until his death in 1814. His grave in Auteuil is marked by an elaborate stone, kept attractive by joint contributions of the American Academy of Arts and Sciences and Harvard University.

Among Count Rumford's bequests was a considerable sum of money to Harvard College, now amounting to over $60,000. The general purpose of the gift according to the will is "to teach the utility of the physical and mathematical sciences for the improvement of the useful arts, and for the extension of the industry, prosperity, happiness, and well being of society."

The Rumford professorship of the physical and mathematical sciences as applied to the useful arts was established in 1816. Noted men have filled this chair, one being Eben N. Horsford, an industrial chemist, whose work has had a fruitful influence on the practical development of science in the United States.

Count Rumford's work as a scientist and philanthropist is commemorated not only in medals, but also in portraits and monuments. Two paintings show him as a young man, another just beyond middle life, when he was sent as ambassador to England, and two others in his later years—one by Kellerhofen and one by Rembrandt-Peale, the latter painted a short time before Count Rumford's death in Paris. There are two monuments in Munich. In front of the National Museum in Maximilianstrasse stand four bronze figures, ten feet in height; one of these is Count Rumford. This statue was erected in 1867, at the king's private expense. And in the English Garden, which Count Rumford planned and laid out, is a monument erected by grateful citizens during his absence in England in 1796. And in Woburn, Mass., there is a replica of the Munich statue.

Making an aerial survey, so to speak, of Count Rumford's work as a scientist and philanthropist, one is astounded by its extent, variety and originality. One marvels, too, that so much of his work was practical and useful, though planned by a scientific investigator and pursued in most cases solely to discover facts. One wonders, also, how he found time and strength to perform and record such a vast number of experiments. In this address much of his work has been left untouched, but enough has been considered to demonstrate that Count Rumford was a wonderful man and undeniably deserves the high place given him among the world's most famous scientists and philanthropists.

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IMPROVEMENT IN MORTALITY RATES AND EXPECTATION OF LIFE IN THE UNITED STATES FROM 1890 TO 1920[1]

THE problem of race betterment is qualitative and quantitative. We shall deal only with some of its quantitative aspects. It is one thing to be alive and in full possession of those physical and mental faculties which come with freedom from disease and favorable inherited tendencies and quite another to be substandard in vitality and ability to think and act. But when we deal quantitatively with longevity we are obliged to depend upon data which tell us only that a man is alive or dead. This dichotomy is peculiar to the population and vital statistics gathered by our Census Bureau. We can take no account of the man who is half dead—we count him as living to the same extent as the most splendid physical specimen in our broad land—he is a unit either in the census or the death register.

From this mass of raw data every ten years we construct life tables. Census statistics may be regarded as the journal entries of our bookkeeping and the life tables as the periodic balances which we strike in the ledger of life. They tell us nothing about ourselves as individuals, but reveal many interesting and important things about us as we are in the aggregate. If men are going to live and die during the next two or three decades under the same essential conditions as during the last decade, life tables enable us to predict the rate of mortality, expectation of life and numerous other things for each year of age with remarkable precision. So certain is this forecast that one of the greatest activities of modern civilization, the insurance of lives, is based on life tables and generally regarded as the most stable financially among them all.

We shall take the figures from 1890 to 1920 furnished by the Census Bureau at their face value and draw from them the best conclusions we can, whether or not they agree with what we would like them to be. They are disappointing in some respects because they lead to the conviction that we are not strongly headed towards substantial improvement in longevity if we understand by this term that most men can reasonably expect in the near future to live to be eighty years of age or over. Our life tables show that in this country since 1890 the average length of life at birth has increased at the rate of about five months per year from forty-three years to fifty-five years, or more than twelve years in all. Nor is there as yet a

[1] Address given in Battle Creek on January 3, at the meeting of the Third Race Betterment Conference.

decided diminution in the strength of this tendency towards improvement. What, then, is the cause for apprehension? An analysis of the distribution of this gain will show the weak link in the chain and reveal some very disturbing factors.

Writers and lecturers—and through them reports in the press and magazines—have fixed attention too closely upon this steady increase of the expectation of life *at birth*. They have predicted for man an average span of life of one hundred years, and even one hundred and fifty years, at a time not far away. The oft-repeated statement that we have increased the expectation of life fifteen years in the last three decades followed by the prediction that we may expect to double this gain in another quarter century is absurd, if we take all the implications of our life tables at their face value. What stands in the way of this advance?

We are all accustomed to the idea that general death-rates can not be employed to compare the standard of health and mortality in two communities unless the age distribution is the same in those communities. The expectation of life at birth is the reciprocal of the general death-rate and if one is not a good measure the other can be no better. A little consideration will also show that the expectation of life at birth taken alone is not a good measure of longevity. The age distribution of this gain must be determined. If it is all or nearly all under age fifty it can not be inferred that those who are living at ages beyond fifty are any better off than before. If the rates of mortality beyond age fifty remain the same the expectation of life at this age will not be changed and we have only nursed more people up to the age of fifty to be leveled off by the grim reaper in the same ratio as before. These rates unchanged will kill off ten million people at the age of fifty and over in the same time and proportionate incidence as ten thousand people.

Mortality rates during the last thirty years at ages beyond fifty have not shown a satisfactory decrease. In fact, in some states, for example, Michigan, the rates at these older ages have actually increased since 1901. In the original registration states the gain in the expectation of life at these ages during the first twenty years of this century has been practically nil. In Massachusetts during the thirty-year period 1890–1920 the improvement in expectation of life at age fifty-two has been less than three months. At age seventy-two the result is negative and men and women at this age in 1920 may expect on the average to live half a year less than those at the same age in 1890. The situation is more hopeful in the large cities; New York, Boston and Chicago show an improvement between one and two years in the expectation of life at age fifty-two, and it is likely that a similar condition exists in the other large cities. Apart from this there is no such decided tendency for improvement at these older ages as is shown during the first twenty years of life.

Many able writers have studied the possibilities of improvement in longevity by setting up hypothetically attainable mortality rates with a view of ascertaining the increase in expectation of life at birth. The answer has usually been between sixty and sixty-five years, a possible gain of ten to fifteen years over present average conditions. Too often these results are so promising that the author or his interpreters assume that a further lowering of mortality rates would add another fifteen years to the average lifetime at birth. But there is a limit to these possible gains. Suppose that we go to the extreme and assume that all the agencies at work are so effective that infant mortality is entirely eradicated, even more, that there are no deaths during the first twenty-two years of life. Then *if the mortality rates beyond this age are not improved* the expectation of life at birth would simply be twenty-two years plus the expectation of life at age twenty-two. This would give for the original registration states, males of 1920, an expectation at birth of sixty-five years. If no deaths should occur before age fifty-two, the expectation at

TABLE A

EXPECTED YEARS OF LIFE IN SELECTED AGE INTERVALS

Expected years of life	Males			Females		
Original Registration States						
In age interval	In 1901 Years	In 1920 Years	Gain Years	In 1901 Years	In 1920 Years	Gain Years
Birth to age 22	17.46	18.92	1.46	18.01	19.42	1.41
Age 22 to age 52	26.38	27.13	0.75	26.65	27.13	0.48
Age 52 to age 72	15.42	15.77	0.35	15.88	16.13	0.25
Age 72 to death	8.11	8.17	0.06	8.64	8.66	0.02
New York City						
In age interval	Years	Years	Years	Years	Years	Years
Birth to age 22	16.36	18.33	2.47	17.01	19.34	2.33
Age 22 to age 52	24.99	26.81	1.82	25.97	27.08	1.11
Age 52 to age 72	13.58	14.68	1.10	14.44	15.41	0.97
Age 72 to death	7.09	7.67	0.58	7.61	8.26	0.65

birth would increase to seventy-two years. This gives us some idea of the supreme importance of improving the rates of mortality beyond age fifty-two. Those who have attained this age are up against a fearful handicap and their chief hope for relief must come from those investigators who will find a way to reduce the rates of mortality at the *older* ages. He is a hopeful prophet who will predict an average age of eighty, ninety or one hundred years for those who are born now, if the cold facts are faced. There is an absolute limiting value for this expectation at any age equal to the sum of the age and the expectation of life at that age. But unfortunately the value of the latter depends almost entirely on the rates of mortality at that age and higher ages.

We shall now turn our attention to a brief study of the incidence of gains in the expectation of life at different periods of life. For example, we may well ask what gain has been made since 1890 in the *average* number of years one may expect to live between birth and age twenty-two. The application of simple actuarial formulas to our life tables enables us to answer this question. In 1890 for Massachusetts males the expectation was 16.04 years, in 1920 it was 18.81 years; thus a gain of 2.77 years was

TABLE B

COMPLETE EXPECTATION OF LIFE AT SELECTED AGES

Original Registration States

At age	Years	Years	Years	Years	Years	Years
Birth	47.88	54.05	6.17	50.70	56.41	5.71
22	40.55	42.69	2.14	42.11	43.59	1.48
52	19.35	19.91	0.56	20.43	20.79	0.36
72	8.11	8.17	0.06	8.64	8.66	0.02

New York City

At age	Years	Years	Years	Years	Years	Years
Birth	40.65	51.61	10.96	44.86	54.83	9.97
22	34.90	40.10	5.20	38.15	42.07	3.92
52	16.01	17.86	1.85	17.51	19.24	1.73
72	7.09	7.67	0.58	7.61	8.26	0.65

made for this period of life. For the age interval between age twenty-two and age fifty-two the gain was 1.57 years, between age fifty-two and seventy-two it was 0.44 years, and from age seventy-two to age at death it was – 0.40 years, in other words, a retrogression. The same type of gain is obtained from the life tables for Massachusetts females.

Similar results are exhibited by other classes of the population. The notable thing in all of them is the marked decrease in gains in the periods beyond age fifty-two. The large cities, New York, Boston and Chicago, show much better gains in these older age intervals than the other classes of the population. The explanation of the gain raises an interesting question; perhaps a large measure of this gain in the cities may be accounted for through easier access to the best hospital and medical service.

What constructive measures, then, can we formulate to meet this outstanding problem? They must be far-reaching and involve much beyond what we are doing now. We must appeal to every effective agency to make a renewed effort at this point. Investigators in biology, genetics, eugenics and bio-chemistry may discover methods for prolonging life more potent than those of the physician. When we reach a limiting point in the elimination of disease, the only one which remains is what we may call "Old Age." Most of us believe that human longevity is inherited and this may give a promising lead. In recent years students of genetics have been very active in investigating those characters which can be strengthened through inheritance. There is a question as to whether the improvement of mortality rates through a recognition of inheritance of long life should not be the starting point after medicine and all the other effective means with which we are familiar have been pushed to the absolute limit. The statesman and sociologist, the scientist in many fields, the educator and the enlightened press will all be prominent coworkers in this broader line of attack. The increase in the span of life is now the outstanding unsolved problem of the human race. Its supreme importance to man from every point of view should command the effective support of individuals and governments through scientific foundations of the broadest scope and unlimited resources.

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SCIENTIFIC EVENTS

THE DANISH OCEANOGRAPHIC EXPEDITION[1]

THE oceanographical cruise on which the *Dana* recently started will be the first round-the-world oceanographical expedition since the the return of H. M. S. *Challenger* from her famous voyage more than 50 years ago. The leader of the expedition is Dr. Johannes Schmidt, and the general direction of it is entrusted to a committee under the patronage of Prince Valdemar, with Professor C. H. Ostenfeld, a member of the board of directors of the Carlsberg Fund, as president, and Vice-Admiral C. Amdrup as vice-president. The *Dana*, fully equipped, is placed at the disposal of the expedition by the Danish government; all other expenses than those of its preliminary equipment will be borne by the Carlsberg Fund.

[1] From the London *Times*.