AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 68: 281–299 (1985)

Pubic Symphysis Age Distributions

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KEY WORDS Pubic symphysis, Demography, Age assessment, Ontario Indians

ABSTRACT A further discussion of age assessment and palaeodemography requires detailed reviews of methods, especially pubic symphysis techniques. Before reanalysis of changes in symphyseal form, the initial steps in distributing ages must be examined. Use of the mean values for age scores gives age distributions that are not real, but subject to systematic distortions, and cumulative percentages of skeletal samples can be shown to reflect the mean ages. Distributing skeletal ages using 95% probability distributions provides a more accurate estimation of true ages for palaeodemography and a better basis for discussions of pubic symphysis aging techniques.

Bocquet-Appel and Masset (1982) argue that all populations aged using the McKern and Stewart (1957) method will have an adult age distribution similar to that of the Korean war dead "reference population." In this paper I will focus on the method of aging that relies on changes in the pubic symphysis and the 349 individuals (Fig. 1A) on whom the method was based. The question at issue is very clear: does the McKern and Stewart method itself impose an age structure that is neither real nor random, but the result of "some systematic error" (Bocquet-Appel and Masset, 1982:321)? Ideally this question should be answered using skeletons of known age. It cannot be answered using age distributions from archaeological sites unless we have full knowledge of the exact contribution of pubic symphysis aging techniques and whether or not the distributions were smoothed.

Ossuaries, such as those found on Huron sites in Ontario, provide an excellent test case for the use of pubic symphysis aging techniques. An osteologist working on ossuary dead, or on other disarticulated, mixed, and broken human skeletal material, relies heavily on pubic symphyses for age distributions. Age distributions from a number of Huron ossuaries and Neutral cemeteries in Ontario in which adult age assessment was based on examination of pubic symphyses by the McKern and Stewart method, show a consistent and unexpected peak of mortality in the 35–40-year age category (Fig. 2A, B., D). This pattern is also found in a number of sites that are widely separated in time and space (e.g., Mobridge, unsmoothed data, Palkovich [1981a,b]; Nea Nikomedia and Palaeolithic and Mesolithic sites, Angel [1971]; Indian Knoll, Johnston and Snow [1961]). I have always found this mortality peak a perplexing anomaly. I will examine the reason for this anomaly and propose a method to deal with it.

The data used initially in this paper to demonstrate methods of distributing pubic symphysis ages are based on Saunders's analysis (1974) of 100 adolescent and adult innominates from the late precontact Kleinburg Ossuary north of Toronto, Ontario. Saunders carefully studied the innominates using several methods (McKern and Stewart, 1957; Gilbert and McKern, 1973; but not Todd, 1920) and reported her findings in full.

AGE DISTRIBUTION OF THE DEAD

Any discussion of the position taken by Bocquet-Appel and Masset, and indeed any broad discussion of the possible error in the assessment of adult ages in human skeletons, must focus first on the final step in the assignment of an age by the McKern and Stewart (1957) and Gilbert and McKern (1973) methods. In general, as Ubelaker

Received May 30, 1984; revised March 26, 1985; accepted March 29, 1985.

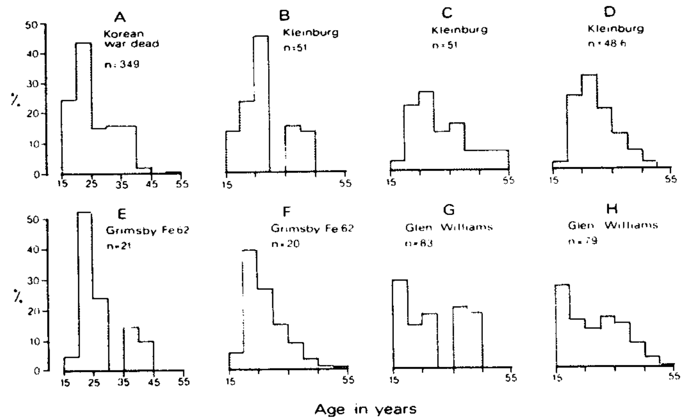


Fig. 1. Percent age distribution of individuals from ages 15 to 54.9. A) The 349 Korean War dead on whom McKern and Stewart (1957:11, 81) based their pubic symphysis technique: The 30 to 40 year olds were grouped together. B) Kleinburg males distributed according to mean values of scores (McKern and Stewart). C) Kleinburg males with equal distribution over age ranges of pubic scores. D) Kleinburg males: probability distribution over ±2 SD for each pubic score. E) Grimsby Feature 62 male right pubes distributed according to mean values of scores. F.) Grimsby Feature 62 male right pubes: probability distribution over ±2 SD for each pubic score. G) Glen Williams male and female right pubes distributed according to mean values of scores. H) Glen Williams male and female right pubes: probability distribution over ±2 SD.

(1978:58) states, the mean age associated with a pubic symphysis score is used as the best estimate of the age of the individual being considered. The resulting age distribution may be markedly uneven, as shown , for example, in Figure 1B.

Snow (1983) has suggested substituting for the mean age of each score a predicted age derived by regression. Even if, as Snow claims, his approach provides more accurate age estimates, it does not differ significantly from the method based on mean ages.

Osteologists studying ossuaries have attempted to smooth age distributions by considering the pubic symphysis score age range rather than the mean age. Demographic studies use not exact ages but age assessments within 5 year age categories. Thus, both Pfeiffer (1983), in studying the demography of the Uxbridge Ossuary, and Melbye (1981), in reassessing the age distribution of the Fairty Ossuary as originally published by Anderson (1961), distribute individuals fractionally over age ranges. Figure 1C shows that this method smooths age distributions very considerably.

Several other methods of distributing adult ages based on pubic symphysis assessment can be envisioned. Table 1 summarizes the eight possible methods of distributing ages, taking into account the fact that (unless Todd/Brooks methods were used) prior to 1973 all adults were aged on the male standard of McKern and Stewart (1957), while the Gilbert and McKern method (1973) was probably used for females after 1973.

In considering which of these approaches provides a best estimate of age distribution, it is necessary to evaluate the comparability of the male and female data. The female age assessment technique may have inherent problems of interobserver error (Suchey, 1979). Evaluation of the data in Table 2 shows that the females do seem to be much more variable than the males. Female coefficients of variation ([standard deviation × 100]/mean) may be more than double those of males and are unacceptably high for biological data (e.g., see Thomas, 1976:84). Table 2 indicates that with the McKern and Stewart and Gilbert and McKern techniques, young male age assessment may be more

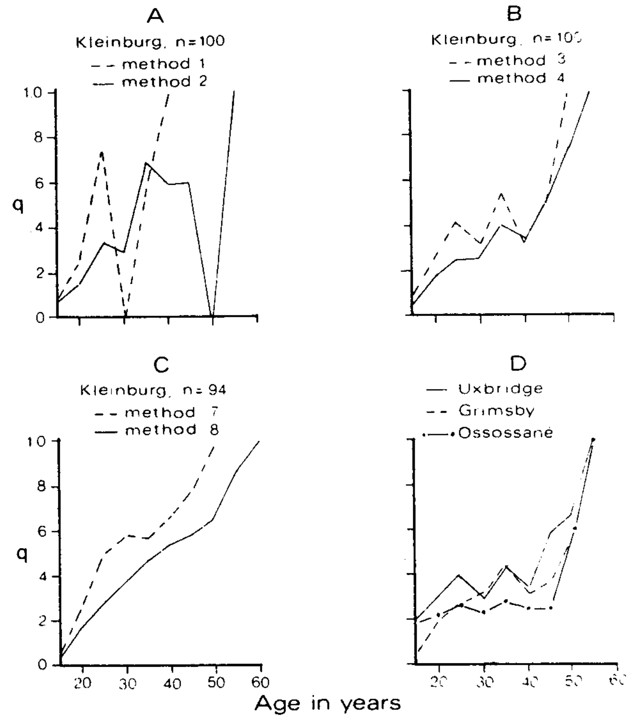


Fig. 2. Comparison among methods of distributing adults based on mortality quotients. A, B, C) Mortality quotients for Kleinburg adults. Comparison of the results of six different methods of distributing pubic scores (see Table 1). D) Comparison of mortality curves for Uxbridge (N = 323; method 4), Grimsby (N = 225; method 2), and Ossossané (N = 155). Ossossané aged by method 2 with smoothing of female distribution and aging of 38 unsexed adults using Todd (1920) technique: See Katzenberg and White. (1979).

accurate than that for females, but older females can be aged more accurately than older males.

DISCUSSION OF METHODS OF ASSIGNING AGES BASED ON PUBIC SYMPHYSES

Mean values

Mean values give a very uneven distribution across the possible adult ages simply because, for example, three McKern and Stewart means fall into the 20–24.9 age category. There are age categories that are consistently unrepresented. As an example, we can look at Figure 1, where the age distributions for several archaeological populations from Ontario are shown. The sites represent late precontact Huron (Kleinburg; Saunders, 1974) and both precontact (Glen Williams; Hartney, 1978, 1981) and postcontact (Grimsby; Jackes, 1985a) Neutral populations. For each sample there is one distribution, aged according to the McKern and Stewart mean values, which shows a gap in the 30–45 year age range (Fig. 1B, E, G). This seems unreasonable, and the explanation must lie in the method, not in some biological or cultural fact affecting both the Huron and the neutral over several hundred years.

Furthermore, if mean values are used, males and females cannot be combined be-

TABLE 1. Possible methods of distributing ages

1 Males and females given McKern and Stewart (1957) mean age
2 Males given McKern and Stewart mean ages and females given Gilbert and McKern (1973) mean ages
3 Males and females distributed over McKern and Stewart age ranges
4 Males distributed over McKern and Stewart age ranges and females over Gilbert and McKern ranges
5 Males and females distributed over the range of McKern and Stewart ±1 standard deviation for each pubic symphysis score
6 Males distributed over the McKern and Stewart and females over the Gilbert and McKern ±1 standard deviation range
7 Males and females distributed over the range of McKern and Stewart ±2 standard deviations for each pubic symphysis score
8 Males distributed over the McKern and Stewart ±2 standard deviation range for each pubic symphysis score and females over the corresponding Gilbert and McKern (1973) ranges

TABLE 2. Ranges associated with McKern and Stewart and Gilbert and McKern pubic symphysis scores

Score	Mean	SD	CV	Range	±1 SD	±2 SD	N
Males (McKern and Stewart, 1957)							
0	17.29	0.49	2.8	?–17	16–17	16–18	7
1–2	19.04	0.79	4.1	17–20	18–19	17–20	76
3	19.79	0.84	4.3	18–21	18–20	18–21	43
4–5	20.84	1.13	5.4	18–23	19–21	18–23	51
6–7	22.42	0.99	4.4	20–24	21–23	20–24	26
8–9	24.14	1.93	8.0	22–28	22–26	20–28	36
10	26.05	1.87	7.2	23–28	24–27	22–29	19
11–13	29.18	3.33	11.4	23–39	25–32	22–35	56
14	35.84	3.89	10.8	29–?	31–39	28–43	31
15	41.00	6.22	15.2	36–?	34–47	28–53	4
Females (Gilbert and McKern, 1973)							
0	16.00	2.82	17.6	14–18	13–18	10–21	2
1	19.80	2.62	13.2	13–24	17–22	14–25	12
2	20.15	2.19	10.9	16–25	17–22	15–24	13
3	21.50	3.10	14.4	18–25	18–24	15–27	4
4–5	26.00	2.61	10.0	22–29	23–28	20–31	7
6	29.62	4.43	15.0	25–36	25–34	20–38	8
7–8	32.00	4.55	14.2	23–39	27–36	22–41	14
9	33.00	7.75	23.5	22–40	25–40	17–48	5
10–11	36.90	4.94	13.4	30–47	31–41	27–46	11
12	39.00	6.09	15.6	32–52	32–45	26–51	12
13	47.75	3.59	7.5	44–54	44–51	40–54	8
14–15	55.71	3.24	5.8	52–59	52–58	49–62	7

cause the coefficients of variation for Gilbert and McKern female scores are so high (see Table 2). Females with symphysis scores of between 0 and 6 will be assigned their correct age only 9 to 18% of the time when mean values are used. This is in sharp contrast with males. For males whose scores are between 0 and 7, 33 to 65% will be of the exact age of the mean. These probabilities are given in Tables 3 and 4 which will be discussed in full later.

Equal distributions

The distribution of individuals fractionally over all the years within an age range is not a satisfactory solution to the problem. In the first place, several of the McKern and Stewart ranges are open-ended. In this paper, it is assumed that the oldest individual is 54 years of age (as in Fig. 1A; he was in fact 50). The McKern and Stewart ranges, while not invariably the equivalent of ±2 standard deviations, are generally so. On the other hand, the ranges given for the Gilbert and McKern scores are extremely variable. They are sometimes equivalent to ±2 standard deviations, but more commonly they bear a rough relationship to ±1 standard deviation. The effect of this is that the McKern and Stewart ranges will encompass around 95% of the possible real ages while the Gilbert and McKern ranges represent from 62 to 95% of possible real ages. Furthermore, the female ranges are very broad, up to 21 years, while the male (McKern and Stewart) ranges are typically more restricted (Table 2). It is improbable that an age 10 years from the mean is as likely a real age as one close to the mean.

Probabilities under the normal curve over ±2 standard deviations (McKern and Stewart, Gilbert and McKern methods)

I propose that we do not equally distribute those having a given pubic symphysis score over the corresponding age range, but that we distribute according to the probabilities under the assumption of a normal distribution. The probabilities for each age within ±2 standard deviations are given for each score in Tables 3 and 4. The choice of a range over ±2 standard deviations allows us to standardize the male and female data so that we may assume that we are encompassing 95% of the possible ages for all male and female scores.

The technique of distributing individuals proposed here is very simple. For example, eight individuals at Kleinburg were given a score of 15 on the McKern and Stewart models. Each of the probabilities listed under 15 in Table 3 should be multiplied by 8. The results for ages 50 and over are 0.160, 0.128, 0.088, and 0.032. The individuals to be counted toward age 50 are found only under

TABLE 3. Probabilities by age and pubic symphysis score using the McKern and Stewart method on males (and females)

Age in years	Scores 0	1–2	3	4–5	6–7	8–9	10	11–13	14	15
16	0.254									
17	*0.649*	0.071								
18	0.051	0.386	0.151	0.029						
19		*0.408*	*0.425*	0.177						
20		0.089	0.326	*0.327*	0.053	0.029				
21			0.052	0.292	0.260	0.082				
22				0.124	*0.385*	0.143	0.029	0.009		
23				0.005	0.224	0.194	0.084	0.028		
24					0.032	*0.201*	0.151	0.045		
25						0.160	0.202	0.065		
26						0.099	*0.205*	0.086		
27						0.046	0.157	0.106		
28							0.092	0.116	0.016	0.004
29							0.034	*0.119*	0.028	0.011
30								0.111	0.040	0.016
31								0.093	0.055	0.020
32								0.073	0.071	0.025
33								0.052	0.085	0.031
34								0.034	0.097	0.037
35								0.017	*0.101*	0.044
36									*0.101*	0.049
37									0.094	0.055
38									0.081	0.059
39									0.066	0.062
40									0.050	*0.064*
41									0.035	*0.064*
42									0.024	0.062
43									0.010	0.059
44										0.055
45										0.049
46										0.044
47										0.037
48										0.031
49										0.025
50										0.020
51										0.016
52										0.011
53										0.004

Italics indicate score means.

a score of 15, so the total for age 50 is 0.160. For age 30, however, one would have to total the $(n \times p)$ products under scores 11–15 and reach the sum of 4.786. Having summed across for 1 year, one can sum the totals by the appropriate 5-year age categories. In this case, the total for Kleinburg males and females aged 50 to 54.9 on the McKern and Stewart probability distribution is 0.408. The calculation of the probabilities is explained, and an example of the use of the probability tables is given in the Appendix.

Figure 1D, F, and G demonstrates the results of probability distributions. It is now possible to see that the sudden spurt in mortality at age 35 was neither real nor random, but the result of using McKern and Stewart mean values as the best estimate of age (cf. Fig. 2A and C). The next question is the extent to which we can rely on the probability distributions of age to give us information about palaeodemographic trends.

Can we rely on McKern and Stewart pubic symphysis scores (an archaeological case study)?

We may assume that the adult males in the Kleinburg Ossuary represent all males (except those dead by drowning or violence) who died within a limited area and time span just prior to direct European contact (ca. AD 1550–1600). The age distribution of the Kleinburg adult males is here compared with that for Feature 62 in the Grimsby cemetery on the western shore of Lake Ontario. Feature 62 was a large burial pit containing 28% of the 373 individuals excavated from the cemetery. The sex and age distribution within the feature presents a problem, not in palaeodemography, but in the interpretation of Neutral burial practices, which are complex and not fully understood (White, 1966; Jackes, 1982); but it is clear that cultural selection of individuals for burial in certain graves was practiced. Grimsby (ca. AD 1630–1650) covers the 20 years of famine, disease, and warfare leading up to the destruction of the Neutral Nation. Feature 62 contained a number of males assessed as being of quite advanced age on the basis of dental attrition, antemortem tooth loss, vertebral osteophytosis, and suture closure (Jackes, 1985a). The pubes, however, do not support this, especially based on the mean McKern and Stewart ages.

The distribution for Feature 62 males (Fig. 1E, F) is reminiscent of that for Kleinburg males, despite the fact that the two are very dissimilar sites. Kleinburg is a low mortality site (Jackes, 1985b), while the mortality pattern of the Grimsby cemetery as a whole indicates extremely high mortality rates. Examination of childhood mortality suggests that Grimsby mortality was *at least* double that of Kleinburg (Jackes, 1985b). We have no way of knowing the true distribution of male ages in these sites but it seems unlikely that they should be so similar. Pfeiffer's analysis (1985) of the ages of Kleinburg adults, using the Thompson technique of examining femoral cortical remodelling, suggests that adult ages at death were from 10 to 15 years older than those implied by the pubic symphyses.

The McKern and Stewart pubic symphysis method does not allow us to distinguish what *should be* totally distinct palaeodemographic patterns. Comparison of the overall Kleinburg and Grimsby *q* curves (Fig. 2B [method 4] and D [Grimsby]) shows the two to be virtually identical. This not only disallows valid palaeodemographical analyses but makes detailed comparative studies almost impossible. For example, possible dietary differences require confirmation based on dental pathology (Jackes, 1985b). It appears that the dental pathology rates at Kleinburg are much higher than those for the Grimsby population. No definitive statements can be made, however, because it is impossible to determine whether the Kleinburg dead are actually older, on average, than the Grimsby sample. Childhood mortality suggests this, adult mortality denies it (although we must be careful about equating the rates of child and adult mortality).

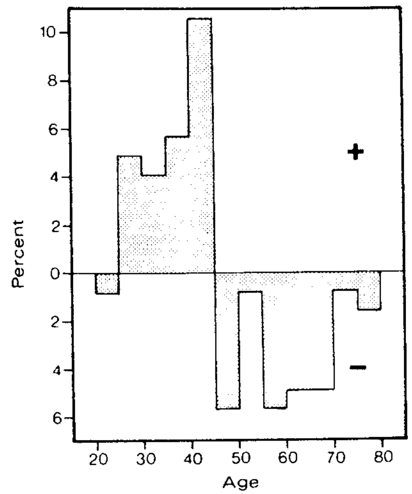
Figure 2C illustrates clearly that by using method 8 (Table 1) we can obtain a reasonable mortality quotient *(q)* curve. However, this curve is actually far too steep for the apparent low mortality of Kleinburg.

MORTALITY CURVES AND PUBIC SYMPHYSIS AGING BY OTHER METHODS

The work of Meindl et al. (1983) allows us to examine the accuracy of a combination of age estimation techniques and from this we may suggest that apparent high mortality among young adults in archaeological sites, as suggested by the steep curve in Figure 2C, results from the techniques used. Meindl and his colleagues, using a sample of individuals of known age, made an extremely careful age assessment as a test of techniques (including examination of pubic symphyses). While the concordance of real and assessed ages for the 20–25 year age category appears fairly good, all assessed age categories between the ages of 25 and 44.9 contained too many individuals. I estimate that 25% of individuals with real ages of ≧45 years were put in the 25 to 44.9 age categories. Conversely, of course, the ages from 45 to 79.9 were underpopulated (Fig. 3). This pattern of error, in which individuals over 45 are aged too young and placed in categories from 25 to 44.9, may explain exactly the pattern that is demonstrated in Figure 1D. It is a pattern that makes palaeodemographic studies require special techniques (Jackes and Lubell, 1985; Jackes, 1985a,b) and disallows the estimation of such values as the child woman ratio and general or total fertility rates. A simple test of the effect of this was carried out on Coale and Demeny (1966:3) West Mortality Level 2 with sexes pooled. The older age categories were collapsed into the 25–44.9 categories to reduce the >45 sample by 25%. This reduced mean age at death by 10% and increased the total fertility rate by 6%.

The Todd Method

Meindl et al. (1983) used the Todd method (1920) of assessing pubic symphysis changes in their test of techniques and in their original study of the Libben site (Meindl et al., 1980). They concluded that the Todd method is responsible for "the tendency to underage" and that pubic indicators are "unreliable," especially for individuals over 45 years (1983:81). I conclude that the problem of age assessment from pubic indicators lies, not in the method of McKern and Stewart (1957), but with the use of pubic symphyses by no matter what method.



Data used to construct figure

Age	Real %	Assessed %	Difference
20	8.2	7.4	−0.8
25	9.0	13.9	4.9
30	15.6	19.7	4.1
35	11.5	17.2	5.7
40	4.9	15.6	10.6
45	13.1	7.4	−5.7
50	12.3	11.5	−0.8
55	11.5	5.7	−5.7
60	5.7	8.2	−4.9
65	5.7	8.2	−4.9
70	0.8	0.0	−0.8
75	1.6	0.0	−1.6

Fig. 3. Difference between the distribution of real and assessed ages by 5-year age categories expressed as percentages estimated for sample 1 of Meindl et al. (1983, Fig. 4).

Van Gerven and Armelagos (1983) state that the Todd method avoids the errors that Bocquet-Appel and Masset (1982) claim to be a result of the McKern and Stewart method. Todd (1920:328) gives the age and score distribution of 306 males, and this permits a closer analysis of his method.

Table 5 shows the age distribtuion of the Todd sample and the scores assigned by Todd (I have excluded one pathological individual here). In Table 6, the Todd data are organized to accord with the data for McKern and Stewart and Gilbert and McKern given in Table 2. The CVs demonstrate that from scores 8 to 10 the variation is unacceptably high. It would, presumably, have been even higher had Todd been able to decide what to do with the individuals he scored as 7–8, 8–9, and so on. The CVs do not support those (e.g., Jerkic, 1975:185) who use McKern and Stewart for younger ages and Todd for older individuals, on the grounds that the Todd method is more accurate for higher ages (cf. Stewart, 1973:163).

Todd's method of pubic symphysis assessment is presented in the anthropological manuals (Anderson, 1962; Bass, 1971; Ubelaker, 1978) as a simple 10 phase system, each phase associated with a reasonably narrow age range. But Todd himself could not accomodate 27% (the intermediate scores) of his sample within his 10 point schema. Moreover, he had many examples of ambivalent cases with one phase superimposed on another. It is necessary to consider how the age distributions will differ when anthropologists deal with these problems in different ways. Examples are presented in Table 7, where, using Todd's own data, I compare the distributions resulting from three ways of assigning ages by the Todd method.

Column A in Table 7 illustrates Todd's own distribution of ages as given in the last column in Table 6. However, in Table 7 the intermediate scores are distributed according to the mean value for each; e.g., individuals who scored 6–7 and 7–8 are all assigned to the 35 to 40 age range. We can assume that this type of distribution is not usual, since the Todd scores are always presented in the literature as ranges without mean values.

Column B shows the age distribution that results when the intermediate scores are divided equally between their adjacent scores; e.g., 9.5 of those given score 8–9 by Todd go into the 40 to 45 age range and 9.5 go into the 50 to 55 category. This is likely to be the distribution most commonly employed.

Column C illustrates another problem of the Todd method. It shows the distribution when the individuals that Todd considered to have one phase "superposed" on another are put into the age categories of their basic scores.

If the Todd method is used, probabilities (Table 8) will give the highest level of accuracy. Table 9 shows that a probability distribution is almost identical with the actual distribution of ages. However these probabilities (derived from Table 8) are based, not on a 10 phase as used by Todd and most subsequent investigators, but a 14 or 15 phase system (depending on whether or not 5–6 is

TABLE 4. Probabilities by age and pubic symphysis score using the Gilbert and McKern method on females only

Age in years	Scores											
	0	1	2	3	4–5	6	7–8	9	10–11	12	13	14–15
10	0.015											
11	0.040											
12	0.066											
13	0.095											
14	0.123	0.011										
15	*0.138*	0.040	0.006	0.015								
16	*0.138*	0.069	0.046	0.035								
17	0.123	0.103	0.088	0.057				0.003				
18	0.095	0.134	0.137	0.080				0.010				
19	0.066	*0.150*	0.173	0.104				0.011				
20	0.040	0.146	*0.178*	0.122	0.005	0.004		0.014				
21	0.015	0.123	0.150	*0.128*	0.035	0.017		0.017				
22		0.090	0.102	0.122	0.062	0.025	0.001	0.020				
23		0.057	0.058	0.104	0.097	0.034	0.015	0.025				
24		0.030	0.016	0.080	0.129	0.046	0.023	0.028				
25		0.001		0.057	*0.149*	0.059	0.032	0.032				
26				0.035	*0.149*	0.069	0.042	0.037		0.001		
27				0.015	0.129	0.080	0.054	0.040	0.013	0.012		
28					0.097	0.087	0.065	0.043	0.019	0.014		
29					0.062	*0.090*	0.075	0.046	0.026	0.020		
30					0.035	0.088	0.083	0.049	0.035	0.024		
31					0.005	0.082	*0.087*	*0.051*	0.045	0.031		
32						0.073	*0.087*	*0.051*	0.054	0.037		
33						0.061	0.083	*0.051*	0.064	0.044		
34						0.050	0.075	*0.051*	0.071	0.050		
35						0.037	0.065	0.049	0.078	0.055		
36						0.027	0.054	0.046	*0.080*	0.060		
37						0.019	0.042	0.043	*0.080*	0.064		
38						0.006	0.032	0.040	0.077	*0.065*		
39							0.023	0.037	0.070	*0.065*		
40							0.015	0.032	0.062	0.064	0.007	
41							0.001	0.028	0.052	0.060	0.025	
42								0.025	0.043	0.055	0.038	
43								0.020	0.033	0.050	0.055	
44								0.017	0.024	0.044	0.074	
45								0.014	0.018	0.037	0.091	
46								0.011	0.010	0.031	0.104	
47								0.010		0.024	*0.111*	
48								0.003		0.020	0.108	
49										0.014	0.098	0.016
50										0.012	0.083	0.034
51										0.001	0.065	0.053
52											0.046	0.076
53											0.031	0.097
54											0.018	0.114
55												*0.123*
56												0.119
57												0.105
58												0.085
59												0.062
60												0.042
61												0.025
62												0.003

Italics indicate score means.

TABLE 5. Data from Todd (1920) on his sample scores[1] *compared with his definitions of those scores*[2]

Age	N	%	Sample scores	Defined scores
15	4	1.3	1	1
20	13	4.3	2–3	2–3
25	19	6.2	3–5[3]	4–5
30	20	6.6	5–8	5–6
35	38	12.4	5–8/9	6–8
40	39	12.8	7–10	8
45	41	13.4	8–10	9
50	38	12.4	8–10	9–10
55	20	6.6	9–10	10
60	29	9.5	9–10	10
65	20	6.5	9–10	10
70	12	3.9	9–10	10
75	6	2.0	9–10	10
80	3	1.0	10	10
85	3	1.0	10	10
Total	305			

[1]pp. 328–329.
[2]pp. 313–314.
[3]Anomalous score 8 excluded.

used). In other words, the accuracy in using the Todd system is likely to be lower than is suggested by the results of a probability distribution as shown in Table 9.

Examination of the trend in the mean values in Table 8 may suggest how intermediate cases are best categorized. For example, since the 8 and 8–9 ranges are nearly identical and their mean ages similar, it seems better to classify 8–9 individuals within the 8 rather than the 9 score category. As well, 5–6 individuals would best be accomodated within the 6 category.

The McKern and Stewart and the Todd methods do not seem to give conflicting results (Jerkic, 1975), and I have confirmed this by a limited test on 10 male innominates from Feature 62 at Grimsby. Comparison of the McKern and Stewart and the Todd ages clarifies several features of the distribution shown in Figure 1E. Most individuals (64%) in the 20–25 age category had a McKern and Stewart score of 9. All pubes with a score of 9 were assessed as 25–26 on the Todd system. Thus, the disparity between the 20–25 and 25–30 age categories may be an artifact of the grouping of the 8 and 9 scores with a common mean of 24 years. Similarly, the 35–40 category is based on a score of 14, which, by the Todd method, may represent an age of 30–35. The gap in that age range is again an artifact of the distribution based on mean values. Use of the ±2 standard deviation range probabilities provides a better method of comparing distributions.

TABLE 6. Ranges associated with Todd pubic symphysis scores

Score	Mean	SD	CV	Todd phase age range	Actual age range	± 2 SD	N
1	18.2	0.50	2.75	18–19	18–19	17–19	4
2	20.5	0.71	3.46	20–21	20–21	19–21	2
3	23.7	1.68	7.09	22–24	22–27	20–27	14
4	25.6	0.55	2.15	25–26	25–26	24–26	5
5	29.3	2.74	9.35	27–30	27–36	23–34	15
5–6	—	—	—	—	36	—	1
6	33.6	2.15	6.40	30–35	30–38	29–37	18
6–7	35.8	3.48	9.72	—	32–43	28–42	7
7	36.9	2.83	7.67	35–39	32–40	31–42	22
7–8	37.2	2.17	5.83	—	35–40	32–41	5
8	41.1	4.97	12.09	39–44	28–52	31–51	29
8–9	43.5	3.84	8.83	—	36–52	35–51	19
9	52.6	9.29	17.66	45–50	40–77	34–71	66
9–10	58.7	11.28	19.22	—	48–79	36–81	50
10	63.8	11.06	17.34	50+	44–88	41–85	48

TABLE 7. Variations in age distribution of Todd's sample resulting from different methods of dealing with intermediate and mixed "phase" individuals (see text for explanation)

	Methods		
Age	A (n.)	B (n.)	C (n.)
15	4	4	4
20	16	16	16
25	20	20	20
30	19	22.5	41.5
35	34	28	36
40	48	41	36
45	66	100.5	87.5
50	0	73	64
55	50	—	—
60	48	—	—

The Nemeskéri Method

Bocquet-Appel et al. (1978) have used the known age Coimbra population as the starting point for a study of techniques of age assessment. The actual population is used as a basis for a theoretical population with more or less equal representation across age categories.

They used the 5 stage system of examining pubic symphyses defined by Nemeskéri et al. (1960; see also Acsádi and Nemeskéri, 1970). This method differs from the others discussed here in that older age groups are apparently distinguished with greater accuracy (Table 10). The low coefficients of variation, the lack of overlap between ±2 standard deviation ranges, and the high mean ages immediately give hope that this is a useful method. There are a number of problems, the first with reference to the younger age categories. The sample size for stage I was 4 and I estimate that the standard deviation for stage I was 12.6. This gives a ± 2 SD range of 1.1–51.5 years. Obviously, one need not consider unfused pelves by the pubic symphysis method of assessing ages: one need consider only individuals who might be assessed as 18 years or more. In Table 11 the probabilities have been collapsed onto the ± 1 SD range (14–39 years) and are calculated for SD = 6.3. The result is a gap from age 39 to age 42.

The second major problem is that this system, far from resulting in too many individuals in the 25–45 age categories, forces too many into the 45–59.9 age categories. In the theoretical population of Bocquet-Appel et al. (1978) 23.6% of males and 21.1% of females are 45 to 59.9 years. Use of the mean values for distributing ages forces 92.7% of males and 91.8% of females into the 45–59.9 age categories (Table 12). This distortion will not be markedly improved by using probabilities, since the ±2 SD ranges will only expand the distribution to cover ages 40 to 64.9. In fact, 84% of males and 84.5% of females are aged, on the probabilities, at 45 to 59.9.

Pubic symphysis correlation coefficients

Analysis of the Coimbra collection using the Nemeskéri method, gives a correlation of 0.43 between actual age and pubic symphysis form, somewhat below that for the Todd method (see Meindl et al. [1983], who calculate that r = 0.57). Brooks (1955:572) states that, at least for males, the correlation between age and pubic stage is much higher. However, the reported percentage of correct ages (1955:583) does not suggest high correlations, nor does the scatter plot (1955:579, Fig. 5) of real ages against Brooks' slight modification of the age ranges of Todd's phases 1–9. This plot shows that, up to age 40, 50% of males are likely to be assessed as older than they really are. Correct prediction is most likely for the 40–44.9 age category, but only in 61.5% of cases. After age 45, it seems that assessed ages will be too young. The real ages of those assessed as phase 10 were not reported. Females, on the other hand, are assessed as anything up to 20 years older than the real age, and prediction is good only for ages 45–49 (75% correct assessment but with two individuals [25%] assessed as around 15 years too young). Overall, Brooks' scatter plot indicates that correct age assessment (within the 5-year age categories) for females may be as low as 39% even for phases 1 to 9 (cf. Stewart, 1957).

I have calculated the correlation coefficient for my estimates derived from Brooks (1955:579, Fig. 5) as 0.89 for males and 0.59 for females. Only individuals falling within phases 1 to 9 were plotted by Brooks.

The correlations between estimated and actual ages in studies using the Todd collection will be further reduced when archaeological populations are considered, if it is true that the age distribution reflects the distribution of the reference population, as Bocquet-Appel and Masset (1982) contend. But, as Van Gerven and Armelagos (1983) have pointed out, the age distribution of the Todd collection argues against that contention.

Pubic symphysis score mean ages vs. reference populations

It is not, in fact, the reference populations that directly determine assessed age distributions. Rather, it is the distribution of pubic symphysis score mean ages, and this distribution does indeed give rise to systematic and nonrandom patterns. McKern and Stewart distinguish eight distinct stages between age 15 and age 30 on the basis of the mean values, and almost all individuals they studied fell into this broad age grouping. Nemeskéri et al. (1960) distinguishes three distinct phases between ages 45 and 60, and their sample of known age individuals was indeed skewed in favor of the age groups over 40. Todd's method gives a curve of mean values that is almost as steep as that for the McKern and Stewart method: the mean values of no less than eight of Todd's phases fall between the ages of 15 and 41, even though only 39% of his population were between 15 and 41 years. This indicates that a more evenly distributed study population may also lead to an emphasis on younger individuals.

The extent to which mean scores determine the age distribution can be assessed by plotting the cumulative percentages from age 20, together with the mean ages for each successsive pubic score. In Figure 4A Indian Knoll (Johnston and Snow, 1961) is plotted against the McKern and Stewart mean ages. The age assessment of Indian Knoll was done by dental attrition and by McKern and Stewart pubic symphysis examination methods. The latter is confirmed by the mortality peak at age 35, which shows that the distribution was unsmoothed. For comparison, Figure 4B presents the Todd mean ages plotted with the cumulative percentage age distribution for Meinarti. This was originally reported to have been aged by "des modifications des symphyses pubiennes—d'après les méthodes de McKern et Stewart (1957), et de Todd (1920)" (Swedlund and Armelagos, 1961: 1292–1293), but Van Gerven and Armelagos (1983:354) state that the ages were based "most extensively" on Todd pubic symphysis scores.

CONCLUSION

Osteologists who study disarticulated and mixed human skeletal remains often rely on the pubic symphysis to give an indication of age. Equal distribution over age ranges is sometimes employed in palaeodemographic studies. The age ranges are those published by McKern and Stewart (1957) for males and Gilbert and McKern (1973) for females to accord with scores signifying various age changes in the pubic symphysis. Equal distribution of individuals over age ranges ignores the fact that the ranges generally encompass about 95% of possible ages for males but much less for females. The assessment of female age seems to be much more variable and probably less accurate. The female age ranges are very wide, and equal distribution over broad categories ignores the higher probability of falling near the mean than at the extremes.

The use of the mean age value does not entail much error in the narrow age ranges of a number of the male scores. The error may be considerable with the broad female ranges, and the very breadth of the ranges makes equal distribution an error-prone technique. The solution I propose, so that distributions are smoothed and males and females are given the same treatment statistically, is use of the probabilities derived from the normal curve over ±2 standard deviations. This assures that the shape of the dis-

TABLE 8. Probabilities by age and pubic symphysis score using the method of Todd (1920)

Age in years	Scores													
	1	2	3	4	5	5–6	6	6–7	7	7–8	8	8–9	9	9–10	10
17	0.286														
18	*0.624*														
19	0.044	0.218													
20		*0.518*	0.031												
21		0.218	0.102												
22			0.182												
23			*0.233*		0.004										
24			0.209	0.115	0.031										
25			0.134	*0.628*	0.056										
26			0.061	0.211	0.087										
27			0.002		0.117										
28					0.138			0.002							
29					*0.145*		0.024	0.023							
30					0.131		0.066	0.036							
31					0.106		0.115	0.054	0.019		0.011				
32					0.074		0.162	0.073	0.042	0.003	0.018				
33					0.045		*0.184*	0.091	0.069	0.044	0.026				
34					0.020		0.168	0.107	0.098	0.085	0.033		0.006		
35							0.126	*0.114*	0.124	0.135	0.043	0.002	0.008		
36						0.954	0.075	0.112	*0.139*	0.173	0.052	0.020	0.009	0.004	
37							0.034	0.101	0.137	*0.181*	0.062	0.031	0.012	0.007	
38								0.085	0.120	0.153	0.071	0.044	0.013	0.007	
39								0.065	0.092	0.105	0.076	0.061	0.016	0.008	
40								0.046	0.063	0.058	0.079	0.076	0.019	0.010	
41								0.030	0.038	0.017	*0.080*	0.091	0.020	0.011	0.001
42								0.015	0.013		0.077	0.100	0.024	0.012	0.006
43											0.071	*0.104*	0.027	0.015	0.007
44											0.063	0.100	0.029	0.016	0.008
45											0.054	0.091	0.032	0.018	0.009
46											0.045	0.076	0.035	0.020	0.010
47											0.034	0.061	0.037	0.021	0.013
48											0.027	0.044	0.038	0.024	0.013
49											0.019	0.031	0.041	0.025	0.016
50											0.013	0.020	0.042	0.027	0.018
51												0.002	0.042	0.029	0.019
52													*0.043*	0.031	0.021
53													*0.043*	0.032	0.024
54													0.042	0.033	0.025
55													0.041	0.034	0.027
56													0.039	*0.035*	0.029
57													0.038	*0.035*	0.031
58													0.035	*0.035*	0.032
59													0.032	*0.035*	0.034
60													0.030	*0.035*	0.034
61													0.028	0.034	0.035
62													0.024	0.034	*0.036*
63													0.022	0.032	*0.036*
64													0.019	0.031	*0.036*
65													0.016	0.029	*0.036*
66													0.014	0.028	*0.036*
67													0.012	0.026	0.035
68													0.010	0.024	0.031
69													0.008	0.023	0.031
70													0.007	0.020	0.030
71													0.001	0.019	0.029
72														0.016	0.026
73														0.015	0.025
74														0.013	0.022
75														0.012	0.021
76														0.010	0.019
77														0.009	0.016
78														0.007	0.015
79														0.007	0.013
80														0.005	0.012
81														0.001	0.010
82															0.009
83															0.007
84															0.006
85															0.005

(continued)

Italics indicate score means.

TABLE 9. Comparison of probability distribution with original distribution of Todd's sample

	Todd's sample		Distribution by probability for scores	
Age	N	%	N	%
15	4	1.3	4.25	1.5
20	13	4.3	13.17	4.5
25	19	6.2	17.70	5.4
30	20	6.6	29.30	10.1
35	38	12.4	42.67	14.7
40	39	12.8	35.31	12.1
45	41	13.4	31.35	10.8
50	38	12.4	27.52	9.4
55	20	6.6	28.25	9.7
60	29	9.5	24.91	8.6
65	20	6.5	18.57	6.4
70	12	3.9	11.01	3.8
75	6	2.0	6.28	2.2
80	3	1.0	2.41	0.8
85	3	1.0	0.24	0.1

tribution for each score is taken into account and 95% of possible ages are included in a standardized way. The probabilities have been calculated and are presented here for reference. The greater accuracy that can be obtained using probabilities is shown by an analysis of the data published by Todd (1920).

Data from Saunders (1974) is used to demonstrate the results of the different techniques. The normal curve probabilites give the best curve and indicate that the often-seen mortality subpeak at age 35 is a product of the technique of age distribution. Even using probability distributions, it is still not possible to identify correctly the differences between populations which should be evident. The explanation for this seems to be that the McKern and Stewart pubic symphysis age assessment technique has a tendency to group individuals over 45 years in the 25 to 44.9 age categories. This point of view is supported by Meindl et al. (1983), who employed the Todd method and found that it gave ages that were markedly too young, suggesting that the error lies in reliance on pubic indicators for age assessment by either method.

The Nemeskéri method, on the other hand, gives ages that seem to group at the center of the possible age range. This can be deduced because Bocquet-Appel et al. (1978) have published an analysis of a theoretical equal distribution derived from the Coimbra skeletons. The Nemeskéri method is the least likely to give accurate results, for it is structured in such a way as to emphasize the 45 to 55.9 age categories.

The case of Bocquet-Appel and Masset (1983) may be restated as follows: Some nonrandom factor effects the assignment of pubic symphysis ages. It is the distribution of mean ages for the scores that has the direct effect, and populations aged according to a particular system will reflect that mean age distribution to some extent. The degree to which the population age distributions deviate from the mean age of score distributions will depend on the combination of age assessments used, the completeness and preservation of the skeletons, and the amount and method of smoothing introduced by the osteologist. Some reality underlies age differences in the symphysis pubis, but we are at the moment unable to discern the reality from the pattern imposed by the method. Under these conditions it is impossible to make categorical statements about demographic trends based on skeletal populations.

This paper proposes that ages derived from Todd, McKern and Stewart, and Gilbert and McKern pubic symphysis scores be distributed according to ± 2 SD probabilites. This gives a more rational basis to palaeodemography. It will not solve the problems of adult age assessment, but it will alleviate them. Using mean ages of scores results in systematic, nonrandom, errors. Therefore, they should not be used when data are being prepared for palaeodemographic analysis. The next steps, using probability distributions of ages, will be 1) comparison of methods and techniques, 2) comparison of sites, and 3) comparison of subpopulations within sites. This should provide a stronger foundation for study of the basic difficulties underlying the use of the pubic symphysis for age assessment.

TABLE 10. The Nemeskéri pubic stages

Stage	Mean	SD	Range	±2 SD	CV
I	26.3	?	18–45	?	?
II	46.5	1.76	23–69	43.0–50.0	3.8
III	51.1	1.62	25–76	47.9–54.3	3.2
IV	58.1	2.16	24–81	53.8–62.4	3.7
V	68.5	2.53	41–86	63.4–73.6	3.7

TABLE 11. Probabilities by age and pubic symphysis score using the Nemeskéri method

Age in years	Scores I	II	III	IV	V
14	0.014				
15	0.014				
16	0.019				
17	0.024				
18	0.029				
19	0.036				
20	0.041				
21	0.048				
22	0.052				
23	0.058				
24	0.060				
25	*0.063*				
26	*0.063*				
27	0.062				
28	0.060				
29	0.055				
30	0.051				
31	0.045				
32	0.039				
33	0.033				
34	0.027				
35	0.022				
36	0.017				
37	0.013				
38	0.009				
39					
40					
41					
42					
43		0.055			
44		0.119			
45		0.191			
46		*0.224*			
47		0.191	0.005		
48		0.119	0.070		
49		0.055	0.151		
50			0.226		
51			*0.236*		
52			0.169		
53			0.083	0.006	
54			0.014	0.047	
55				0.090	
56				0.139	
57				0.177	
58				*0.180*	
59				0.148	
60				0.100	
61				0.054	
62				0.013	
63					0.015
64					0.045
65					0.079
66					0.115
67					0.145
68					*0.156*
69					0.145
70					0.115
71					0.079
72					0.045
73					0.015

Italics indicate score means.

ACKNOWLEDGMENTS

I thank Jerry Melbye and especially Susan Pfeiffer for providing the impetus for this paper and Shelley Saunders for reading and commenting on an earlier draft. The comments and suggestions of the reviewers were very helpful. David Lubell drew the final versions of the figures, helped design the probability tables using a Kaypro IV microcomputer purchased through a grant to him from the Faculty of Arts, University of Alberta, and assisted in the preparation of the manuscript.

APPENDIX: CALCULATION OF PROBABILITIES AND USE OF PROBABILITY TABLES

I. Calculation of probabilities

The calculation of the probabilities in Tables 3, 4, 8, and 11 was done using a Texas Instruments TI-59 calculator with the Applied Statistics Module. Several steps were involved.

Step 1: The mean, standard deviation, CV, range, and ±2 SD were established for each score of McKern and Stewart (Table 2), Gilbert and McKern (Table 2; the standard deviations follow Stewart [1979:168]), and Todd (Table 6) and each stage of Acsádi and Nemeskéri (1970) (Table 10). Those data not published were calculated using the TI-59.

Step 2:

The following program was written for the TI-59:

Step	Command	Comment
1	R/S	Activates program, ready for data entry
2	–	
3	RCL	Steps 3 and 4 recall the score mean stored in register 1
4	01	
5	=	
6	÷	
7	RCL	Steps 7 and 8 recall the score standard deviation stored in register 2
8	02	
9	=	
10	2nd	Steps 10 to 13 activate Program 19 of the Applied Statistics Module
11	PGM	
12	19	
13	C	
14	–	
15	RCL	Steps 15 and 16 recall the value 0.5 stored in register 3
16	03	
17	=	
18	R/S	

Step 3: To use this program, the following sequence is entered: (RST) (R/S) (the age [e.g., 16]) (R/S). The resulting value represents the probability of an individual being aged between the mean and, here, 16. In the follow-

TABLE 12. Age distribution of Bocquet-Appel's theoretical population

	Original		Mean values		Probability values	Nemeskéri sample	
Age	N	%	N	%	(%)	N	%
Males							
10	—	—	—	—	0.02		
15	—	—	—	—	0.17		
20	8	2.6	—	—	0.36		
25	23	7.6	4	1.3	0.42	6	9.8
30	23	7.6	—	—	0.27		
35	22	7.3	—	—	0.08	3	4.9
40	19	6.3	—	—	4.06		
45	26	8.6	67	22.2	28.56	18	29.5
50	23	7.6	132	43.8	34.94		
55	22	7.3	80	26.6	20.45	16	26.2
60	29	9.6	—	—	5.03		
65	16	5.3	18	6.0	4.01	9	14.7
70	20	6.6	—	—	1.59		
75	25	8.3	—	—			
80	27	9.0	—	—			
85	18	6.0	—	—		9	14.7
Females							
10	—	—	—	—	0.08		
15	—	—	—	—	0.72		
20	4	2.1	—	—	1.54		
25	16	8.2	11	5.7	1.80	1	2.3
30	10	5.2	—	—	1.16		
35	19	9.8	—	—	0.36	8	18.2
40	17	8.8	—	—	3.57		
45	12	6.2	38	19.6	28.10	4	9.1
50	17	8.8	99	51.0	40.12		
55	12	6.2	41	21.1	16.26	8	18.2
60	14	7.2	—	—	3.86		
65	15	7.7	5	2.6	1.73	15	34.1
70	14	7.2	—	—	0.69		
75	15	7.7	—	—			
80	18	9.3	—	—			
85	6	3.1	—	—		8	18.2
90	0	—	—	—			
95	5	2.6	—	—			

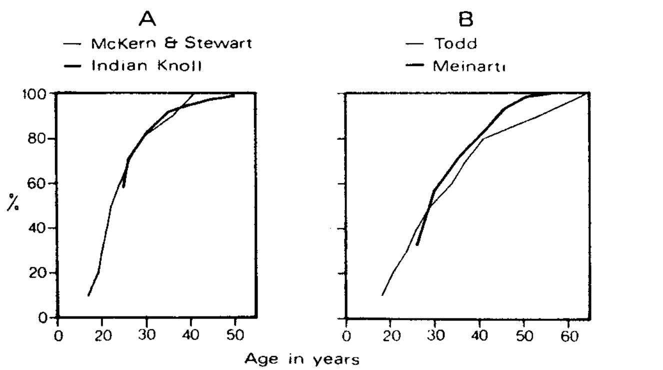


Fig. 4. The distribution of mean ages for pubic symphysis scores compared with the cumulative percentages from age 20 of archaeological samples. A) McKern and Stewart (1957) mean ages for scores compared with Indian Knoll (Johnston and Snow, 1961; N = 444). Method of aging: McKern and Stewart on pubic symphysis, dental attrition. B) Todd (1920) mean ages for scores compared with Meinarti (Swedlund and Armelagos, 1961; N = 203). Method of aging: Todd-Brooks on pubic symphysis "most extensively used" (see Van Gerven and Armelagos, 1983:354).

ing example it is clear that one has to adjust the probabilities to obtain the probability of an individual falling within one 12-month period, granted that it does not fall beyond ±2 SD. Example: McKern and Stewart, Score 0 (Table 2):

$\bar{X}$ = 17.29 (store in register 1)
S = 0.49 (store in register 2)
.05 stored in register 3
+2 SD = 18.27
−2 SD = 16.31.

The following figures are punched into the program outlined above and give the results shown in parentheses:

16.31 (0.477)
17 (0.223)
18 (0.426)
18.27 (0.477).

Probabilities (Table 3) are then calculated as follows: probability of falling between 16.31 and 17: 0.477 − 0.223 = 0.254; Probability of falling between 17 and 18: 0.223 + 0.426 = 0.649; Probability of falling between 18.27 and 18: 0.477 − 0.426 = 0.051.

II. Use of probability tables

Tables 3, 4, 8, and 11 can very easily be used to calculate probability distributions by pubic symphysis age for adults in any archaeological population. The calculations are quite simple, but here were facilitated by the use of the Perfect Calc program (Perfect Software, Inc., Berkeley, CA) and a Kaypro IV microcomputer.

As an example of the use of the tables, we can take the females from the theoretical Coimbra population of Bocquet-Appel et al. (1978) and, using the method of Nemeskéri et al. (1960), construct the table that appears on the following page. The calculations for the column headed "Probability values (%)" in Table 12 are shown below. The number of individuals in each score category is multiplied by the probability for each age within the ± 2 SD range. If an age appears in several score ranges, the probabilities are summed across rows. The final column (Sum of $n \times p$) can be grouped into any set of age categories required, but the total number will represent 95.4% of the original sample.

LITERATURE CITED

Acsádi, G, and Nemeskéri, J (1970) Human Life Span and Mortality. Budapest: Akadémiai Kiadó.
Anderson, JE (1961) The People of Fairty. National Museums of Canada, Bulletin 193. Contributions of Anthropology 1961–1962, Part 1.
Anderson, JE (1962) The Human Skeleton: A Manual for Archaeologists. Ottawa: National Museum of Canada.
Angel, JL (1971) The People of Lerna. Washington: Smithsonian Institution.
Bass, WM (1971) Human Osteology: A Laboratory and Field Manual of the Human Skeleton. Columbia: University of Missouri.
Bocquet-Appel, J-P, Maia Neto, MA, Tavares da Rocha, MA and Xavier de Morais, MH (1978) Estimation de l'âge au décès des squelettes d'adultes par régressions multiples. Coimbra: Tipografia da Atlantida.
Bocquet-Appel, JP and Masset, C (1982) Farewell to paleodemography. J. Hum. Evol. *11*:321–333.
Brooks, ST (1955) Skeletal age at death: The reliability of cranial and pubic age indicators. Am. J. Phys. Anthropol. *13*:567–598.
Coale, AJ and Demeny, P (1966) Regional Model Life Tables and Stable Populations. Princeton: Princeton University Press.
Gilbert, BM, and McKern, TW (1973) A method for aging the female *Os pubis*. Am. J. Phys. Anthropol. *38*:31–38.
Hartney, P (1978) Palaeopathology of Archaeological Populations From Southern Ontario and Adjacent Region. Ph.D. thesis, University of Toronto.
Hartney, P (1981) Tuberculous lesions in a prehistoric population sample from southern Ontario. In J Buikstra (ed): Prehistoric Tuberculosis in the Americas. Evanston, IL: Northwestern University Archaeological Program, pp. 141–160.
Jackes, M. (1982) Historic Neutral burial practices. Paper presented to the 10th Annual Meeting, Canadian Association for Physical Anthropology, Guelph.
Jackes, M (1985a) The Osteology of the Grimsby Site. Toronto: Royal Ontario Museum (forthcoming).
Jackes, M (1985b) The Mortality of Ontario Archaeological Populations. In S. Pfeiffer (ed): The Skeletal Biology of Ontario Populations. Anthropological Papers of the University of Alberta, No. 1 (in press).
Jackes, M and Lubell, D (1985) Where are the old folks? In M. Schiffer (ed): Advances in Archaeological Method and Theory (manuscript to be submitted).
Jerkic, S. (1975) An analysis of Huron Skeletal Biology and Mortuary Practices: The Maurice Ossuary. PhD. thesis, University of Toronto.
Johnston, FE and Snow, CE (1961) The reassessment of the age and sex of the Indian Knoll skeletal population: Demographic and skeletal aspects. Am. J. Phys. Anthropol. *19*:237–244.
Katzenberg, MA and White, R (1979) A paleodemographic analysis of the os coxae from Ossossané ossuary. Can. Rev. Phys. Anthropol. *1*:10–28.
McKern, TW, and Stewart, TD (1957) Skeletal age changes in young American males. Quartermaster Research and Development Command Technical Report EP-45.
Meindl, RS, Lovejoy, CO, and Mensforth, RP (1980) Multifactorial determination of skeletal age at death: A double blind test on a population of known age [Abstract]. Am. J. Phys. Anthropol. *52*:255.
Meindl, RS, Lovejoy, CO, and Mensforth, RP (1983) Skeletal age at death: Accuracy of determination and im-

Score	I		II		III		IV		V		
N	11		38		99		41		5		
Years	*p*	*n* × *p*	*p*	*n* × *p*	*p*	*n* × *p*	*p*	*n* × *p*	*p*	*n* × *p*	Sum of *n* × *p*
14	0.014	0.15									0.154
15	0.014	0.15									0.154
16	0.019	0.21									0.209
17	0.024	0.26									0.264
18	0.029	0.32									0.319
19	0.036	0.40									0.396
20	0.041	0.45									0.451
21	0.048	0.53									0.528
22	0.052	0.57									0.572
23	0.058	0.64									0.638
24	0.060	0.66									0.660
25	0.063	0.69									0.693
26	0.063	0.69									0.693
27	0.062	0.68									0.682
28	0.060	0.66									0.660
29	0.055	0.61									0.605
30	0.051	0.56									0.561
31	0.045	0.50									0.495
32	0.039	0.43									0.429
33	0.033	0.36									0.363
34	0.027	0.30									0.297
35	0.022	0.24									0.242
36	0.017	0.19									0.187
37	0.013	0.14									0.143
38	0.009	0.10									0.099
39											
40											
41											
42											
43			0.055	2.09							2.090
44			0.119	4.52							4.522
45			0.191	7.26							7.258
46			0.224	8.51							8.512
47			0.191	7.26	0.005	0.50					7.753
48			0.119	4.52	0.070	6.93					11.452
49			0.055	2.09	0.151	14.95					17.039
50					0.226	22.37					22.374
51					0.236	23.36					23.364
52					0.169	16.73					16.731
53					0.083	8.22	0.006	0.25			8.463
54					0.014	1.39	0.047	1.93			3.313
55							0.090	3.69			3.690
56							0.139	5.70			5.699
57							0.177	7.26			7.257
58							0.180	7.38			7.380
59							0.148	6.07			6.068
60							0.100	4.10			4.100
61							0.054	2.21			2.214
62							0.013	0.53			0.533
63									0.015	0.08	0.075
64									0.045	0.23	0.225
65									0.079	0.40	0.395
66									0.115	0.58	0.575
67									0.145	0.73	0.725
68									0.156	0.78	0.780
69									0.145	0.73	0.725
70									0.115	0.58	0.575
71									0.079	0.40	0.395
72									0.045	0.23	0.225
73									0.015	0.08	0.075
Total	0.954		0.954		0.954		0.954		0.954		
Total based on 95.4% of original sample					185.08						
Total of original sample					194.00						

plications for human demography. Hum. Biol. *55:*73–87.

Melbye, FJ (1981) The Fairty site revisited. Paper presented to the 9th Annual Meeting, Canadian Association for Physical Anthropology, Banff.

Nemeskéri, J, Harsányi, L, and Acsádi, G (1960) Methoden zur diagnose des lebensalters von skelettfunden. Anthropol. Anz. *24:*70–95.

Palkovich, AM (1981a) Demography and disease patterns in a protohistoric Plains group: A study of the Mobridge site. Plains Anthropologist, Memoir 17, pp. 71–92.

Palkovich, AM (1981b) Tuberculosis epidemiology in two Arikara skeletal samples: A study of disease impact. In J Buikstra (ed): Prehistoric Tuberculosis in the Americas. Evanston, IL: Northwestern University Archaeological Program, pp. 161–176.

Pfeiffer, S (1983) Demographic parameters of the Uxbridge ossuary population. Ontario Archaeol. *40:*9–14.

Pfeiffer, S (1985) Comparison of adult age estimation techniques using an ossuary sample. Can. Rev. Phys. Anthropol. *4:*13–18.

Saunders, S (1974) The pelvis as a whole—sex and age determination of the the Kleinburg population. Paper presented to the 3rd Annual Meeting of the Canadian Society for Physical Anthropology, Peterborough.

Snow, CC (1983) Equations for estimating age at death from the pubic symphysis: A modification of the McKern Stewart method. J. Forensic Sci. *28:*864–870.

Stewart,TD (1957) Distortion of the pubic symphyseal surface in females and its effect on age determination. Am. J. Phys. Anthropol. *15:*9–18.

Stewart, TD (1973) Essentials of Forensic Anthropology. Springfield: Charles C. Thomas.

Suchey, JM (1979) Problems in the aging of females using the *os pubis.* Am J. Phys. Anthropol *51:*467–470.

Swedlund, AC and Armelagos, GJ (1961) Une recherche en paléo–démographie: la Nubie soudanaise. Ann. Economies, Sociétés, Civilisations 24:1287–1298.

Thomas, DH (1976) Figuring Anthropology. New York: Holt, Rinehart and Winston.

Todd, TW (1920) Age changes in the pubic bone. I. The male white pubis. Am. J. Phys. Anthropol. *3:*285–334.

Ubelaker, DH (1978) Human Skeletal Remains. Chicago: Aldine.

Van Gerven, DP and Armelagos, GJ (1983) "Farewell to paleodemography?" Rumors of its death have been exaggerated. J. Hum. Evol. *12:*353–360.

White, ME (1966) The Orchid Site ossuary, Fort Erie, Ontario. Bull. NY State Archaeol. Assoc. *38:*1–24.

Age	Dx	%
10–14	0.154	0.08
15–19	1.342	0.73
20–24	2.849	1.54
25–29	3.333	1.80
30–34	2.145	1.16
35–39	0.671	0.36
40–44	6.612	3.57
45–49	52.014	28.10
50–54	74.245	40.12
55–59	30.094	16.26
60–64	7.147	3.86
65–69	3.200	1.73
70–73	1.270	0.69
Totals	185.076	100.00