Suggested Method of Computing and Standardizing the Maternal Mortality Rate

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SINCE the publication of my original paper on this subject I have had, from different parts of the world, several letters containing criticisms and suggestions regarding the proposed method of computing and standardizing the maternal death rate. As the method suggested necessarily involves some of the principles of the present method, a good share of the criticisms aimed at me also strike at the method now in vogue of arriving at the maternal death rate. My paper, then, has evidently served a twofold purpose.

The present work is the result of an attempt to rewrite the original article in simpler form, using as a guide the material found in those letters which my correspondents have kindly forwarded to me.

In the United States for the year 1928 the maternal death rate was 69 per 10,000 live births. For the same year in the Netherlands the rate was 34 per 10,000 live births. Does this mean that the pregnant woman in the United States actually runs double the risk of dying in childbirth of her sister in the Netherlands? Or might the difference in the two rates be due, in some measure, to variation in methods of computation?

Of late, considerable attention has been directed toward certain fallacies which may arise in the comparison of maternal death rates. The League of Nations has given several reasons why comparison of International Vital Statistics may lead to erroneous conclusions. The publications of the U.S. Bureau of the Census also caution the reader in this regard.

Hospitals, maternal welfare or visiting nurse organizations, etc., sometimes quote their maternal death rates and then commit the unpardonable error of comparing these "low" rates with the "high" rate of the country as a whole.

The death rate of the maternity hospital or organization is a selective and necessarily lower rate than that of the community or country of which it is a mere sample. There are two chief reasons for this: (1) the difficulty, especially in a large metropolitan center, of following to the end of 1 month after birth all women registered for childbirth; (2) the maternity institution being primarily concerned with birth of children has on its records a relatively small proportion of cases such as abortion, miscarriage, ectopic. However, the deaths from these, as well as the deaths of women not accounted for 1 month after giving birth, appear on the roster of the Board of Health.

* Read before the Child Hygiene Section of the American Public Health Association at the Sixty-first Annual Meeting in Washington, D. C., October 24, 1932.
Yet from surveys such as these has emanated the widely disseminated assertion that in the United States 2 of every 3 maternal deaths are unnecessary.

Physicians actually in attendance on confinement cases terminating fatally often find it difficult to state on the certificate whether death was due to childbirth or to some complicating condition such as heart disease, tuberculosis, etc. His opinion as to the cause of death is final only if it agrees with the vital statistician’s interpretation of the classification in the International List of Causes of Death. It is readily seen that the maternal death rate may vary with precision of application of the rules for allocation of causes of death, and this quite independent of number of deaths. In spite of this possible obvious disparity, the maternal death rate is computed to within 0.1 per cent.

The primary object of computing a death rate is to compare it with that of some other community or country. It is important, therefore, that if death rates of different areas are to be compared, first, all deaths must be included, and second, there must be some standard method of computation. The crude, general and true death rate is the result of computing the relation between the exposure group, or number of persons alive at the beginning of an interval of time, and the number in that exposure group who died during the same interval.

In case of the maternal death rate the method of computation is somewhat different. If in a given area in a given year, 668 women died of causes directly assignable to childbirth, and if during that year there were 121,462 babies registered as born alive, then the maternal death rate is 55 per 10,000 live births, as given by

\[
\frac{668}{121,462} \times 10,000 = 55.0000 \ldots \ldots (1)
\]

Because of the very incomplete registration of pregnancies which issue in the form of abortion, miscarriage, and ectopic gestation, there is no accurate record of the number of women in whom pregnancy terminated in less than 28 weeks. Since the number of live births from pregnancies under 28 weeks is very small, the exposure group in the definition of maternal death rate, 121,462 in equation (1) above, refers practically only to the last 12 weeks of pregnancy. The number of deaths, 668, refers, however, to the whole 40 weeks of pregnancy. The denominator of (1) is short the number of women whose pregnancy ended under 28 weeks. The effect of this is to give a relatively high value for the maternal death rate.

As the denominator, 121,462, of the fraction for getting the maternal death rate refers only to “live” births, it is readily seen that the rate would rise in proportion to deficiency in birth registration. The same thing might happen where the proportion of live births—of all births—was relatively low.

It is seen then, that the maternal death rate as defined in terms of registered live births, varies with the rigidity of application of the rules for allocation of causes of death; is overstated by its own definition; increases with deficiency of birth registration, and with the number of maternal deaths which occur before birth of child; very probably increases where the proportion of live births in all births is relatively low.

It is quite natural then that we should seek a method of measuring the maternal death rate which would be free of the variables mentioned above, which would conform to the definition of the crude or true death rate, and which could be used to make reliable comparisons, national or international.

Registration of births of gestation 28 or more weeks permits of a method
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(q.v.) of computing the corresponding exposure group of women, which when related to the deaths in this same group gives the death rate of women in this span of pregnancy. But there still remains to be considered those women whose pregnancies terminate by abortion, miscarriage, or ectopic. The incomplete registration of these does not allow of calculation of the exposure group and hence of a true death rate. These deaths might be related to the number of non-childbearing females in the same age class, or they could be stated as a percentage of the total deaths for all periods of gestation. Employment of either of these two methods is merely making the best of the situation.

A woman pregnant 28 or more weeks is said to have a viable pregnancy. This class of women I have designated the childbearing group, or the exposure group.

The number of deaths in women in the childbearing group is, of course, the number of death certificates in women pregnant 28 or more weeks, on which certificates pregnancy or childbirth is given as either the primary or contributing cause of death. Pregnancy advanced to the period of viability, or even to the 5th or 6th month, is not likely to escape mention by the medical attendant. When necessary, further information as to period of gestation and whether death occurred before or after delivery, can be obtained by a supplementary communication to the physician. Generally speaking, this information is as available as any other data on the death certificate.

As practically all deaths related to pregnancy or childbirth have occurred by the end of 1 month after birth, we shall consider all deaths in childbearing women which take place during the pregnancy or within 1 month after birth.

The exposure or childbearing group is obtained from birth registration data and is the number of women in whom pregnancy terminated by live birth or stillbirth during or after the 28th week of uterogestation. Referring to these viable pregnancies, the number of women in the exposure group would be found by adding the live births to the stillbirths, deducting 1 and 2 for twins and triplets, and adding the number of women who died before giving birth.

Unfortunately, bureaus of vital statistics do not usually make a separate tabulation of stillbirths of gestation 28 or more weeks. Also, the number of multiple (twin or triplet) births listed may include cases of gestation under 28 weeks. On the other hand, the registered live births is a much more reliable figure and it can, when necessary, be corrected for any deficiency in birth registration. Furthermore a "live birth" practically always implies gestation of 28 or more weeks. Therefore, in case of live births, classification of these in terms of gestation is not necessary in arriving at the exposure group.

If bureaus of vital statistics would furnish separate tabulations for multiple births and stillbirths of gestation period 28 or more weeks, then the number of women in the exposure or childbearing group is very accurately and readily obtained. It should be remembered that most women bearing children can be just as accurate about the time of expected confinement as they are in regard to giving their age.

There is a second, and I think fairly reliable method of calculating the exposure group. It has no direct relation to plural births or to stillbirths. An institution such as a maternity hospital or maternity service can have, and usually has, complete record of all births as well as the period of uterogestation of each woman giving birth. If we deduct the number of women
whose pregnancies terminated under 28 weeks and then relate this remainder to the number of number of live births we can get a very useful ratio.

In Table I is shown a representative and aggregate sample of consecutive cases from 5 maternity services in greater New York, in the year 1930. The ratio of childbearing women to live births multiplied by 1,000 (column 3) is what I have chosen to call the "converting ratio."

The result for the converting ratio obtained in column 3 of Table I allows us to say, for the representative sample, that for every 1,000 babies born alive there were 1,110 childbearing women. Assuming, as we have done, that our sample is a representative cross-section of the whole city, then the number of women bearing children in New York City is found by multiplying the number of live births, 74,233, by the value of the converting ratio, 1,010/1,000, giving 74,975 (column 5).

Generally speaking, the proportion of live births in home confinements is probably comparable to that of the institution. It is true that the difficult cases are more liable to gravitate to the hospital, but it is also true that the hospital has more facilities for conserving life. As may be seen later, a fairly wide margin of error in the converting ratio gives rise to a relatively small deviation in the computed death rate.

In Table II the number of women bearing children, 74,975, when added to the number of women who died before giving birth, gives us in column 3 the number of women in the exposure or childbearing group, viz., 75,009. When the number of deaths from all causes in women in childbearing or exposure group, 246, is divided by the number of women in the group, 75,009, we obtain as is shown by column 5 of Table II and by the equation

$$\frac{246}{75,009} = 3.28 \ldots \ldots (2)$$

<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The number of women bearing children, obtained from registered live births by the method of the converting ratio</strong></td>
</tr>
<tr>
<td>New York City</td>
</tr>
<tr>
<td>Livebirths</td>
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<tr>
<td>Column 2</td>
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<tr>
<td>5,083</td>
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<td>5,083</td>
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<td>5,083</td>
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<td>5,083</td>
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</tbody>
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* Aggregate sample of consecutive cases from maternity services in New York City in year 1930: Manhattan Maternity and Dispensary, Sloane Hospital for Women, City Hospital, New York Nursery and Child's Hospital, and the Methodist Episcopal Hospital of Brooklyn.
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TABLE II

DEATH RATE IN CHILDBEARING WOMEN IN AGE CLASS 20–29 FOR NEW YORK CITY IN YEAR 1930

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women bearing children</td>
<td>Deaths before birth of child</td>
<td>Women in childbearing group</td>
<td>Deaths from all causes in childbearing women during pregnancy or within 1 month after birth</td>
<td>Death rate in childbearing group</td>
</tr>
<tr>
<td>74,975</td>
<td>34*</td>
<td>75,009</td>
<td>246†</td>
<td>3.28 per 1,000</td>
</tr>
</tbody>
</table>

* There were 68 women in all age groups who died before giving birth. As about half the births occur in the age class 20–29, I have assumed likewise that about half the deaths, viz, 34, also took place at these ages.

† In the age class 20–29 there were 319 deaths in women at any period of gestation. Referring to all ages, of the total of 667 deaths, 515 or about 78 per cent were in women pregnant 28 or more weeks. On the assumption that the proportion 78 per cent holds good, approximately, for the separate age groups, 246 is found, by taking 78 per cent of 319. It will be seen then that this assumption will have the effect of slightly under- or over-stating the death rate in the separate age groups. In this series I have been given to understand that practically all deaths in women pregnant 28 or more weeks are listed as of maternal origin.

the death rate of 3.28 per 1,000 for women in the childbearing group.

In equation (2) we have an expression which conforms to the definition of the crude or general death rate. It is therefore the true death rate from all causes of childbearing women in age class 20–29. It is seen that the true death rate, so arrived at, involves no element of correction or personal equation. It depends only on standard data—age of mother, status in pregnancy, and relation of death thereto—all of which can be obtained by birth and death certification in any locality or in any country.

In making a comparative study of maternal death rates it is this general death rate in childbearing women to which we should direct our attention, rather than the corrected rate given in terms of live births which, as we have seen, can by its own definition, vary within wide limits.

In my original paper I did not compute rates for the separate age groups. For this I have been criticised and, I presume, rightly. It may be noticed, however, that this criticism has not been aimed at the present method, giving the rate in terms of maternal deaths per 1,000 live births.

The crude and general death rate for childbearing women in the age class 30–34 in New York City, 1930, I have computed in the same way and find it to be 4.69 per 1,000.

We have seen, for instance in the age class 20–29, that the 3.28 per 1,000 of equation (2) includes all deaths. If we use round numbers and regard the rate as 328 per 100,000 we may ask in how many of the 328 women death was caused by some complicating ailment such as heart disease or tuberculosis. How many of them would have died even if not pregnant? Or, what is the death rate in puerperal women from causes other than childbirth—the so-called normal death rate? If such a rate can be obtained and then subtracted from the general death rate in childbearing women the remainder is the death rate in women who died solely
because of pregnancy and childbirth—the death rate *per se* due to pregnancy and childbirth.

In attempting to get a value for the normal death rate we should examine the death rate in a group of women identical with childbearing women except as to pregnancy and childbirth. We might then regard, for the particular year and age class, the death rate in married non-childbearing women. This data can be obtained from bureaus of vital statistics and from the census figures.

In Table III is shown the death rate in childbearing women and the rate in married non-childbearing women for the age class 20–29 in a given year. As may be found from actual computation, a wide margin of error incident to estimating the population for an intercensus year involves a relatively small deviation in the computed death rate.

If the death rate in married non-childbearing women is to be compared with that of the childbearing group we must multiply by 16/52. Then, by subtracting the two rates and placing them in equation form we have, for age class 20–29,
When this rate is compared with the 220 per 100,000 for age group 20–29 it is readily seen that the rate per se increases with advance of age, and this quite apart from the increase in the general death rate due to age.

In the original paper the deductive factor, represented as 108 per 100,000 in equation (4) in the present work, included all women who did not bear children during the year. One or two of my critics pointed out that inasmuch as the death rate in those physically or mentally unfit for marriage would be relatively high, the deductive factor would be correspondingly raised, and hence the death rate per se would be proportionately understated. With this in mind, I have made up Table IV.

On comparing the two values of the deductive factor for the same age class, in Table IV, does it seem to make very much difference whether or not the deductive factor takes into account marital status? Of course, Table IV represents only 1 year in New York City.

It will be seen that equation (4) is true only if the normal death rate in childbearing women (the rate of death from causes other than puerperal) equals the value of the deductive factor. The right to assume this has been questioned. James B. Russell and I are at present gathering some data pertinent to this matter and we are testing out a modified * form of equation (4).

We observe from Table IV, age class 20–29, that the rate of death per se is about two-thirds the crude death rate. If we were to compute the maternal death rates in terms of live births, we should also find approximately the same relation. In the age class 30–34 (line 2 of Table IV), the death rate per se is about one-quarter less than the crude death rate. There seems to be no reason to suppose that this excess of a quarter or a third would not also be true for deaths in women pregnant less than 28 weeks. The proposed method of computation then, may serve as a check on the present method. In view of the fact that New York City affords a real representative cross-section of a cosmopolitan population, and assuming that 1930 is very probably not different from any other year, may we hazard the guess that the maternal death rate as computed by the present method, is a quarter to a third overstated?

**SUMMARY**

It is thought that the present method of computing the maternal mortality rate, as the relation between maternal deaths and registered live births, is subject to several sources of error:

1. It varies with the precision of application of the rules for the allocation of causes of death.
2. It is overstated by its own definition.
3. It increases in proportion with deficiency of birth registration and with the number of maternal deaths occurring before birth of child.
4. It very probably increases when the proportion of live births—of the total of all births—is relatively low.

Because of the errors incident to computation of maternal death rates by the present method, the comparison of maternal mortality rates in different areas or countries may often lead to unwarranted conclusions.

Sweeping generalizations from rates in small samples usually lead to mis-
interpretation. It has been pointed out that the death rate of a country, state, or large center is the representative and nonselective rate while that of the maternity organization—hospital, visiting nurse service, etc., is necessarily a selective rate and one which does not represent conditions in general.

A low maternal death rate attainable in an institution in a large center does not imply that the rate for the country at large could be reduced to the same level.

Bureaus of vital statistics usually do not have record of the number of women giving birth. If these bureaus would make a separate tabulation of stillbirths and multiple births of gestation 28 or more weeks, the number of women pregnant 28 or more weeks (childbearing group) would be found by adding these live births and stillbirths to the number of childbearing women who died before delivery and then deducting one and two respectively for each set of twins or triplets. If these tabulations are not available, then the number of childbearing women in a given area may be obtained from the number of live births in that area by the method of the converting ratio as shown in Tables I and II.

The exposure or childbearing group of women, however gotten, when related to all deaths in that group, gives the crude, true and uncorrected death rate from all causes in childbearing women. It is this true and uncorrected death rate which should receive first consideration when national or international comparisons are made.

The death rate due to pregnancy and childbirth per se is calculated by deducting from the crude death rate the so-called normal death rate or death rate in childbearing women from causes other than puerperal. Generally speaking, the normal death rate in a country for a given age class should parallel the general or crude death rate (from all causes) in the same age class. It should be remembered that the maternal death rate in a certain country may be high partly because that country has a high general death rate in women of comparable age. It is in such a circumstance that the mortality rate due to pregnancy and childbirth per se has an important application.

In closing, let me state that the main object of this paper is the presentation of methods, rather than the exhibition of death rates arising therefrom. It is hoped, at least, that the suggested scheme will stimulate a few individuals to further research. The author will gladly assist any workers who may have difficulty in applying actual data to the tables or equations for arriving at rates.

REFERENCE