
1200-1500	The medieval average listed in Table 1 was used. The data from Kunitz, SJ, 1997, Table 1, p. 275, have not been included, since Kunitz cites Huber, N, 1968, as the source of his data, yet his numbers are almost an inch shorter than what Huber cites from apparently the same evidence.
1650-1700	Data provided by Kunitz were used, as the only data available for this time period.
1700-1820	Data from Floud, R, *et al.*, 1980, p. 288-91 were used, which agreed within a fraction of an inch with the Kunitz data.
1820-1850	Floud data were used because Kunitz cited an unpublished manuscript from Floud, but then cited 5' 7" for the average adult stature, rather than the stature data reported by Floud.
1850-1900	Floud data were used, which agreed within a fraction of an inch with the Kunitz data in Table 1, p. 275.
1935:	Data from Huber, p. 94, were used.
1966:	Data from Floud, p. 10, were used.
1984:	Data from Knight, 1984, p. 7, were used.

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[91] Loschky, D; Childers, BD, 1993, p. 88.

[92] Ibid, p. 88.

[93] Hatcher, J, 1986, p. 28.

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[94]Lancaster, HO, 1990, p.44.
[95]Russell, JC, 1948, p. 374.
[96]Knight, I, 1984, p. 7-11.

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