Epidemics in Renaissance Florence

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Abstract: Epidemics and mortality in 15th and 16th century Florence, Italy, were investigated by use of records of the government-sponsored Dowry Fund. These records contain the date of birth, date of investment, and date of dowry payment or death of 19,000 girls and women. Major epidemics ("plagues") occurred repeatedly. The most severe were in 1430, 1437–38, 1449–50, 1478–79, and 1527–31. Annual death rates of girls enrolled in the Dowry Fund increased by 5 to 10 times in each of these periods. During the last period, at least 20–25 per cent of the population of Florence is likely to have died. Recurrent epidemics accounted for 38 per cent of the total mortality experienced by girls enrolled in the Dowry Fund. The frequency of serious epidemics diminished with the passage of time, and overall mortality declined by about 10 per cent over the 15th and 16th centuries. Epidemic mortality was not consistently related to age. The effects of epidemics were most severe in the summer and autumn. Non-epidemic mortality was also greater in the summer and autumn than in the winter and spring. (*Am J Public Health* 1985, 75:528–535.)

Between the Black Death of 1348 and the French plagues of the 1720s, western Europe was struck by a series of epidemics. These epidemics were a major historical force and they continue to be the subject of investigation and debate.[1-5] We have a rich heritage of literary and pictorial images of the suffering, terror, and devastation that were created, but we lack many of the corresponding numerical facts: the severity and even the existence of specific outbreaks, mortality by time and by age, and the contribution of these epidemics to the total death rate.

Some of this information is derived from records which have survived in archives throughout Europe. Much of what has come to light so far is drawn from death registrations; the London Bills of Mortality[6] are the best-known source of this type. Early death registrations were the forerunner of present-day death certificates. However, the registrations were crude. They give at most only a rough indication of age; they usually cannot be linked to populations of known size; and the sources varied greatly in their thoroughness from time to time.

We have used the records of the Florentine Dowry Fund (*Monte delle doti*) in a study of epidemics in the 15th and 16th centuries. These records are unique for their time because of their "longitudinal" structure: each record gives the date of birth and the dates on which observation begins and ends, including the date of death, when applicable. Deaths can be referred to a population of known size and age composition to give age-specific death rates, in times of both epidemics and "normal" mortality.[7] Dowry Fund records exist for nearly 25,000 girls and a small number of boys, and the useful information encompasses a very long period, about 1430–1570. In this report we use the Dowry Fund records to investigate the occurrence and severity of epidemics in Renaissance Florence, their age and seasonal patterns, and long-term trends of mortality. We also compare our results to historical reports of epidemics and to findings based on death registrations in Florence. (Data on boys were excluded from our analysis because investments for boys represented only about 1 per cent of the total, and because these records are not as complete as the girls' records with respect to the information necessary for mortality analysis.)

Material and Methods

The Dowry Fund was established on February 23, 1425, when the Florentine government was engaged in a long and costly war against Milan. Fathers of daughters were invited to make a cash deposit for a term of 7½ or 15 years. After 7½ years the deposit would yield a dowry of 2½ times the original investment; after 15 years the yield would be five-fold. After the term of investment passed and the girl's marriage had been consummated, the dowry would be paid to the girl's husband, or to a third party designated by him.[8-10] If the girl died before marriage, or if she failed to marry at all, the government retained the deposit and the girl's family lost its investment.

Only a handful of deposits were made at the outset, even though the yield compared favorably with returns from other investments. The plague of 1423–24, although minor compared to the Black Death 75 years before and the plagues of 1400 and 1417,[2,11] may have made Florentines wary of possibly losing their investments in the Fund. In April 1433, the existing Dowry Fund legislation was amended in several respects. Most significantly, the sum deposited would be reimbursed to the girl's father or to her brothers if the girl died before the term of deposit had elapsed.[12] The rate of investment in the Dowry Fund increased dramatically. Eight hundred and sixty-four girls were enrolled in the Fund in 1433, compared to only 48 in the period 1425–1432.

In 1437, the government promised to refund the deposits made for girls who later became nuns. Henceforth, each of these girls would be treated "as if she were truly dead," and the capital would be paid to the monastic institution in which the girl had taken her religious vows.[13] This innovation

encouraged prospective investors by further diminishing the risk.

Almost from the start, the finances of the Dowry Fund were troubled, and over the years the regulations concerning the Dowry Fund were often modified. The changes concerned extension of the authority for the Dowry Fund, eligibility for enrollment, durations and other conditions of investment, and mechanisms for payment of matured dowries. The numbers of girls enrolled in the Fund fluctuated from year to year as a result of these changes, but the Fund was quite active until 1530. Smaller numbers of investments were made until 1550, and a few were made at substantially later dates. We have been unable to determine whether the Dowry Fund was ever discontinued formally.

The Dowry Fund was created by the Florentine ruling class, and the names of virtually all the prominent families—such as Bardi, Peruzzi, Medici, and Pitti—appear in the records. We were able to evaluate the economic standing of Dowry Fund investors by use of a city-wide tax assessment (*Catasto*) carried out in 1480, virtually the mid-point in the life of the Fund. Of unmarried girls in households with real property that had a valuation of at least 2500 florins (the highest 4 per cent of households with unmarried girls), over 50 per cent had Dowry Fund investments. Investments were also held for 14 per cent of girls in families whose wealth was valued at less than 100 florins (the lowest 23 per cent). Thus, Dowry Fund investments were held primarily, but not exclusively, by the wealthy.

The 1425 law that established the Dowry Fund stipulated that the Fund's officials were to prepare "books and registers" in which all deposits were to be recorded. The names of the depositor and the girl, as well as "other characteristics", were to be recorded, so that, in settling accounts in the future, "if possible, mistakes might be avoided." This provision was repeated in all subsequent acts affirming or amending the original law.

The officials responsible for these records maintained a format nearly unchanged throughout the period of the Fund's existence. For each investment, the data are arranged in two paragraphs. The first paragraph typically contains the following information: the girl's two Christian names, the name of her father, her mother, and her two grandfathers; the girl's date of birth and the date when the deposit was made; the sum deposited, the type of currency used, the term of the deposit, and the amount of the matured dowry. Very frequently, the scribe identified the person making the deposit and often specified, as well, the relationship of the girl to the depositor. The scribe sometimes included information on the place of residence and the legitimacy of the girl's birth.

The second paragraph describes the outcome of each deposit. If the girl married, one finds the full name of the husband as well as the date on which he received payment of his dowry. If the girl died before payment was made, the date of her death is given, and frequently the name of the church or monastery where she was buried; the date when her death was notified to the *Monte* officials, the date when the deposit was returned, and the name of the recipient also are stated. Finally, in those cases when the girl took religious vows this date is given, as well as the name and location of the nunnery, the date on which the deposit was refunded to the nunnery, and the date on which the Dowry Fund office was notified.

More than one deposit was made for a number of girls. Most frequently, subsequent deposits were registered to-gether with the original one. On occasion, however, they were registered separately. If so, they were cross-referenced.

Customarily, deaths of girls enrolled in the Fund were reported to the *Monte* officials by a relative or by a cleric of the church in which the girl was buried. If questions arose regarding the report of a death, it could be certified legally either by the sworn testimony of four witnesses, or by the submission. A provision enacted in February 1447 required that deaths be reported to the officials of the Fund within two months.[15]

It can be difficult to have much confidence in the accuracy of records created so long ago. In an earlier investigation we compared data from private diaries regarding birth date, date of deposit in the *Monte delle doti*, amount deposited, etc., with the Dowry Fund records themselves. We found no omissions and only a few discrepancies other than apparent scribal errors.[10] In view of the well-known importance attached to private records in late medieval and early modern Florence, it can probably be assumed that the Dowry Fund records are comparable in quality to the best records kept at that time. In any event, the types of errors to which the Dowry Fund records were subject would most likely have been "nondifferential" and, therefore, would have damped real trends rather than created artifactual ones.[16] Thus, the records would be expected to reflect real variation, such as epidemics, seasonal trends, and age trends, unless the frequency of errors were excessive.

Originally, the registers of the Dowry Fund comprised 20 large volumes. Eighteen of these volumes have been found. Records are missing for investments made in 1452–54 and 1477–83. The 18 extant volumes consist of approximately 4,600 parchment folios and include records of an estimated 32,000 investments, a number of which are illegible. We made abstracts of 25,475 records, of which 19,158 contain at least the year of birth, year of enrollment, year of termination, and reason for termination (i.e., dowry payment, death, or taking religious vows). Of the 19,158, the months of birth, enrollment, and termination are known for 18,069.

Statistical Methods

Our results are given primarily in terms of mortality rates—the number of deaths that occur in a group under observation divided by the total amount of observation-time (person-years) accumulated by the group.[16] All mortality rates in this report are stated as the number of deaths per 1,000 person-years (PY). This value can be interpreted as the number of deaths that would occur in a year's time in a hypothetical constant population of 1,000 subject to the rate at hand. The mortality rate, rather than the proportion of girls that died in a period, is used as the measure of mortality since the rate intrinsically compensates for temporal changes in the composition of an observed population-at-risk. In the Dowry Fund, girls were being enrolled, and leaving, frequently, so there would not have been a group of any specified size and age distribution under observation for more than a short period. The proportion of a group of *fixed* size initially that dies during an epidemic, or nonepidemic, period is slightly *less* than the product of the initial size of the group, the mortality rate during the period, and its length. This is so because the number of people to which the rate applies is progressively reduced by deaths as time passes. For example, a population fixed initially at 40,000 (roughly the number of people in Florence in the 15th century) would

experience 3223* deaths, rather than 3360, during a year-long period in which the mortality rate is 84 per 1,000 PY (as observed in the Dowry Fund in the epidemic of 1479). In a population such as a real city, in which the population is not fixed, the actual number of deaths also would depend on the rates of in- and out-migration, and the birth rate, during the period under consideration.

For each girl, PY were accumulated beginning at the time of the first investment, and ending at the time of the first dowry payment, or of death, or entry into a religious order. (In the case of multiple dowry payments subsequent to marriage, the first payment, rather than any later one, was taken as the end of observation because we were uncertain that deaths after an initial payment were recorded reliably.) From 1425 through 1600, there were 3,151 deaths, and a total of 260,483 PY were accumulated, of which 84 per cent were derived from girls who were 5–19 years old. Cause of death was almost never stated in the records of the Dowry Fund; thus, it was not possible to analyze mortality according to cause. Some information on cause of death in Renaissance Florence can be derived from another source, the Books of the Dead. This material is discussed below.

Results

Epidemics

The mortality rate is shown by year in Figure 1, and Table 1 gives the data by age for every year in which the rate for all ages was at least 10 per 1,000 PY, and for the period 1425–1600. (Figure 1 also presents death registration data that are discussed below.)

There was a major epidemic in 1430, and the mortality rate for that year—200 per 1,000 PY—is the highest that was found for any year-long period. However, the amount of data available in this early period was small; the observed

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*This number is derived from the expression, proportion of deaths = 1-exp(-rate × time).

death rate is based on only four deaths and 20 PY and thus is only an imprecise estimate of the true force of mortality. The number of PY jumps from 36 in 1432 to 695 in 1433 (as a result of the 1433 legislation), and the annual number of PY does not again fall below 500 until 1545. Therefore, most of the remaining death rates are comparatively reliable.

Figure 1 shows a number of additional periods of elevated mortality during the next 50 years. A small peak is evident for 1433–34. The large increase in mortality in 1437–38 is the first of five peaks (the remaining ones being 1449–50, 1457, 1464, and 1468) that in sequence decrease in size but are increasingly closely spaced. Between these peaks, as well as at other times, there are small year-to-year fluctuations in the mortality rate. Mortality was relatively low from 1469 through 1477, but in 1478–79, Florence was struck by a very severe epidemic.

Following this, there was a period of about 40 years without major epidemics, although Figure 1 suggests minor epidemics in 1497–98, 1505, and 1523–24. The long quiescent period was broken in 1527 for what was to be a five-year span of greatly elevated mortality. During this period the rate was highest in 1527—110 per 1,000 PY. In 1528 and 1529 it dropped sharply, and then increased to 52 per 1,000 PY in 1530, dropping to 18 in 1531, the last year of the epidemic.

As indicated above, the proportion of a population of initially fixed size that dies in a given year is slightly less than the numeric value of the death rate for that year. Thus, about 8 per cent of girls enrolled in the Dowry Fund died in 1479, and about 20–25 per cent died during the epidemic of 1527–31. Because the enrolled girls were well-to-do, their death rates were probably lower than those in Florence generally. Therefore, the epidemics may have been even more serious than the figures indicated.

From 1532 on, the year-to-year changes in mortality were similar to those in the period 1480–1526. Beginning in the mid-1540s, there were a number of fluctuations, but the mortality rate was never extremely high. The highest rate in this last period was 29 per 1,000 PY, recorded in 1568, near
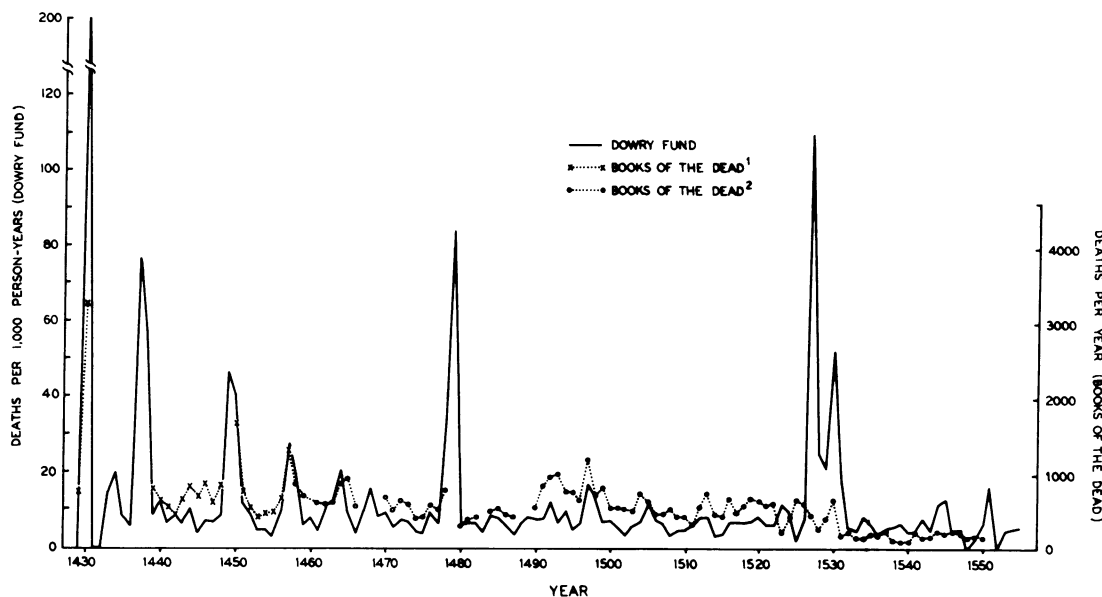

FIGURE 1—Mortality Rate by Year (Dowry Fund). Death Registrations by Year (Books of the Dead; 1—reference 19, 2—reference 23)

TABLE 1—Mortality Rate[1] and Person-years (PY) of Observation by Age for Years with an Overall Rate > 10 per 1,000 PY, and for the Entire Period 1425–1600

Year	0–4		5–9		10–14		15–19		20–59		All ages	
1430	325	(6)[2]	239	(4)	104	(10)		(0)		(0)	200	(20)
33	27	(295)	8	(264)	0	(129)	0	(7)		(0)	14	(695)
34	35	(289)	15	(328)	9	(215)	0	(12)		(0)	20	(845)
37	147	(96)	79	(430)	41	(319)	118	(94)	0	(3)	77	(940)
38	64	(63)	61	(360)	52	(328)	56	(125)	0	(4)	57	(880)
40	42	(169)	7	(453)	9	(444)	10	(194)	0	(14)	13	(1274)
44	28	(72)	12	(328)	2	(516)	19	(320)	0	(30)	10	(1266)
49	54	(147)	40	(497)	53	(581)	41	(362)	49	(41)	47	(1628)
1450	74	(188)	43	(510)	34	(623)	27	(372)	64	(47)	40	(1741)
51	21	(374)	10	(786)	6	(790)	16	(380)	23	(43)	12	(2374)
56	0	(38)	18	(552)	11	(997)	1	(698)	17	(60)	10	(2346)
57	30	(133)	34	(444)	27	(959)	25	(770)	15	(67)	27	(2373)
58	44	(412)	25	(484)	14	(943)	13	(800)	11	(91)	20	(2730)
62	33	(277)	10	(1034)	6	(727)	9	(748)	8	(133)	11	(2919)
63	24	(335)	13	(1202)	8	(779)	14	(693)	9	(116)	13	(3125)
64	36	(440)	19	(1423)	20	(957)	15	(686)	15	(135)	20	(3641)
67	17	(477)	10	(1645)	9	(1625)	13	(720)	0	(179)	10	(4647)
68	25	(407)	15	(1718)	14	(1761)	16	(815)	23	(218)	16	(4920)
1470	33	(511)	6	(2000)	6	(2012)	11	(1118)	8	(256)	10	(5896)
76	0	(198)	11	(1297)	11	(2494)	9	(1910)	7	(605)	10	(6503)
78	12	(85)	25	(843)	31	(2099)	37	(2164)	38	(656)	33	(5846)
79	30	(33)	59	(626)	77	(1732)	88	(2103)	117	(683)	84	(5177)
92	17	(120)	15	(585)	7	(401)	13	(157)	10	(292)	12	(1556)
94	16	(127)	12	(671)	3	(623)	0	(156)	32	(159)	10	(1736)
97	14	(71)	13	(600)	17	(754)	15	(397)	38	(131)	17	(1953)
98	0	(77)	17	(518)	17	(749)	8	(495)	7	(145)	14	(1984)
1505	72	(55)	11	(267)	5	(406)	8	(660)	21	(286)	12	(1674)
23	0	(43)	14	(357)	20	(455)	5	(442)	7	(143)	12	(1439)
24	0	(50)	16	(373)	9	(432)	7	(436)	6	(154)	10	(1445)
27	69	(116)	93	(420)	131	(451)	111	(395)	123	(163)	110	(1545)
28	11	(89)	20	(395)	22	(404)	42	(359)	18	(166)	25	(1413)
29	10	(100)	23	(440)	16	(435)	21	(336)	41	(146)	21	(1456)
30	93	(107)	61	(461)	48	(440)	49	(349)	23	(172)	52	(1529)
31	25	(79)	19	(424)	16	(444)	17	(359)	24	(165)	18	(1470)
44	0	(25)	16	(124)	10	(101)	14	(140)	8	(120)	12	(510)
45	0	(17)	7	(136)	0	(106)	33	(90)	20	(102)	13	(452)
1551	0	(12)	15	(132)	20	(147)	22	(91)	0	(23)	17	(405)
61	0	(3)	143	(7)	0	(28)	11	(93)	0	(31)	12	(162)
63	0	(2)	0	(3)	0	(18)	22	(46)	0	(32)	10	(102)
64	0	(1)	0	(3)	0	(10)	0	(38)	36	(28)	12	(80)
1425–1600[3]	23	(15651)	11	(66050)	10	(82724)	12	(70741)	14	(25317)	12	(260483)

[1]Deaths per 1,000 PY.
[2]The rate is followed by the corresponding number of PY in parentheses. Discrepancies between totals and age-specific values are the result of rounding error.
[3]The rate for all ages 0–59 was 29 (35 PY) in 1568 and 168 (6 PY) in 1576.

the end of the operation of the Dowry Fund. As in the opening period, few data were available, The rate for 1568 was based on only one death and 35 PY of observation.

Long-term Mortality Trends

It is apparent in Figure 1 that severe epidemics occurred less frequently in the 16th than in the 15th century. The over-all death rate declined by about 10 per cent. The age-standardized rate was 12.4 deaths per 1,000 PY for the years 1425–1499, and 11.1 for the years 1500–1570. Mortality in non-epidemic years was fairly stable over the long period encompassed by the Fund.

Based on our data, a mortality rate of 20 per 1,000 PY seems to be a reasonable criterion to distinguish a year with a serious epidemic from other years, and there were 17 years (1430, 1434, 1437–38, 1449–50, 1457–58, 1464, 1478–79, 1527–30, 1568, 1576) in which the rate was at least that high. If the deaths and PY for those years are excluded, the over-

all death rate drops from 12.1 per 1,000 PY to 7.5, a rate that can be taken as typical of the mortality experienced by well-to-do girls during non-epidemic periods in both the 15th and 16th centuries. The difference between the over-all mortality rate, 12.1, and the mortality rate in non-epidemic years, 7.5, represents the contribution of major epidemics to the total mortality that girls experienced during their period of enroll-ment in the Fund. Proportionally, this contribution was 12.1-7.5/12.1 = 38 per cent. That is, the excess mortality experi-enced in 17 years of major epidemics (12 per cent of the total PY of observation) caused 38 per cent of the total mortality.

Mortality by Age

Mortality rates are shown according to age (and com-pared to modern rates[17]) in Figure 2. From a high value of 55 per 1,000 PY for girls less than a year old, the death rate falls sharply during the first few years of life. The lowest rates seen are those for girls 8–12 years old. The death rate then
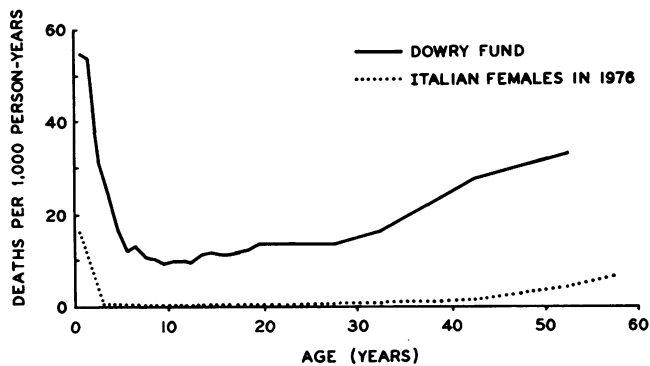
FIGURE 2—Mortality Rate by Age (modern rates from reference 17)

climbs slowly with increasing age. The observed death rate for the first year of life, in particular, is an underestimate of the corresponding true death rate. Girls would not have been enrolled in the Dowry Fund until they had survived at least the first few months of life, the period of highest mortality.

The "U"-shaped curve of mortality rate by age in the Dowry Fund is generally similar to the present-day pattern. As expected, death rates in the Renaissance were much higher than those in modern Italian girls. The relative discrepancy between the Renaissance and modern rates is great, the Renaissance rates being 30–50 times the modern ones for most of the age range available. The discrepancy diminishes at the extremes, the Renaissance rate being about three times the modern rate for girls in the first year of life, and eight times the modern rate in women 45 or more years of age.

An important issue concerning the effects of epidemics is their relative severity at different ages. Were the very young, or other groups, struck disproportionately? Figure 3 presents curves of mortality rate by year according to age group (see also Table 1). Because of the sparseness of data at the beginning and end of the timespan of the fund, the curves are limited to the period 1433–1532, and the data are not shown for rates based on <50 PY. Relatively few observations are available for the youngest age group, 0–4 years. Therefore, the rates for this group are affected by substantial chance variability.

The curves for individual age groups clearly reflect each of the periods with the highest mortality rates: 1437–38, 1449–1450, 1457–58, 1478–79, and 1527–31. In 1437–38, the death rate was highest among girls 0–4 years old, followed in order of decreasing rate by girls 15–19, 5–9, and 10–14. In 1449–50, the death rate again was highest for girls age 0–4, followed by the rates for girls 10–14, 5–9 and 15–19. In 1457–58, the death rate decreased with increasing age, and the rates for girls 10–14 and 15–19 were similar. A rather different pattern was present in 1478–79: the rates increased with age. For the period 1527–31, the two peaks are considered separately. In the earlier peak the rate was highest for girls age 10–14, followed in diminishing order by girls age 15–19, 5–9, and 0–4. In the later, smaller peak, the highest rate was observed for girls 0–4. The rates for ages 5–9, 10–14, and 15–19 were similar. For the 17 epidemic years in which the over-all mortality rate was at least 20 per 1,000 PY, the rate in children 0–4 years old was 49 per 1,000 PY compared with a rate of 45 for girls age 5 years and over during the same years.

In short, mortality was highest in the youngest girls in four of the six periods of severe epidemics. Considering the
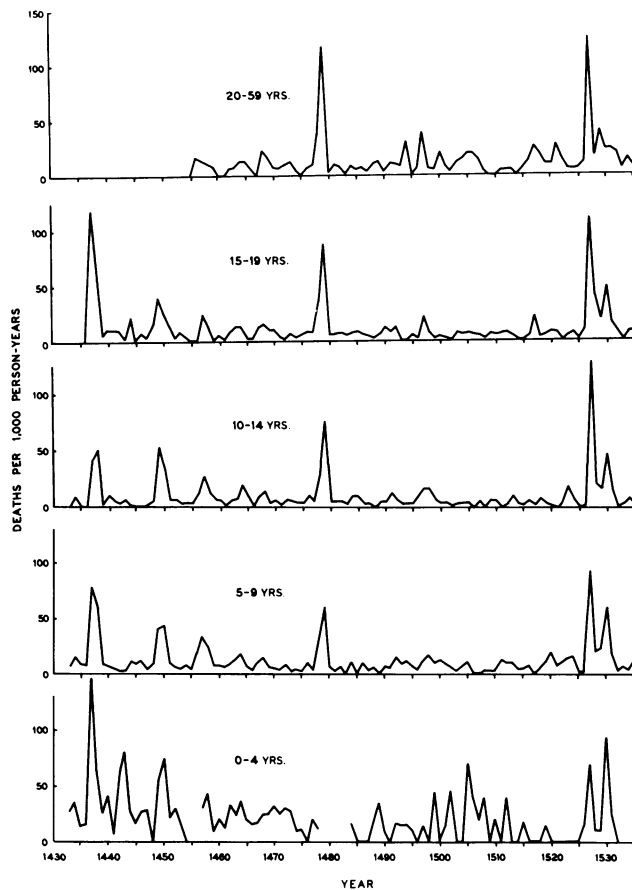

FIGURE 3—Age-specific Mortality by Year

periods combined, however, epidemic mortality was only slightly higher in young versus older girls. Moreover, the level of non-epidemic mortality was much higher among girls 0–4 years old (19 per 1,000 PY) than among older girls (7 per 1,000 PY). Therefore, a given mortality rate during an epidemic would actually represent a smaller increase over the non-epidemic rate for very young than for older children.

Seasonal Pattern

Death rates by season are presented graphically in Figure 4 for five periods encompassing the years of highest annual mortality. Although each epidemic period differed with respect to the size of the increase in mortality, its duration, and the precise seasonal pattern, each period has nonetheless one feature in common: relatively low mortality during the winter. The recurrent epidemics were primarily summer and autumn phenomena, the elevations in summer generally, although not always, being somewhat greater than those in the autumn. There was no epidemic in which peak or nearly peak mortality was experienced in the winter, and the winter rate was essentially normal even in the midst of some epidemic periods.

For all years combined, the death rate was 11 per 1,000 PY in the spring, 19 in the summer, 12 in the autumn, and 6 in the winter. Table 2 compares death rates in the spring, summer, and autumn to those in the winter separately for years in which the overall death rate for the year was ≥20, 10–19 or <10 per 1,000 PY. These groups correspond roughly to years of major epidemics, minor epidemics, and no epidemics. The Table gives both the rates and the ratio of
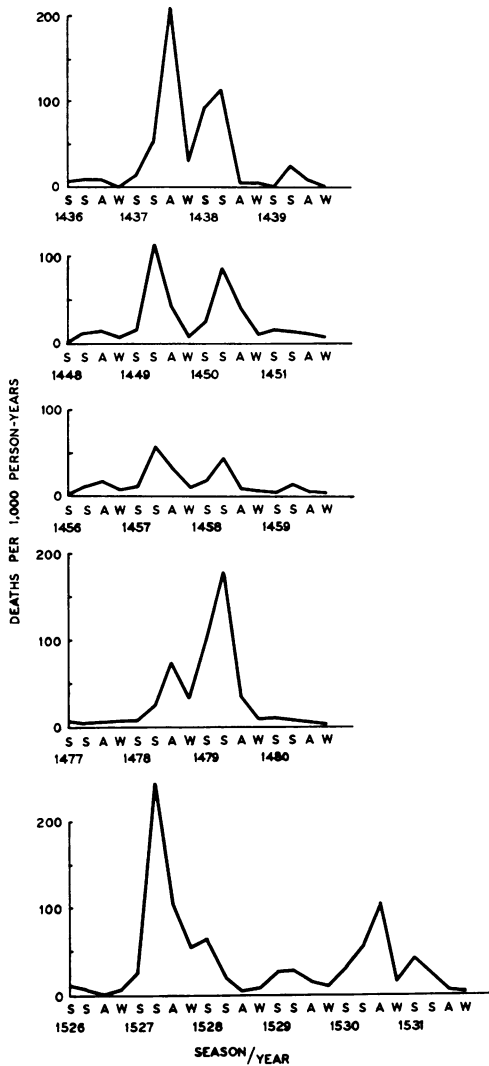
FIGURE 4—Mortality Rate by Season in Epidemic Periods

TABLE 2—Mortality Rate by Season according to Age and Overall Death Rate for the Year

Rate[1] for year	Age (years)	Spring	Summer	Autumn	Winter
≥20	0–4	33(1.8)[2]	94(5.2)	58(3.2)	18(1.)
	5+	36(2.4)	78(5.2)	46(3.1)	15(1.)
10–19	0–4	20(1.7)	34(2.8)	27(2.3)	12(1.)
	5+	12(1.7)	17(2.4)	9(1.3)	7(1.)
<10	0–4	14(1.3)	32(2.9)	13(1.2)	11(1.)
	5+	6(1.5)	7(1.8)	5(1.3)	4(1.)

[1]Deaths per 1,000 PY.

[2]The first number is the rate. The number in parentheses is the ratio of the respective rate to the winter rate in the same row.

relatively well-off, and it seems likely that unhealthy girls would not have been enrolled. Nonetheless, the data provide useful documentation of several features of epidemics and overall mortality in early modern Florence.

Our finding that epidemics in Florence during the 15th and 16th centuries did not take an especially heavy toll of young children runs counter to the view of some modern historians, that the burden of epidemic mortality fell most heavily on the young.[2,18,19] A number of technical issues bear on the interpretation of this discrepancy. As Del Panta[20] has pointed out, there are few bodies of information dating from before the 19th century that allow reasonably precise comparison of age-specific mortality rates between epidemic and non-epidemic periods. Given the high proportion of young children in pre-industrial populations, and the relatively high underlying mortality of the very young, the proportion of very young decedents is *expected* to be high whether or not that group is struck disproportionately by epidemics. The effects of an epidemic on different age groups can be compared most readily if the age distribution of the population, as well as the number of deaths by age, is known before, during, and after the epidemic. The immediate availability of this information is one of the greatest strengths of the Dowry Fund material, even though these records furnish little information on the middle-aged, and none on the elderly. Most other observations on mortality in early modern Europe are based on death registrations. In such records, the specification of age is nearly always imprecise, and the completeness of registration might well change as epidemics progressed. Moreover, the size and age distribution of the corresponding live population, and the changes in these features, would rarely if ever be known accurately.

Further, we know of no reason to assume that the age-pattern of mortality would be constant from one epidemic to another. The patterns varied within the Dowry Fund material. The characteristics of the illnesses responsible must have changed with time, even in epidemics that would be attributed to the same disease. The severity of an illness by age probably varied with time as did the probability of infection. Our data only partially overlap the epidemics described by others. Thus, disparate results may stem either from differences in the nature of the sources or from differences in the epidemics themselves.

Narrative Historical Accounts

Serious epidemics were reported reliably by contemporary observers. Corradi[21] assembled a comprehensive collection of references to epidemics in Italy, and Biraben[1] constructed a summary list of epidemics considered to be

each rate to the corresponding winter rate. Thus, children aged 0–4 had a rate of 94 per 1,000 PY in the summer of major epidemic years—a rate 5.2 times the winter rate for the same years. The amount of increase in spring, summer, and autumn rates compared to winter rates obviously depends on the overall rate for the year, but even in years of low rates, mortality was about twice as high in the summer as in the winter. The most striking difference between years of high rates and years of low rates is that autumn mortality was greater than spring mortality during years of major epidemics, but similar otherwise.

Another important observation bears on the relation of these patterns to age. The warm-weather increase of mortality in very young girls was similar to that among older girls in periods of major, minor, and no epidemics. The result broadens our finding, described above, that epidemic mortality did not in general depend strongly on age.

Discussion

Death rates derived from the Dowry Fund probably were underestimates of death rates that prevailed at the time. Economically and socially, the enrolled girls were

"plague," presumably *Yersinia pestis* infection. (We have not evaluated the clinical descriptions on which plague attributions are based.) Of the 128 years from 1433 to 1560 (inclusive), plagues are reported in 85, or 66 per cent. Plague epidemics were reported to have affected Florence or Tuscany in the years 1429–30, 1436–39, 1448–50, 1456, 1478–79, 1494, 1497, 1505, 1509, 1522–29, and 1531. The close correlation between these reports and the peaks in death rates seen in Figure 1 is obvious. On the other hand, smaller changes in mortality in our data are not as well correlated with the chronicles. Mortality rates between 10 to 19 per 1,000 PY are seen in the Dowry Fund for 17 periods lasting a year or more during the 1433–1560 interval; only six of these (36 per cent) are cited. However, plagues were reported *somewhere* in Italy during most of the periods of lesser elevations of mortality, especially during the 15th century. Relatively few plagues were reported anywhere in Italy during the periods of low mortality in Florence.

Death Registrations

In Florence, death registration was conducted by two agencies. The *Grascia* board, which was reponsible for ensuring adequate food supplies for the city, registered deaths from 1385 to 1778. The Guild of Physicians and Apothecaries registered deaths from 1450–1808. Together these sets of registers have become known as the Books of the Dead. Both series are apparently based on reports made by gravediggers. Neither series of records is now complete. There are some similarities between the Books of the Dead and the parish records that were the basis of the later English Bills of Mortality.[22] But, the Italian records have a secular rather than religious origin, and these records were not summarized and published as were the English Bills.

To estimate mortality rates from the Books of the Dead, it would be necessary to know the geographic boundaries of registration and the population of that area by time. Without this information, death registrations cannot provide estimates of the proportion of a population that died, although they can indicate the relative size of changes in rate, if changes in the size of the population and the probability of a death being registered are small.

Figure 1 compares the yearly number of registrations in the Books of the Dead to mortality rates as derived from records of the Dowry Fund. Epidemics in 1430, 1450, and 1457 are shown in both sources, and both sources show the epidemic in 1430 being greater than that in 1450 which was, in turn, more severe than the 1457 epidemic. Registration records are missing for the period 1431–38, which includes the 1437–38 epidemic shown in the Dowry Fund.

The Books of the Dead also show a peak in mortality in 1464–65. This peak corresponds in timing and size to the 1464 epidemic observed in the Dowry Fund material. The death registrations suggest the beginning in 1478 of the epidemic that became so severe in 1479, although records for the latter year are missing. The two sources show similar trends during the relatively calm years of 1480 to 1520, but the registrations give no indication of the large and sustained increase in mortality from 1527–30. The typical number of burials in a year is lower after 1500, compared to the earlier period, and this reduction is much greater than any underlying change in death rate as shown by the Dowry Fund, or change in the population of Florence.[2,11]

Herlihy concluded that the quality of the Books of the Dead deteriorated after the mid-15th century.[18] Comparison of the death registrations with death rates derived from the Dowry Fund also indicates a decline in quality, although this might not have occurred until early in the 16th century.

The dramatic epidemics shown so clearly in the Dowry Fund and death registration data lead to an obvious and important question: What diseases were responsible? This question cannot be answered with the Dowry Fund material, but the Books of the Dead contain some intriguing clues.

Beginning in 1424, an epidemic year, an indication of the cause of death accompanied substantial numbers of registrations. Portions of this diagnostic material have been analyzed by Carmichael,[19] and by Herlihy and Klapisch-Zuber.[2] The diagnoses reflect great concern with plague, presumably bubonic plague. Several terms appear to refer to this affliction: *pestilenza, peste,* and *segno.* Other diagnoses refer to intestinal disorders, respiratory illness, childbirth and neonatal deaths, and smallpox. A number of deaths were given very vague designations such as "long illness," "fever," "serious illness," and "old age."

The relationship of cause-of-death as given in the Books of the Dead to a modern classification of disease is uncertain. The number of cause-of-death categories in the Books is small, so that most categories must include cases of rather diverse illnesses. Further, some of the categories are descriptions of symptoms or vague conditions and could refer to almost anything. Finally, we have little idea of the criteria by which people were assigned to even the more specific categories. How did the gravediggers, who are supposed to have been the source of diagnoses, acquire the necessary medical knowledge? How was it known that someone died of plague? Sometimes, clinical signs must have been clearly recognizable, but other times, not. Furthermore, Carmichael suggests that "once a death of plague was declared in a household, subsequent deaths in a family might automatically be called plague without further inquiry."[19]

Despite these caveats, the causes of death contained in these books constitute the only quantifiable diagnostic information available for Renaissance Florence. Diagnoses were given for 90 per cent or more of registrations in the years 1424, 1430, 1449–50, and 1457. Each of these years encompassed an epidemic described in historical accounts as a "plague." Of the registrations with a stated cause of death, the percentage described as "plague" varied from 59 per cent in 1457, to 86 per cent in 1430. Causes of death also were stated for smaller, but nonetheless substantial, fractions of registrations in years adjacent to epidemics. In the remaining years, cause of death was generally given in no more than a few per cent of cases, and few of these diagnoses refer to plague.[19] Because causes of death were recorded mainly in epidemic periods, the majority of all diagnoses given refer to plague. Thus, 68 per cent of diagnoses made in 1424–30 are "plague." Of the remaining diagnoses in this period, the greatest proportions were intestinal disorders (7 per cent), "old age" (7 per cent) and "fever" (4 per cent).

The number of plague deaths increased enormously in the summer and autumn months. In the 1424–30 period, 73 per cent of the plague deaths occurred in July, August, or September, compared to less than 1 per cent in January through March. The frequency of death from most other causes also increased in the summer and fall; except for plague, the greatest seasonal change was seen for intestinal illnesses. There was only a small change in the monthly distribution of deaths from "old age."[2] In view of the infrequency of diagnostic information during non-epidemic

years, an interpretation of the patterns cannot be made with much confidence.

In her analysis of the Books of the Dead for the 1385–1458 period, Carmichael related the frequency of registration to season.[19] Figure 5 compares the three epidemics for which seasonal data are available from both the Books of the Dead and the Dowry Fund. Unfortunately, death registration data are missing for portions of two of the periods. Nonetheless, the seasonal trends reflected in the two sources are essentially the same. The similarity is noteworthy, since the procedures by which the data were collected appear to have been entirely independent, and the girls enrolled in the Dowry Fund constituted only a small part of the population of Florence.

The seasonal trends of epidemic mortality in Florence support numerous other observations.[24] There can now be no doubt that serious epidemics in early modern Europe were primarily summer and autumn events. Furthermore, the Dowry Fund data indicate that the seasonal trend of mortality during non-epidemic periods was similar qualitatively to the trend during epidemics.
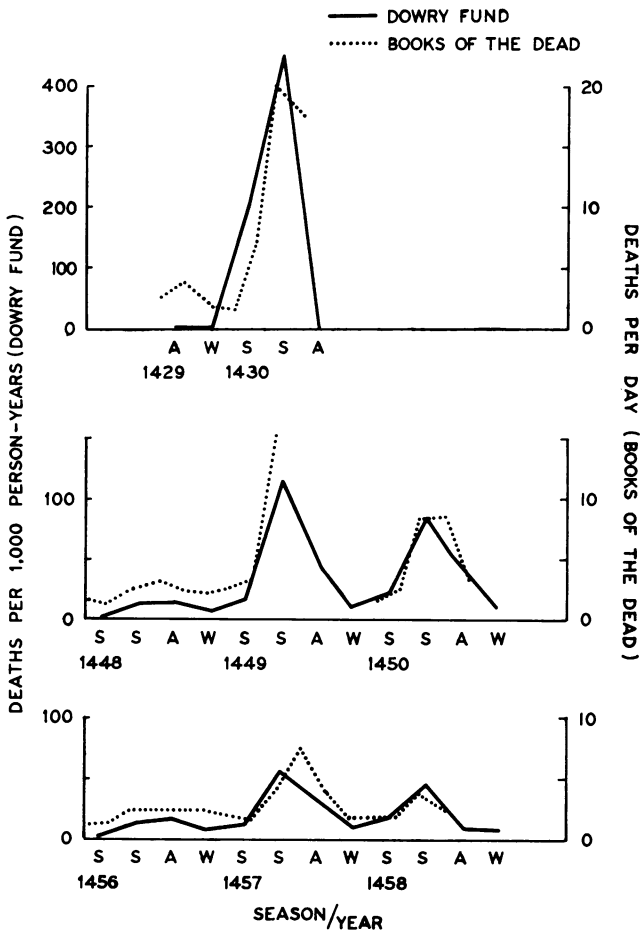
FIGURE 5—Seasonal Patterns of Deaths during Epidemic Periods Compared between Records of the Dowry Fund and the Books of the Dead (reference 19)

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