

## WORKING LIFE OF HEALTH PROFESSIONALS

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Estimates of the average working life<sup>4</sup> of health professionals are valuable inputs to the planning process. With upper limits of 40 to 45 years generally determined by the effects of age and retirement norms, significantly lower or falling values for the average working life may indicate problems such as a supply/demand imbalance, low job satisfaction, or strong incentives for emigration/problems which may jeopardize the future manpower supply. This paper describes some methods for estimating the working life for an occupational category and illustrates their application with data on physicians drawn from three different countries. It should be emphasized here that these methods can be used with equal facility for other manpower categories such as dentists, nurses and pharmacists, and the use of physician data here reflects nothing more than the ready availability of detailed information on this category. Quite apart from the relevance these methods have for calculating working life values, they can also be used to help project manpower losses, which are an essential input to supply projections.

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<sup>4</sup>Working life tables are double decrement tables, i.e., an initial group of professionals is subjected to two forms of exits, one of which is mortality, and the other is exit from the profession due to reasons other than death

### Data Requirements

The most complete and accurate working life tables will require the following information; profession-specific mortality tables by age and sex; the proportion of the profession which is inactive in each age and sex category; and the rate of entrance to the profession (new graduates and the in-migration of professionals trained abroad) by age and sex. Few countries will have all of the above information for any one profession, much less for all of the principal occupational categories. Following sections of this paper describes methodological simplifications that have been or can be made in order to cope with data limitations.

Primary data sources for the required information are several. This paper will not discuss the specifics of data collection and verification<sup>5</sup> except to note in passing several common problems encountered in many countries which may limit or otherwise bias input data. These are:

- 1) Manpower registries which continue to include in their active files many professionals who are in fact deceased, retired, or emigrated, or which have very incomplete files on in-migrants who were trained abroad;
- 2) Data sets which include but do not adequately differentiate as such many persons who are only marginally active in their profession.

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<sup>5</sup>The interested reader is referred to the following two sources for detailed discussions on the collection of supply data: Kriesberg, H.M., et al. (1974); Methodological Approaches for Determining Health Manpower supply and Requirements, Volumes I (Analytical Perspective) and II (Practical Planning Manual); Rockville, Maryland (USA); U.S. Dept. of Health, Education, and Welfare, Public Health Service, Bureau of Health Planning and Resources Development; and, Hall, T.L. and Mejia V., A., co-editors (1978); Health Manpower Planning: Principles, Methods and Issues, (see especially Chapter 4 on "Supply"); Geneva; World Health Organization

The effects of these and related problems are varied and in some cases may be so great as to compromise the utility of the derived working life calculations. The more usual consequences of most of the above data limitations are the overestimation of the current supply of active professionals, of the projected supply and of the average working life, and the underestimation of manpower attrition. When the statistical system is unable to maintain complete files on in-migrants one is likely to find widely variable and unexpectedly low or even negative attrition rates during the first several decades post entry into the profession - a situation which will confound any attempt to develop working life tables. These and other less common potential sources of error will need to be taken into account and if possible corrected for when developing working life tables and attrition rates.

#### Construction of Working Life Tables for Physicians

As stated before detailed data needed for constructing accurate working life tables for physicians are hard to come by. To cope with this problem, tables for physicians are sometimes obtained by a method identical to that used for tables of economically active life.<sup>6</sup> For this method, the age specific professional activity rates, i.e., number of active physicians in an age group divided by the total number of persons in the same age group, and the life tables representing the current mortality situations of the respective populations are the basic materials for these tables. These tables represent the life-cycle of physician activity in a synthetic cohort, i.e., generations of male or female subjects at each period of their lives to given rates of mortality and participation in physician activity. The tables provide measures of the

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<sup>6</sup>See Bui-Dang-Ha Doan. "La table de vie professionnelle en médecine (1968)." Cahiers de sociologie et de démographie médicale, XVe année, n° 1, pp. 28-36 (January-March 1975). For details on method interested readers may refer to United Nations, Methods of Analysing Census Data on Economic Activities of the Population, Population Studies No. 43, Department of Economic and Social Affairs, New York, 1968.

average length of active life, and age specific rates of entry into and exit from the profession.

Underlying assumptions in the method are that:

- 1) All persons who enter the profession at any time in their lives do so prior to the age at which the professionalization rate reaches its maximum and no one enters into inactive status prior to this age.
- 2) Mortality rates of physicians and of other members in the population are the same.

In addition, the method also implies that age specific professional activity rate observed at a given moment represent the life cycle of physician activity. Such an interpretation would be valid only if the age-specific professional activity rates are unchanging over time.

As a result, the validity of results from this method depends on how well the above conditions are satisfied. Illustrative working life tables of the U.S. and Colombian physicians by this method are presented in Tables 1,2 and 3 of the Appendix to this paper. The data sources and derivations and definitions of functions in the tables are explained in detail in the Appendix.

For the United States, however, we have direct information on active and inactive status of the U.S. physicians as well as information on physicians' mortality. Tables 4 and 5 in the Appendix for the U.S. are obtained by using this information. The tables begin with a cohort of physicians at age 25 and subject it to age specific death rates and activity rates of physicians as it passes through different ages of its life cycle. These tables also provide similar measures as in the method discussed above except that no information on entry into profession is provided by this method.

Ideally the statistician would like to have direct information on mortality and inactivity rates as is available in the U.S. and hence method for working tables using such information subsequently in the text is referred to as "direct." In most cases, however, information on professional specific mortality and on active and inactive status of physicians are not available and hence certain assumptions must be made for obtaining measures of working life. Such is the case for the method used for obtaining Tables 1, 2 and 3 in the Appendix and hence is termed hereafter as "indirect."

In the following sections, first we describe the results for the U.S. physicians based on the direct method and provide a comparison of these results with the results from the indirect method. In a subsequent section results for Colombian physicians are briefly described.

#### Results for the U.S. Physicians

The summary results from the working life tables for the U.S. physicians obtained by the direct method are shown in Table 1.

#### Working Life Expectancies: Active and Inactive Life

Two measures of average length of active life of physicians are provided in Table 1. The first (Col. 3) is that of expectation of active life for surviving physician and second (Col. 4) is expectation of active life for active surviving physician at each age. According to these results for a male physician in the U.S. at the beginning of his career, i.e., at age 25, the duration of active life is 43.8 years and for a female physician is 45.9 years, indicating that if 1969-73 conditions prevail, a male physician entering the profession at age 25, will, on the average spend 43.8 years and a female 45.9 years of his/her remaining life as an active member of the medical profession.

The results also indicate that surviving physicians in the U.S. continue to be active at an older age. This is evident from the high values of active years in the profession at older ages; for example, average working years remaining for a male physician at ages 60 and 65 are about 12 and 8 years respectively. Even at age 85 a surviving male physician in the U.S. has remaining 1.7 years of active professional life.

Table 1 also provides values for the average duration of inactive life at each age for all physicians and active physicians. According to these results, out of total expected life of 49.7 years for all male physicians at age 25, 43.7 years would be spent in active professional life and 6.0 years in an inactive state. Female physicians have more years of inactive life than male physicians. Since inactivity rates used in male and female tables are the same, this finding is of particular interest. The reason for longer duration of inactive life for female physicians than male physicians is the lower mortality of females than males. As a result of this lower mortality more females than males survive to older ages where inactivity rates are high.

The working life tables can also be used to estimate the reduction in the average professional life due to death prior to completion of potentially active years. This is done by comparing the expectation of working life of all members of the hypothetical cohort with the gross years of professional life, an index obtained from the age-specific activity rate of physicians alone. The index is obtained by multiplying each of the age specific activity rates with the number of years in the age interval and by summing over all the age groups. The index shows the average number of active years per person in the absence of mortality. The difference between the gross years of active life and the net, or actual

active working life of all members of the hypothetical cohort provides an indication of loss by mortality. While calculations can be made for each age, the primary interest usually is in the effects of mortality at the age of entry into profession, say, 25 years, for the U.S. The calculation shown below indicates that after age 25, loss of active years for the U.S. male and female physicians respectively are 7 and 5 years.

	<u>Males</u>	<u>Females</u>
Gross years of active life	50.82	50.82
Expectation of Active Life at Age 25	43.80	45.90
Loss Due to Mortality	7.02	4.92

#### Retirement and Losses Due to Death

Working life tables presented in the Appendix also provide information on the annual rates of departure broken into two components, death (Col. 13) and other causes (Col. 14), primarily retirement from the profession by age. These rates are entirely the product of the data on mortality rates, and the proportion of inactive physicians and in the construction of these tables.

Some interesting features of these rates may be noted. One, both sets of departure rates for reasons of death and for other reasons show a regular tendency to increase with age, an expected phenomenon, indicating that as the age of the physician increases the risk of departure for reason of death and other reasons (retirement) increases. Second, for ages under 55 the annual rates of departure for reason of death are higher than the rates for other reasons. This indicates that in ages under 55 for the U.S. physicians, the risk of departure due to death is higher than the probability of leaving the profession for other reasons. This is not because the U.S. physicians are exposed to risk of unusually higher mortality; rather it is that not many physicians retire during these ages. Finally, after age 55, the risk of leaving the profession for other

reasons is generally higher than the risk of dying.

Indirect vs. Direct Method: Checking Validity of Assumptions--

In the absence of direct information on mortality rates of the professional group and entry into and exit from the profession, an alternative method (termed as indirect method) uses information on professionalization rate, i.e., number of physicians in a given age by total number of persons in that age, by age for arriving at measures of working life. As discussed before, certain assumptions are necessary for this method. Since tables for the U.S. could be constructed using somewhat adequate data based on direct observations, it is, therefore, possible to check the validity of some of the underlying assumptions and their effects on the working life parameters obtained by the indirect method.

Table 2 presents a comparison between some summary measures, average duration of working life, rates of exit from the profession obtained from the tables constructed by the two methods for male physicians. (Similar Table for female physicians can be obtained from Tables in the Appendix.) This comparison reveals large differences between the two sets of data.

According to the results obtained by the use of the indirect method, average duration of working life at age 25 of a U.S. male physician is 34.1 years. Which is substantially lower than the corresponding value from the direct method of 43.8 years. In general, the duration of working life of a U.S. physician at each age obtained by the indirect method is lower than the corresponding figure from the direct method. For male physicians, the difference in the duration is about ten years for ages under 40, about 6-8 years at age 40 and 45 and between 2 to 4



years between ages 50 and 70. Much larger differences in the case of female physicians -- about 16-19 years in ages below 40, about 7-9 years at ages 40 and 45, and about 2-7 years between ages 50 and 60 -- are noticed between the values obtained by the two methods.

These differences between the values obtained by the two methods primarily are a result of the shortcomings of the indirect method. As reported earlier, underlying assumptions in the indirect method are that, (i) mortality rates of physicians and of other members of the population are the same, and (ii) the professionalization rates by age observed at a given moment represent the life cycle of physician activity, i.e., of a generation of males or females.

For the U.S. physician, studies on physician mortality indicate that the first assumption is not valid. For example, during 1969-73, male physicians experienced 74.7% of the number of deaths that would have been expected on the basis of the prevailing age-specific death rates of the white male population. For female physicians, the similar ratio was 84.1%. Comparison of mortality rates by age indicated that until age 60 physicians had a substantially lower mortality rate than the rest of the white population.<sup>7</sup> This is also evident from the result in Table 2 which shows the exit rates due to death for the U.S. physician from the direct method (which uses observed mortality rates of physicians) and the indirect method (mortality rates used are of white population in the U.S.). As a result of the lower mortality of physicians than of the rest of the population, the indirect method will over-estimate the number of years lost due to mortality and under-estimate the average years of working life. Since a larger number of years is lost if a death occurs at an earlier age than at a later age, the under-estimation of duration of working life by the conventional

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<sup>7</sup> Goodman, Louis J., "The Longevity and Mortality of American Physicians", 1969-1973. Milbank Memorial Fund Quarterly, Vol. 53, No. 3, 1975, pp. 353-375.

method will be greater at the earlier ages than the later ages. The greater divergence at younger ages than older ages between the average working life of the U.S. physicians obtained by the two methods in part is a result of this assumption.

However, the differences in the values for the U.S. physicians between the two methods are also in part due to the second assumption which, in the case of the U.S. physician, is perhaps also not valid. The data on the professionalization rate present a cross-sectional view of the professional life histories from different birth cohorts, whose survivors are found in different age groups. These rates will be representative of the life cycle of physician activity of a given cohort only if they remain unchanged over time. Where these rates change over time, then cross-section rates at a given date reflect these changes as well as age-to-age change of cohorts' activity. For example, when there is an upward trend in professionalization rate (i.e., over time a relatively larger number of birth cohort membership become physicians), cross-sectional measures of net entry into the profession are underestimated and net rates of exit from the profession for other reasons other than death are over-estimated.

In the case of the U.S. physicians while direct data on how many members from each of the past birth cohorts became physicians is not yet available, there is evidence that in recent times there has been an upward trend in the professionalization rate. This is evident from the available information on numbers of physicians per 100,000 of the total U.S. population. The U.S. data indicate that numbers of physicians per 100,000 population remained relatively constant at 149 and from 1950 through 1960 but has increased since then to an

estimated high of 169 per 100,000 in 1971. The numbers of active physicians in given years, which constitute the basic data for the tables by the indirect method, remained at a level of 140 per 100,000 population from 1950 through 1960 but since then increased to 158 in 1971.<sup>8</sup>

As a result of this upward trend in the professionalization rate, one would expect that the rates of exits for reasons other than death obtained by the indirect method for the U.S. physicians to be biased upward. A comparison of the exit rates obtained by the indirect method with those from the direct method (i.e., empirical data) finds large differences. Generally the rates are higher by the indirect method than those implicit in the empirical data used in the direct method. The large differences in the rates, however, are generally confined in the younger age groups between ages 30 through 50. This is expected on the basis of observed trends in professionalization rates, which in the distant past seem to have been constant and only in the most recent past shows an upward trend. Since an upward trend in the professionalization rate is translated into exit rates by the conventional method, the measures of working life for the U.S. physicians are biased downward.

Further evidence that parameters from the working life table obtained by the indirect method have serious biases in them is indicated if one uses them for studying the changes in the professional group. By applying the exit rate by age from the tables to the corresponding actual number of active physicians of the country concerned and summing up the results for all ages, one obtains an estimate of the number of physicians who will leave the profession in the following year.

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<sup>8</sup> U.S. Department of Health, Education and Welfare, Health Resources Statistics, Health Manpower and Health Facilities, 1975. Health Resources Administration, National Center for Health Statistics, 1976, pp. 161-165.

Similarly, one can obtain the number of total entrants into the profession by multiplying the rate of entries by age with the number of active physicians in those ages. By dividing the annual entry numbers and exit numbers by the total number of physicians, one gets the crude rates of entries and exits for the medical profession. Using estimated entry and exit rates derived by the use of the indirect method and 1971 U.S. active physicians, one obtains results which are shown below. These results are compared with those based on the direct observations during 1971-72.<sup>9</sup>

	Estimates Using Rates from the Tables	Observed Changes for the U.S.
(Numbers in thousands)		
Number of entries	5.15	14.5
Number of Exits	9.22	3.4***
(i) Due to Death	3.54	NA
(ii) Due to other reasons	5.68	NA
Crude Rate of Entries	15.99*	45.0*
Crude Rate of Losses	28.63*	10.6*
(i) Due to Death	10.99*	NA
(ii) Due to other reasons	17.64*	NA
Replacement Rate Per 1000 Active Physicians	-12.64*	34.4*

\* Per 1000 active physicians in 1971

\*\* Data pertains to new entrants

\*\*\* Estimated by taking the difference between new entrants and net increase in the number of physicians during 1971-72

The indirect method predicts a net decline in the number of U.S. physicians, while in reality the number of U.S. physicians increased. Similar results for French physicians were obtained by Bui-Dang-Ha Doan<sup>10</sup> when he used the data from working life tables of French physicians for studying changes in the professional group.

<sup>9</sup>U.S. Bureau of Census, Statistical Abstract of the United States, 1974. Department of Commerce; Washington 1976, Tables 106 and 115.

### Working Life Expectations for the Physicians of Colombia

The working life table for Colombian physicians, presented in the Appendix, is also obtained by using the indirect data method for the year 1965. A comparison of the average working years of the Colombian physicians with those for the U.S. (males) and French physicians, all of them are obtained by the indirect method, is also made in Table 3.

In view of the results and discussion presented in the previous section, caution should be exercised in the interpretations of the results in Table 3. For U.S. physicians, the values in Table 3 grossly understate the actual years of working life. For the French physicians, there is also convincing evidence that such may be the case. If we assume that similar biases also exist in the values of working life for the Colombian physicians, then the actual duration of working life by age for the Colombian physicians is higher than those shown in Table 3. The data in Table 3, though not strictly comparable in time period, also indicate that the working life of Colombian physicians is somewhat smaller than counterparts in France and the U.S. However, these differences may be partially the result of the differences in the survival probability, which is lower in Colombia than in the U.S. or France (see Table 4 which compares the death rates for the U.S. and Colombian populations.)

In Table 4 a comparison of the rates of exit for reasons other than death between Colombian and U.S. physicians shows higher rates for the former than the latter. Whether these differences represent the real differences in the two populations or are the artifacts of the methodology is difficult to say. However, in part these differences may be due to emigration of Colombian physicians to

foreign countries. A survey conducted in 1965 indicated that 25 percent of all medical graduates of Colombia were living in foreign countries.<sup>11</sup> Since the values of working life are based on the active physicians in the country, the physicians who leave the country will be represented in the exit rates for reasons other than death.

In view of the shortcomings of the method and uncertainties about the data sources for Colombia, the results on the working life of the Colombian physicians should be viewed as being only approximate. However, given the nature of the assumptions made, they can be viewed as conservative estimates.

Summary:

A comparison was made between the indirect method of preparing a profession Specific Working Life table and the direct method. The former uses data on number of physicians per 1,000 population by age and assumes that mortality rate for the profession is equal to that of the population as a whole. The latter method makes use of information on profession specific mortality and on active and inactive status of living physicians. These two approaches were applied to physician data for the U.S. and it was noted that the direct method gives estimates of the working life and the total life expectancy that are significantly higher than by use of the indirect method. The likely magnitude and directions of the biases inherent in each of the methods are then discussed. A comparison is made of the estimated working life for U.S., French, and Colombian physicians using the indirect method.

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<sup>11</sup> Study on Health Manpower and Medical Education in Colombia, Vol. 11, 1967, Sponsored by the Milbank Memorial Fund, World Health Organization, and ministry of Public Health of Colombia.

Table 1

Average Life Expectancy and Working Life Expectancy  
of the U.S. Physicians by Sex Using Direct Method: 1971

Age	Male Physicians					Female Physicians				
	Total Life Expectancy*	Working Life Expectancy	All ** Physicians	Active *** Physicians	Inactive Life	Total Life Expectancy *	Working Life Expectancy	All** Physicians	Active*** Physicians	Inactive Life
	2	3	4	5	6	7	8	9	10	11
25	49.7	43.8	43.8	5.9	5.9	54.6	46.0	46.0	8.6	8.6
30	44.9	38.9	39.0	6.0	5.9	49.7	41.1	41.2	8.6	8.5
35	40.0	34.1	34.5	5.9	5.5	44.9	36.3	36.7	8.6	8.2
40	35.3	29.4	29.7	5.9	5.6	40.2	31.6	31.9	8.6	8.3
45	30.7	24.7	25.0	6.0	5.7	35.6	26.9	27.2	8.7	8.4
50	26.3	20.3	20.6	6.0	5.7	31.1	22.4	22.7	8.7	8.4
55	22.1	16.0	16.4	6.1	5.7	26.8	17.9	18.4	8.9	8.4
60	18.2	11.9	12.6	6.3	5.6	22.6	13.6	14.5	9.0	8.1
65	14.7	8.3	9.7	6.4	5.0	18.6	9.7	11.3	6.9	7.3
70	11.7	5.4	7.8	6.3	3.9	14.9	6.3	9.1	8.6	5.8
75	9.1	3.4	6.0	5.7	3.0	11.5	3.9	7.0	7.6	4.5
80	6.9	1.7	4.0	5.2	2.9	8.5	2.0	4.6	6.5	3.9
85	5.2	.6	2.8	4.6	2.4	6.2	.7	3.3	5.5	2.9

Notes:

- \* Values obtained by constructing life tables for U.S. physicians based on their death rates for the period 1969-73. (see column 10 of Tables 4 & 5 in the Appendix.) Represent average total life of surviving physicians.
- \*\* From column 11 of Tables 4 & 5 in the appendix. Represent active working life expectancies of all surviving physicians.
- \*\*\* From column 12 of Tables 4 & 5. Represent active working life expectancies of all surviving active physicians.

TABLE 2

Working Life Expectancies, and Exit Rates for the Active Male Physicians of the United States  
A Comparison of the Results from Direct Method and Indirect Method

Age	Working Life Expectancy (Active Physicians)*		Death Rate (Active Physicians)** (deaths/1000/year)		Rates of Exits for Reasons Other than Death***	
	Direct Method	Indirect Method	Direct Method	Indirect Method	Direct Method	Indirect Method
25-29	43.8	34.1	0.66	1.70	+	+100.2
30-34	39.0	29.5	0.71	1.86	+	+25.6
35-39	34.5	24.8	1.39	2.74	-	-18.5
40-44	29.7	22.3	2.17	4.18	+	-17.6
45-49	25.0	19.6	4.27	6.73	-	-16.1
50-54	20.6	16.7	6.60	10.99	-	-21.8
55-59	16.4	14.2	11.03	17.76	-	-5.0
60-64	12.6	10.7	18.67	26.53	-	-19.6
65-69	9.7	7.7	29.19	40.22	-	-64.2
70-74	7.8	6.4	47.14	59.21	-	-75.2
75-79	6.0	5.5	69.27	88.24	-	-53.4
80-84	4.0	3.8	108.77	124.79	-	-107.6
85+	2.8	2.6	121.09	146.11	-	-242.8

Note:

\* Values are for exact age at the beginning of the interval. See column 12 of Table 1, and 4 in the Appendix.

\*\* See column 13 of Tables 1 and 4 in the Appendix.

\*\*\* See column 14 of Tables 1 and 4 in the Appendix; '+' indicating entry into; '-' indicating exit from the profession.

† Entry rates not available .



TABLE 3

Working Life Expectancies of Active Physicians in Colombia, France and United States Using Indirect Method

Age x	Colombia* 1965	France** 1968	USA*** 1971
25	30.6	33.4	34.1
30	26.0	28.6	29.5
35	21.4	23.8	24.8
40	17.4	19.4	22.3
45	14.6	15.7	19.6
50	14.5	12.9	16.7
55	12.7	10.3	14.2
60	9.8	7.9	10.7
65	6.9	8.0	7.7

Note:

\* See Col. 12 of Table 3 in the Appendix

\*\* Bui-Dang-Ha Doan. "La table de vie professionnelle in medicine (1968)." Cahiers de sociologie et de demographie medicale, Sve anne, n° 1, pp. 28-36 (January-March 1975).

\*\*\* For U.S. Male Physicians, see column 12 of Table 1 in the Appendix.

TABLE 4

RATES OF ENTRY AND EXIT OF PHYSICIANS FROM PROFESSION AND OF DEATHS PER 1000  
ACTIVE PHYSICIANS, COLOMBIA, 1965, U.S. MALES 1971

AGE	Exits/Entries per 1000 Active Physicians per year		Deaths per 1000 Active Physicians per year	
	Colombia *	U.S. Males**	Colombia *	U.S. Males**
20-24	+ 24.2	+ 77.8	3.28	1.99
25-29	+110.5	+100.2	3.31	1.70
30-34	+ 64.6	+ 25.6	3.94	1.86
35-39	- 6.5	- 18.5	4.72	2.74
40-44	- 21.4	- 17.6	5.87	4.18
45-49	- 58.7	- 16.1	7.94	6.73
50-54	- 33.8	- 21.8	12.26	10.99
55-59	- 23.2	- 5.0	15.56	17.76
60-64	- 16.7	- 19.6	28.96	26.53
65-69	- 9.7	- 64.2	36.94	40.22
70-74	-454.2***	- 75.2	69.57***	59.21
75-79		- 53.4		88.24
80-84		-107.6		124.79
85+		-242.8		146.11

Note:

\* See Columns 13 &amp; 14 of Table 3 in the Appendix

\*\* See Columns 13 &amp; 14 of Table 1 in the Appendix

\*\*\* For age group 70 and over

AppendixWorking Life Tables of Physicians; Sources of Data, Definition and Derivations of Functions:

The Working Life Tables of Physicians, in the U.S. and Columbia as discussed in the text are presented in Tables 1 through 5. For Tables 1, 2, and 3, basic material used for obtaining different indices in the tables is the age-specific professional activity rates; i.e., number of active physicians in an age group divided by the number of total persons in the same age group; and the life tables representing the current mortality situations of the respective populations.

For the U.S., (Tables 1 and 2), number of active physicians by age are obtained using data on all living physicians in 1971 taken from an article by Goodman<sup>1</sup> and the information on inactive and active status of all living physicians collected by the American Medical Association.<sup>2</sup> The life tables used are those constructed by the National Center for Health Statistics<sup>3</sup>, for the period 1969-71 for white males and females respectively. In order to compute the professional activity rate, data on population are obtained from the Demographic Yearbook, published annually by the United Nations.<sup>4</sup>

For Colombia, the number of physicians by age in 1965 was obtained from a study on Health Manpower which was jointly sponsored by Milbank Memorial Fund and the World Health Organization.<sup>5</sup> In the absence of life tables for Colombia, the representative life table came from the Model Life Tables,<sup>6</sup> chosen to match the over-all level of mortality for the male population in Colombia.<sup>7</sup> The data on the population for Colombia came from a publication, La Población de Colombia.<sup>8</sup>

Tables 4 and 5 are constructed by using available information on active and inactive status of the U.S. physicians and life tables representative of physicians' current level of mortality. For computing life tables of physicians, data on death rates of physicians for the 1969-73 period came from the

article by Goodman. The information on the active or inactive status of physicians were available on the basis of year of graduation rather than by the current age of physicians. In order to use these rates, an assumption of universal graduation at age 26 was made. By using this assumption, the data by year of graduation was transferred into the current age of physician.

Definition and derivation of functions of the Working Life Table using Table 1 for the U.S. male physicians as an illustration are as follows:

Column (1) Age Interval: The functions in Columns 3, 4, 5, 10, 11 and 12 refer to exact ages at each birthday 'x' while those in the rest of the columns refer to age interval (x to x+5).

Column (2)  $P_{n\ x}$ : Number of Active male physicians in the U.S. per 100,000 U.S. males in each age group, or the professional (physician) activity rate of the U.S. male population. This is obtained by dividing the number of active male physicians in an age group with corresponding U.S. male population in the same age group.

Column (3)  $P_x^0$ : Professional activity rate at exact age 'x', and is obtained from the  $P_{n\ x}$  values by using the Sprague's Interpolation formulas.

Column (4)  $l_x$ : The values in this column are taken from the 1969-71 life table for white males of the United States. These values refer to the number of persons starting with a cohort of 100,000 births who will survive to exact age 'x' when subjected to the 1969-71 mortality conditions of white males throughout their life time.

Column (5)  $l_x'$ : Refers to number of survivors of 100,000 male births expected to be active physicians at exact age 'x'.

$$l_x' = P_x^0 \times l_x$$

Column (6)  ${}_5L_x$ : The values in this column are also taken from the 1969-71 life table for white males of the United States. These refer to number of persons who will be alive in the successive age intervals under the assumption that 100,000 annual births are exposed, throughout their life time, to the 1969-71 mortality conditions of white males in the United States.

Column (7)  ${}_5L'_x$ : The number of males in the stationary population expected to be active physicians at each age, i.e.; stationary physician population; under the prevailing conditions of professionalization rate.

$${}_5L'_x = {}_5L_x \times {}_5P_x$$

Column (8)  $T_x$ : The total number of years of life remaining at age 'x' and in all following years for white males alive at the exact age 'x'. It is obtained as follows:

$$T_x = \sum_{x=x}^{\infty} {}_5L'_x$$

Column (9)  $T'_x$ : The total number of active years of life remaining at age 'x' and in all following years for male physicians alive at the exact age 'x'. It is expressed as:

$$T'_x = \sum_{x=x}^{\infty} {}_5L'_x$$

Column (10)  $e_x^0$ : The average number of years of life remaining at age 'x' for white males who are alive at exact age 'x'; that is,

$$e_x^0 = \frac{T_x}{l_x}$$

Column (11)  $e_{ax}^0$ : This refers to average number of active physicians years remaining for all males surviving to exact age 'x'. It is obtained as follows:

$$e_{ax}^0 = \frac{T'_x}{l_x}$$

Column (12)  $e_x^{0'}$ : This measure refers to length of active life; i.e., average remaining years of active life per physician active in the profession at age 'x'. For ages above the point at which the professional activity rate is maximum, this is obtained as follows:

$$e_x^{0'} = T_x' / l_x'$$

In the case of the U.S., the maximum professional activity rate is noted in the age group 30-35; therefore, values in the column at age 35 and beyond are obtained by using the above relationship. However, at ages below the point of maximum professional activity rate, a modification of the method, (computations not shown in Tables 1, 2, and 3), was necessary. This involved calculation of two sets of new values. The number of surviving physicians at exact age ( $l_x''$ ) and number of physicians in the stationary population ( ${}_5L_x''$ ) who would be hypothetically active if professional activity rates under age 35 were the same as the maximum rate. In obtaining values for ages under 35,  $T_x'$  values were recomputed by replacing  $L_x'$  with  $L_x''$  values and  $e_x^{0'}$  values were derived by dividing these recomputed values with the  $l_x''$ .

Column (13)  $1000d_x$ : These are the rates at which active professionals leave the profession by death. The rates are expressed per 1000 active physicians per year.<sup>9</sup>

Column (14)  $1000r_x$ : These figures are the rates per 1000 active physicians per year at which physicians are entering and leaving the profession by all causes except deaths.<sup>9</sup>

The definition and derivations of functions in Tables 4 and 5 are identical to those described above, except columns (2) and (3). In Tables 4 and 5, Column (2) refers to number of active physicians per 1000 physicians

by age; obtained by dividing the active physicians in an age group with corresponding number of total physicians in the same age group. Figures in Column 13 are obtained from Column (2) in a fashion similar to that described in Column (2) above. Figures in Columns (4) and (5) are from life tables of physicians rather than of the total population.

Footnotes to the Appendix

<sup>1</sup> Goodman, Louis J., "The Longevity and Mortality of American Physicians, 1969-1973). Milbank Memorial Fund Quarterly, Vol. 53, No. 3, Summer 1975, pp. 353-375.

<sup>2</sup> Martin, Beverly C., Medical School Alumni, American Medical Association, Aspen Systems Corp., Rockville, Md., 1975.

<sup>3</sup> U.S. Department of Health, Education and Welfare, United States Life Tables: 1969-71, Volume 1, No. 1, May 1975.

<sup>4</sup> United Nations Demographic Yearbook, published annually by the Department of Economic and Social Affairs.

<sup>5</sup> Study on Health Manpower and Medical Education in Colombia, Volume II, 1967, Sponsored by the Millbank Memorial Fund, World Health Organization, and Ministry of Public Health of Colombia.

<sup>6</sup> Coale, Ansley J. and Paul Demery, Regional Model Life Tables and Stable Populations, Princeton University Press, Princeton, New Jersey, 1966, pp. 672.

<sup>7</sup> Estimate for over-all level of mortality in Colombia is available in the Centro Latinoamérica de Demografía Boletín demográfico, Año IX, No. 18, Santiago de Chile, Julio de 1976., pp. 73.

<sup>8</sup> Asociación Colombiana para el Estudio de la Población, La Población de Colombia, C.I.C.R.E.D. series, 1974., pp. 171.

<sup>9</sup> For the method of obtaining these rates see United Nations, Methods of Analyzing Census Data on Economic Activities of the Population, Population Studies No. 43, Department of Economic and Social Affairs, New York, 1968, pp. 29-32.



WORKING LIFE TABLES FOR MALE PHYSICIANS OF THE UNITED STATES, 1971, CONSTRUCTED BY THE INDIRECT METHOD

Table 1

Age Interval (exact ages, x to x+5)	In Age Interval $\frac{p}{n} \times$	Beginning Age $x \cdot \frac{p}{n} \times$	Total * Survivors at age x of 100,000 born alive	Total * Active $\frac{q}{x} + 4x3$	Total * Stationary Population in age interval $\frac{l}{5} \times$	Total * Active Physicians $\frac{l}{5} \times$	Total * Stationary Population in ages x through $\infty$	Total * Stationary Physicians $\frac{l}{x}$	Total years * Expectation of life at age x $e_0 = \frac{e_0}{x}$	Medical Life $e_0^m = \frac{e_0^m}{9 \frac{7}{4}}$	Average Active Life for Active Physicians $e_0^a$	Deaths of Active Physicians (rate per 1000) $d$	Entry and exit from Profession (rate per 1000) $r$
1	2	3	4	5	6	7	8	9	10	11	12	13	14
20-25	9.2	0	96,480	0	480,020	44	4,845,457	24,450	50.22	.2534	38.7	1.99	+ 77.8
25-30	530.6	300.5	95,524	287	475,553	2,523	4,365,437	24,406	45.70	.2555	34.1	1.70	+100.2
30-35	768.5	684.8	94,716	649	471,472	3,623	3,889,884	21,883	41.07	.2310	29.5	1.86	+ 25.6
35-40	756.2	782.7	93,843	735	466,395	3,527	3,418,412	18,260	36.43	.1946	24.8	2.74	- 18.5
40-45	671.8	712.3	92,631	660	458,745	3,082	2,952,017	14,733	31.87	.1591	22.3	4.18	- 17.6
45-50	637.8	653.7	90,725	593	446,572	2,848	2,493,272	11,651	27.48	.1284	19.6	6.73	- 16.1
50-55	564.2	601.9	87,690	528	427,547	2,412	2,046,700	8,803	23.34	.1004	16.7	10.99	- 21.8
55-60	528.7	540.6	83,001	449	398,442	2,107	1,619,153	6,391	19.51	.007	14.2	17.76	- 5.0
60-65	516.7	527.4	75,969	401	356,831	1,844	1,220,711	4,284	16.07	.0564	10.7	26.53	- 19.6
65-70	415.1	476.0	66,343	316	302,111	1,254	863,880	2,440	13.02	.0338	7.7	40.22	- 64.2
70-75	276.7	342.1	54,138	185	236,680	655	561,769	1,186	10.38	.0219	6.4	59.21	- 75.2
75-80	213.9	239.6	40,324	97	165,221	353	325,089	531	8.06	.0132	5.5	88.24	- 53.4
80-85	146.3	183.1	25,885	47	97,233	142	159,868	178	6.18	.0069	3.8	124.79	-107.6
85-	57.8	103.1	13,527	14	62,635	36	62,635	36	4.63	.0027	2.6	146.11	-242.8**

+ For 1971

\*From the U.S. Life Tables for 1969-71

\*\*Based on the assumption that every physician retires by age 90.

TABLE 3

WORKING LIFE TABLES FOR PHYSICIANS OF COLOMBIA, 1965, CONSTRUCTED BY THE INDIRECT METHOD

Age Interval (exact ages, x to x+5)	Active Physicians per 100,000 populations +	Beginning Age $x_0$	Survivors at age x of 100,000 born alive	Total* Active $l'_x = l_x \times 4x3$	Total* Stationary Population in age interval $5L_x$	Active Physicians $5L'_x$	Total* Population through $\infty$	Stationary Physicians $T'_x$	Expectation of life at age x $e_x = \frac{e_x}{8.4}$	Medical Life $e^0_x = \frac{e^0_x}{9.4}$	Average Active Life for Active Physicians $e^1_x$	Deaths of Active Physicians (rate per 1000) $d_x$	Entry and exit from Profession (rate per 1000) $e^2_x$
1	2	3	4	5	6	7	8	9	10	11	12	13	14
20-25	1	0	82,270	0	408,003	4	3,943,468.6	3,524	47.933	.0428	35.2	3.28	24.2
25-30	63	20	80,931	16	401,335	253	3,535,466.0	3,520	43.685	.0435	30.6	3.31	110.5
30-35	145	109	79,603	87	394,163	572	3,134,131.3	3,267	39.372	.0410	26.0	3.94	64.6
35-40	162	161	78,062	126	385,964	625	2,739,968.4	2,695	35.100	.0345	21.4	4.72	6.5
40-45	146	156	76,323	119	375,980	549	2,354,004.5	2,070	30.842	.0271	17.4	5.87	21.4
45-50	128	140	74,063	104	363,067	465	1,978,024.7	1,521	26.705	.0205	14.6	7.94	58.7
50-55	88	102	71,158	73	345,797	304	1,614,957.5	1,056	22.695	.0148	14.5	12.26	33.8
55-60	88	88	67,160	59	322,287	284	1,269,161.0	752	18.898	.0112	12.7	15.56	23.2
60-65	68	77	61,755	48	290,291	197	946,874.1	468	15.333	.0076	9.8	28.96	16.7
65-70	78	72	54,362	39	247,608	193	656,582.7	271	12.078	.0050	6.9	36.94	9.7
70+	19	68	44,681	30	408,976	78	408,974.9	78	9.153	.0017	2.6	69.57	-454.2**

Notes: \* Based on Coale-Demeny-South life table for males. Life expectancy of 56.3 years. (Estimate of Expectation of life for males in Colombia for 1965 is 56.0 years).

\*\* Assumes that every physician retires by age 75.

+ Estimates for 1965.

WORKING LIFE TABLE FOR MALE PHYSICIANS OF THE UNITED STATES BY THE DIRECT METHOD, 1971

TABLE 4

Age Interval (exact ages, x to x + 5)	Active Physicians per 1000 physicians	Beginning Age* P <sub>x</sub> P <sub>x</sub>	All Physicians alive S <sub>x</sub>	Active Physicians A <sub>x</sub> = S <sub>x</sub> - P <sub>x</sub>	All Physicians Stationary Population in age interval L <sub>x</sub>	Active Physicians A <sub>x</sub> = L <sub>x</sub> - P <sub>x</sub>	All Physicians Stationary Population through ∞ T <sub>x</sub>	Active Physicians A <sub>x</sub> = T <sub>x</sub> - P <sub>x</sub>	Total years age = 8 ÷ 4 E <sub>x</sub>	Medical Life e <sub>ax</sub> = 9 ÷ 4	Average Active Life for Active Physicians e <sub>ov</sub>	Deaths of Active Physicians (rate per 1000) 1000d <sub>x</sub>	Exit from Profession (rate per 1000) 1000r <sub>x</sub>
1	2	3	4	5	6	7	8	9	10	11	12	13	14
25-30	999.6	1,000.00	95,951	95,951	478,960	477,810	4,771,559	4,199,267	49.7	43.8	43.8	0.66	- .64
30-35	992.6	996.81	95,633	95,327	477,323	473,791	4,292,599	3,721,457	44.9	38.9	39.9	0.71	- 1.67
35-40	986.7	988.5	95,296	94,200	474,838	468,523	3,815,276	3,247,666	40.0	34.1	34.5	1.39	- .02
40-45	990.3	988.4	94,639	93,541	470,633	466,068	3,340,438	2,779,143	35.3	29.4	29.7	2.17	+ .04
45-50	985.8	988.6	93,614	92,547	463,123	456,547	2,869,805	2,313,075	30.7	24.7	25.0	4.27	- 1.01
50-55	980.6	983.6	91,635	90,132	450,728	441,984	2,406,682	1,856,528	26.3	20.3	20.6	6.60	- 1.75
55-60	963.6	975.0	88,656	86,440	431,353	415,652	1,955,954	1,414,544	22.1	16.0	16.4	11.03	- 6.79
60-65	907.6	942.2	83,885	79,036	400,648	363,628	1,524,601	998,892	18.2	11.9	12.6	18.67	- 18.82
65-70	768.8	856.4	76,374	65,407	355,750	279,904	1,123,953	635,264	14.7	8.3	9.7	29.19	- 40.91
70-75	608.5	694.5	65,926	45,786	295,333	179,710	768,203	335,360	11.7	5.4	7.8	47.14	- 45.56
75-80	511.5	557.9	52,207	29,126	221,838	113,470	472,870	175,650	9.1	3.4	6.0	69.27	- 48.86
80-85	344.3	430.4	36,528	15,722	142,915	49,206	251,032	62,180	6.9	1.7	4.0	108.77	- 115.49
85+	120.0	227.1	20,638	4,687	108,117	12,974	108,117	12,974	5.2	.6	2.8	121.09	- 240.17***

Note: \*The data on activity rates pertains to both sexes combined.  
 The values for ages 70 and over are obtained by a linear extrapolation of the trend, assuming the Activity Rate at 90-95 = 0, and are adjusted to equal the actual rate of activity for ages 75 and over.  
 \*\* Assumes no physician is inactive at age 25. Values are obtained from P<sub>x</sub> in Column 2 by the use of Sprague's interpolation formulas.  
 \*\*\*Assumes every physician retires by age 90.