2 The Language and Dialect of Health Science

Public Health Schools and Their Statistical Practices

> We, first inspired by [Francis] Galton and Karl Pearson, fought this long battle without the least help from the professional mathematician and against the violent opposition of nearly the whole medical profession. Now that the battle is won, that biometry and statistics are academically respectable …[1]

In a letter supporting his American colleague Raymond Pearl's candidacy for a professorship at Harvard University, Major Greenwood, a professor of epidemiology and vital statistics at the London School of Hygiene and Tropical Medicine, who also acted as the head of the Medical Research Council's Statistical Department,[2] reminisced on the struggle to make biostatistics an academic branch of medical science. As students of Karl Pearson (1857–1936), Greenwood and Pearl represented the first generation of recognized academic researchers to use statistical analysis to explain human life, disease, and death. Their research culminated in the systematic integration of statistical methods into public health research: the only domain of medical statistics in which "the language of quantity [was] very successful," according to Theodore Porter.[3] Meanwhile, statistical thinking was struggling to become systematically integrated into medical research. Although some researchers and administrators had already begun to use descriptive statistics to exhibit and compare the vital and health conditions of populations in the nineteenth century, medical doctors – arguably up until the 1950s – still insisted, understandably, on their patients' individuality and inability to be quantified.[4]

[1] Major Greenwood, "To President A. Lawrence Lowell, University of Harvard," July 20, 1929, I/Greenwood, Major (8) 1929, Raymond Pearl Papers, American Philosophical Society.

[2] Vern Farewell and Tony Johnson, "Major Greenwood (1880–1949): A Biographical and Bibliographical Study," *Statistics in Medicine* 35, no. 5 (2016): 654.

[3] Porter, *Trust in Numbers*, 203.

[4] Desrosières, *La politique des grands nombres*, 104; Porter, *Trust in Numbers*, 203–4. For examples of statistical collection prior to Pearl and Greenwood, see, e.g.: Edward

Greenwood and Pearl's statistical practices can be traced back to the eugenicist Francis Galton (1822–1911) and his experiment on pea seeds. Galton, a cousin of Charles Darwin, based his research on observations of the size of peas; he noticed that the size of large peas would gradually revert to an average size over the course of generations.[5] He published his observations in a book, *Natural Inheritance* (1889), which is generally considered to be the origin of correlation and regression theories. Pearson translated Galton's inheritance theory into pure mathematical equations that explained variations, and devoted himself to extending the application of mathematical statistics from biological research to other disciplines.[6] Pearson established the biometric laboratory at University College London in 1911, where he trained Greenwood and Pearl, who went on to become the first professors of vital statistics on their respective sides of the Atlantic.[7]

This chapter explores the socio-historical context that served as the basis for the integration of Pearson's mathematical statistical method into public health research and its influence beyond the North Atlantic world. While Pearson's contribution to the integration of mathematical statistics into medical research is well known among historians of statistics,[8] it was unclear until now how Pearson's methods became implanted in public health schools outside of the United Kingdom, let alone how they were transferred to China. In this chapter, I show how the Johns Hopkins School of Public Health (JHSPH) and the Peking Union Medical College (PUMC) – two academic institutions that received the lion's share of funding from the Rockefeller Foundation – played an essential role in that process. The Rockefeller Foundation, looking to advance scientific research through support for a public health school, selected

Higgs, *The Information State in England: The Central Collection of Information on Citizens Since 1500* (New York: Palgrave Macmillan, 2004); Morabia, *A History of Epidemiologic Methods and Concepts*; Susser and Stein, *Eras in Epidemiology*.

5 Galton's theory was the basis for the eugenics movement that rose in prominence during the twentieth century. See: Alison Bashford and Philippa Levine, eds., *The Oxford Handbook of the History of Eugenics* (Oxford: Oxford University Press, 2010).

6 See, e.g.: Porter, *The Rise of Statistical Thinking*, 286–97; Theodore M. Porter, *Karl Pearson: The Scientific Life in a Statistical Age* (Princeton, NJ: Princeton University Press, 2004).

7 The two men's titles, however, were not identical. Greenwood's official title at University College London was "Professor of Epidemiology and Vital Statistics," whereas Pearl's was "Professor of Biometry and Vital Statistics." The difference is indicative of the unstable boundary between disciplines at that time when it came to research that used statistics to explain trends in lives, diseases, and deaths.

8 See, e.g.: Eileen Magnello, "The Introduction of Mathematical Statistics into Medical Research: The Roles of Karl Pearson, Major Greenwood and Austin Bradford Hill," in *The Road to* Medical *Statistics*, eds. Eileen Magnello and Anne Hardy (Amsterdam; New York: Rodopi, 2002), 95.

the Johns Hopkins University project led by William Welch.[9] Welch's proposal included a statistics department, which was put under Pearl's leadership in 1917. As the JHSPH was also responsible for training American and foreign public health workers of all grades, the school's statistical practices eventually spread across national borders. As early as the interwar years, some JHSPH alumni later became leading statisticians in their home institutions or at the League of Nations Health Organization (LNHO); some were later recruited by the World Health Organization (WHO) after World War II.

The JHSPH had the resources to spread its statistical practices to public health research institutions in other countries; the PUMC was where those practices were adapted through local innovations. The founder of the PUMC Department of Hygiene and Public Health, John B. Grant (a JHSPH alumnus) and his collaborators played a central role in that process. Not only did they design the Chinese version of the International List of Causes of Death (ICD) and a statistical reporting system for part of Beijing, Grant also trained a group of Chinese experts, including the first Chinese health statistician, Yuan Yijin (Yüan I-Chin), whose work made statistical practices part of public health research in China.

The way statistics were used at the JHSPH can thus be considered the basis for a formal language of statistics, whereas the method employed at the PUMC amounted to developing a local dialect of that language. Experts at the JHSPH did not design a method specific to the Baltimore setting: they conceived of statistics as a universal medium for expressing public health phenomena. In Beijing, on the other hand, the goal was to adapt the "language" of statistical collection to fit the needs and capacities of China.

Through the lens of statistical practices, this chapter touches upon the more general question of how conceptions of the role of statistics in public health science differed between the JHSPH and the PUMC. Though both received Rockefeller money aimed at setting the standard for health research, faculty at the two schools organized their statistical research and training differently. At the JHSPH, Pearl prioritized using biological research to advance statistical theory, and his colleagues Lowell J. Reed and Wade Frost used stochastic simulation to reveal the shared features of epidemics. Grant's conception of health research at the PUMC, however, differed from that of his teachers at the JHSPH. Grant's ambition was to adapt scientific knowledge to the Chinese context by using statistical collection in experiments to develop public health programs that

[9] Elizabeth Fee, *Disease and Discovery: A History of the Johns Hopkins School of Hygiene and Public Health, 1916–1939* (Baltimore, MD: Johns Hopkins University Press, 1987), 51–6.

were suitable for China. Upon taking the helm of the department, Grant designed a public health demonstration area where his students could conduct research and be trained in public health administrative procedures, including statistics collection. In that sense, the PUMC was more advanced than the JHSPH, as the PUMC's demonstration area – the Peking First Health Station (PFHS), also known as the Peiping Health Demonstration Station[10] – began its activities in 1925, seven years before the JHSPH set up its Baltimore health demonstration.

Statistics: Bookkeeping or Scientific Research?

When the Rockefeller Foundation decided to fund an American public health school in 1914, none of its officers had the faintest idea how it should be organized. There were very few such schools in existence, and each had a very different curriculum: some (such as the University of Columbia) were focused on the social and political aspects of public health work, whereas others (including Johns Hopkins) included public health courses within their medical school's curriculum. Meanwhile, the need for trained public health workers had increased as the number of county health units in the US grew from just one, in 1908, to 33 in 1918 (Figure 2.1).

There was also a lack of consensus on statistical practices for public health. Until the 1910s, statistical work in local health offices was considered clerical work that did not require medical or public health knowledge. In county health units across the US, officers who oversaw the compilation of birth and death numbers were variously referred to as "vital statisticians," "health statisticians," "medical statisticians," or even "statistical clerks," with no standardized title or responsibilities apart from amassing numbers concerning births and deaths.[11] Statistical practices were beginning to emerge within public health organizations, but only sporadically.

Despite the lack of a unified title and job description, there was a recognized need for someone to be responsible for calculating numbers in health services. In 1914, during a conference organized by the Rockefeller Foundation's General Education Board to study the need for a new public health school, the New York State Commissioner of

[10] In Chinese: 北平市衛生局第一衛生區事務所, *Beipingshi weishengju diyi weisheng qu shiwusuo*.

[11] Thomas Parran and Livingston Ferrand, "Report to the Rockefeller Foundation on the Education of Public Health Personnel," October 28, 1939, 9, RF/1.1/200/185/2222, Rockefeller Archive Center.

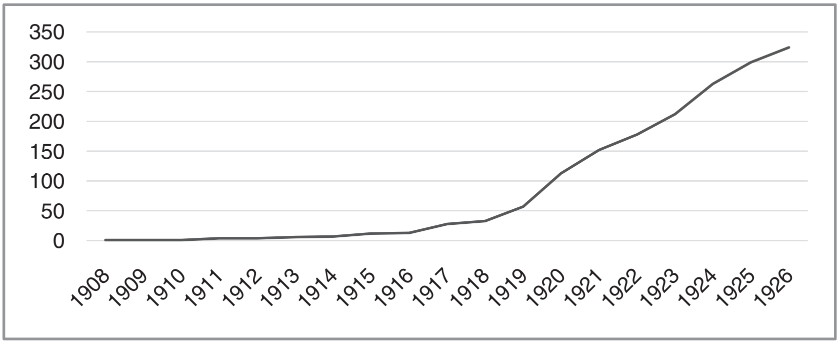

Figure 2.1 Growth in the number of full-time county health organizations (1908–1926).
Note: This figure shows the number of organizations at the close of each year that had been in continuous operation from the date of their opening. Adapted from International Health Board, "Growth in the Number of Full-Time County Health Organisations," n.d., Field Staff/IHB Documents of Record Vol.XI/IHB DR 957, Rockefeller Archive Center. Courtesy of Rockefeller Archive Center.

Health, Hermann Biggs, stated that medical statisticians were "one of the great needs … of public health service in this country."[12] Biggs gave the conference participants a vivid account of his own experience recruiting a health statistician for his department, concluding that "[t]here are no men, or practically no men, who have had experiences and demonstrated ability in this line, and it is a very, very urgent need."[13] Biggs' words carried considerable weight, as he was a renowned expert who had been involved in public health work in New York since the 1890s.[14] His remarks during the conference were clearly taken seriously: in subsequent plans for the new school – though the priority shifted back and forth several times between science and practical training – a statistical department was always included.

The 1914 conference reached the conclusion that the Rockefeller Foundation should fund a new public health school that would undertake both scientific research and practical training. Wickliffe Rose, then the director of the Rockefeller Foundation's International Health Commission, called for the school to be "an institution of [the] highest

[12] Rockefeller Foundation, "Conference on Training for Public Health Service by Rockefeller Foundation – Committee on Institute of Hygiene," October 16, 1914, 5, RF/1.1/200/184/2214, Rockefeller Archive Center.
[13] Ibid.
[14] Duffy, *The Sanitarians*, 195.

standard, scientific in character, and not neglecting the training for practical service, and further, for it to be scientific in character."[15] Rose thus stressed that among the school's dual missions, science and practical training, science should be the prime standard, and the practical training should itself be scientific.

Discussions on how to set up the statistics department within the new school reveal the tension between science and practical training. The school's two designers, Rose and Welch, did not have the same ideas when it came to statistical practices in public health. Rose, who had led the Rockefeller Foundation's hookworm control campaign in the American South, thought the JHSPH should have a medical statistics department devoted to training public health officers in the methods of organizing statistical collection and analysis within local health units.[16] Rose's administrative experience made him see statistical work in public health as based solely on collecting the number of births, disease cases, and deaths, which was the most common responsibility of statisticians at the time. But Welch, a pathologist by training, paid greater attention to the use of statistical methods in scientific research. He wanted to extend statistical practices in public health to applications in research, probably owing to his training in bacteriological laboratory methods. In his draft design for the school, Welch proposed that "while the various questions connected with the collection and study of vital statistics constitute the most important subject in this field, there are other important applications of statistical science to hygiene."[17] Welch thus advocated that the statistical division should not limit itself to collecting and analyzing vital statistics.

The success of Welch's proposal over Rose's was probably owing to chance. As Elizabeth Fee has documented, Rose only wanted Welch to add comments to Rose's draft for the school, but instead, Welch presented his own draft. Because Welch submitted his draft at the last minute, Rose did not have time to review it before it was presented to, and accepted by, the General Education Board with the title "The Rose–Welch Report."[18] Even though Rose's emphasis on basic statistical training was left out, the JHSPH statistics department did end up providing such training from the beginning.

[15] Rockefeller Foundation, "Conference on Training for Public Health Service by Rockefeller Foundation – Committee on Institute of Hygiene," 71–2.

[16] Wickliffe Rose, "School of Public Health," 1916, 4–5, RF/1.1/200/184/2216, Rockefeller Archive Center.

[17] William H. Welch, "Institute of Hygiene," 1915, 12, RF/1.1/200/184/2216, Rockefeller Archive Center.

[18] Fee, *Disease and Discovery*, 40.

Following the acceptance of his proposal, Welch recruited Raymond Pearl as the first director of the statistics department in 1917. Welch's choice was in line with his idea that the department should not focus solely on collecting and analyzing vital statistics. An intellectual descendant of Galton and Pearson, Pearl – who had also been the first chief of the statistical division of the newly established United States Food Administration – was first and foremost a biologist, and had calculated statistical data using logistic curves to demonstrate regularities in heredity.[19] Pearl's research reputation was already established prior to his contact with Welch: after an apprenticeship in Pearson's biometric laboratory in London, he had conducted research into the genetics of domestic animals at the Maine Agricultural Experiment Station and, later, during his service in the Food Administration, had published on food supply and economics in the United States.[20] Pearl's profile as a researcher rather than an administrator made him the ideal candidate for Welch, who gave Pearl full responsibility for organizing the statistics department.

Of Mice and Fieldwork: A Changing Plan for the JHSPH Statistics Department

The invitation to head a statistics department gave Pearl a great opportunity to conduct biological research, his main interest. Following Pearson's tradition, Pearl added "biometry" to the name of the department, and set his own title as "Professor of Biometry and Vital Statistics."[21] By including both the terms "biometry" and "vital statistics" in his title, Pearl revealed the dual aim of his new department: to conduct biological research based on numerical analysis, and to offer training to administrative statisticians, who mostly dealt with vital statistics collection.

Pearl's design for the department was very much oriented toward biological research. The four research projects he chose for the department were all on topics related to biology: alcoholism and heredity; natural selection in humans (including selective death rates and racial effects); heredity as a factor in lifespan and morbidity; and inbreeding in humans.[22] Pearl took an experimentalist approach and set up a mouse

19 Herbert S. Jennings, "*Biographical Memoir of Raymond Pearl (1879–1940),*" *National Academy of Sciences of the United States of America Biographical Memoirs Vol. XXII* (Washington, DC: National Academy of Sciences, 1942), 298.

20 Ibid., 298.

21 Raymond Pearl, "To William Howell," December 31, 1917, JHUSH O.D.Ja National Research Council School of Hygiene 1917–1921/3/a/5/Pearl, R./Dec 1917–July 1920, Johns Hopkins Medical Archives.

22 Raymond Pearl, "To Major Greenwood," October 17, 1923, Greenwood, Major (2) 1923/i, Raymond Pearl Papers, American Philosophical Society.

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colony to conduct biological research on lifespans. He attached great value to laboratory experiments, believing that a well-designed experiment could reveal the statistical regularities governing all human life.[23] Considering the experimental statistical investigation on the life duration of the mouse "an important feature" of the department, Pearl budgeted for a mouse colony.[24] Although the mouse colony was destroyed in a fire, Pearl still managed to publish *The Biology of Death* (1922), in which he presented a comprehensive discussion on longevity and causes of death based on his work on the colony.

The JHSPH statistics department also conducted mathematical research. Pearl hired Lowell J. Reed, a former assistant professor of mathematics at the University of Maine and director of the Bureau of Tabulation and Statistics at the War Trade Board, to be the department's mathematician.[25] With Reed, Pearl tackled biological questions and mathematical theories by analyzing quantified data in the biological and medical fields. For example, the pair studied patterns of population growth using US census records and conducted an experiment using fruit flies that involved putting the flies in an isolated container and observing changes in their numbers over time; they also used hospital records to study genetic factors behind the morbidity and mortality of tuberculosis patients.[26]

Pearl focused most of his efforts on devising logistic curves to represent regularities in population growth and decline.[27] His methodological presupposition of longevity as a natural law was in total opposition to that of public health workers, who believed that lifespans could be extended through public health interventions. George Whipple's review of *The Biology of Death* sheds light on the disagreement between Pearl and public health experts. As Whipple, a distinguished medical doctor and future Nobel Prize winner, wrote: "health officers will find in it

[23] Ibid.
[24] Raymond Pearl, "Immediate Requirements of the Department of Biometry and Vital Statistics," 1919, 2, JHUSH O.D.Ja National Research Council School of Hygiene 1917–1921/3/a/5/Pearl, R./Dec 1917–July 1920, Johns Hopkins Medical Archives.
[25] Johns Hopkins School of Hygiene and Public Health, "Catalogue and Announcement of the School of Public Health, 1919–1920," 1919, 9, The Johns Hopkins University/School of Hygiene and Public Health/Catalogue and Announcement for 1919–1920 (published in 1919), Johns Hopkins Medical Archives.
[26] The American Journal of Hygiene, *The School of Hygiene and Public Health of the Johns Hopkins University*, The American Journal of Hygiene Monographic Series 6 (Baltimore, MD: The American Journal of Hygiene, 1926), 24–5.
[27] On Pearl's contributions to the field of eugenics and population control, see, e.g.: Edmund Ramsden, "Carving up Population Science Eugenics, Demography and the Controversy over the 'Biological Law' of Population Growth," *Social Studies of Science* 32, no. 5–6 (2002): 857–99.

much to criticize, little to commend, and nothing to inspire."[28] Indeed, in contrast to most of his colleagues at the JHSPH, Pearl's priority was to discover statistical regularities within the vital conditions of populations (such as longevity, the duration of diseases, and reproductive behavior); he considered improving health and extending longevity to be secondary concerns. Tellingly, Pearl and Reed's most famous co-authored article is on population growth. In it, the two authors contend that their only purpose was "to demonstrate … the hypothesis here advanced as to the law of population growth, [so] as to make it potentially profitable to continue the mathematical development and refinement of this hypothesis further."[29] The article exemplifies Pearl's priorities when it came to statistical modeling: Pearl and Reed used census records beginning in 1790 to construct a model of US population growth, and concluded that, according to the curve, the population would stop growing once it reached 197 million. (That prediction was proved false when the US population surpassed 197 million in the 1970s.)

Despite his focus on biological research, Pearl did not neglect the mission that Welch and Howell had entrusted to him: training public health workers in statistical skills. Indeed, Pearl set the standard higher than his contemporaries in health administrations. He regarded the ability to compile vital statistics as a basic skill and an insufficient measure of a statistician's competence. Pearl and Greenwood leveled biting criticisms at some well-known statisticians working in public health administration at the time. One striking example is that of Haven Emerson, then representing the American Public Health Association (APHA) in the revision process for the ICD organized by the LNHO. Pearl wrote: "How comes it that Haven Emerson is a member of the International Statistical show? He is no statistician."[30] In a similar vein, Pearl and Greenwood also privately criticized Edgar Sydenstricker, the first statistician at the USPHS and the LNHO, and Otto R. Eichel, of the New York State health department, on the grounds that they were statistically incompetent.[31]

[28] George C. Whipple, Review of *The Biology of Death* by Raymond Pearl, *Journal of the American Statistical Association* 18, no. 143 (1923): 926.

[29] Raymond Pearl and Lowell J. Reed, "On the Rate of Growth of the Population of the United States since 1790 and its Mathematical Representation," *Proceedings of the National Academy of Sciences of the United States of America* 6, no. 6 (1920): 287.

[30] Raymond Pearl, "To Major Greenwood," May 2, 1929, I/Greenwood, Major (8) 1929, Raymond Pearl Papers, American Philosophical Society.

[31] For example, Pearl once wrote to Greenwood that "Sydenstricker is a good fellow, ... and he is, at the best, at least second or thrid rate so far as statistics is concerned." (Raymond Pearl, "To Major Greenwood," September 17, 1923, Greenwood, Major (2) 1923/i, Raymond Pearl Papers, American Philosophical Society.)

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According to Pearl, students specializing in statistics should acquire knowledge in various domains related to public health work. Citing the way health statisticians were trained in Britain (where he himself had been trained), he devised a curriculum that included biology, statistics, medical geography, the natural history of disease, hygiene, and anthropometry.[32] In his plan for the department, Pearl set forth what he thought it meant to be a good biostatistician, which involved mastering

> much more than the customary and traditional official statistics of morbidity and mortality. … [T]he successful leader and practitioner of hygiene and public health in the not distant future must be a man who has been taught to think and reason about every phase of his work quantitatively. The truth that no figure means anything whatever till we know its probably [sic] error must be so ingrained in the mind of every public health worker that it colors every thought or plan that he makes about his work, and lies behind every administrative action he takes.[33]

The quotation captures Pearl's emphasis on integrating mathematical statistics into public health work. Put simply, Pearl considered the theory of errors – a branch of mathematical statistics devoted to forming inferences about a population based on selected samples by estimating the sampling error – to be essential to gauging the real situation. In this sense, Pearl believed statisticians should play a leading role in public health campaigns, as they would design the campaigns in such a way that their effectiveness could be estimated through mathematical statistics. When the Rockefeller Foundation's International Health Board (IHB) asked Pearl to assess its malaria control campaigns in Mississippi, Pearl wrote that, due to the lack of training in quantitative methods, a "vast sums of money are now being virtually wasted in public health work."[34] He further added that because the IHB did not have an overall plan for its malaria control activities, the report based on its fieldwork could not be considered scientific.[35]

Over the following years, Pearl lectured on the general principles of statistics and prepared an outline for laboratory work in which he enumerated the principles of computation and geographical representation.[36] He also offered a workshop entitled "Statistical Clinics" in which

[32] Raymond Pearl, "Plans for the Development of the Department of Biometry and Vital Statistics," 1918, 1, Welch Papers/Papers and Documents of School of Hygiene/Plan for the Development of the Department of Biometry and Vital statistics/100/15, Johns Hopkins Medical Archives.

[33] Ibid.

[34] Ibid.

[35] Ibid.

[36] Raymond Pearl, "Laboratory Outline for Department of Biometry and Vital Statistics," 1920, Welch Papers/Papers and Documents of School of Hygiene/Laboratory Outline for Department of Biometry and Vital Statistics/100/14/1920, Johns Hopkins Medical Archives.

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Figure 2.2 Student laboratory at the Department of Biometry and Vital Statistics.
The American Journal of Hygiene, *The School of Hygiene and Public Health of the Johns Hopkins University*, The American Journal of Hygiene Monographic Series 6 (Baltimore, MD: The American Journal of Hygiene, 1926), 23. Courtesy of Rockefeller Archive Center.

he shared his experiences as a biostatistician with students and prepared them for possible difficulties in recording statistics, especially in hospitals and civil administrations.[37] In 1919, Pearl hired Sylvia Louise Parker, who had worked with him at the Maine Agricultural Experiment Station, to take on teaching responsibilities alongside Reed and himself.[38] Reed and Parker led laboratory sessions during which students were taught to use tabulating machines. The biostatistics department provided first-class teaching equipment; in 1926, every student had his or her own adding machine in the laboratory (Figure 2.2).[39] The statistics courses were quite successful. In a report to the Rockefeller Foundation,

[37] Raymond Pearl, "Statistical Clinics," 1922, Welch Papers Corres/ Pearl, R./41/27/Jan 1922–June 1922, Johns Hopkins Medical Archives.
[38] Johns Hopkins School of Hygiene and Public Health, "Catalogue and Announcement of the School of Public Health, 1919–1920," 9, Welch Medical Library, Johns Hopkins University & Medicine.
[39] The American Journal of Hygiene, *The School of Hygiene and Public Health of the Johns Hopkins University*.

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John Schapiro called the course of Statistics I "excellent" and "of prime importance for successful health officers."[40]

The department's policy changed in 1925, when Pearl left to establish the Institute of Biological Research, also at Johns Hopkins, with Rockefeller funding. The biological research elements of the department moved with Pearl, as his new institute provided lectures on biology and biological research. At the new institute, Pearl continued to use the curve-fitting method to study population growth and became a key figure in international population-control circles. In his opening speech to the 1927 World Population Conference in Geneva, Switzerland, Pearl presented an experiment he had conducted based on observations of flies in which he had concluded that the flies' rate of reproduction adjusted according to the space and resources available. Pearl then drew a parallel with human reproduction, framing the population growth issue as a question of economy and concluding that it was important to balance population growth with national production.[41]

Reed took over Pearl's professorship in the biostatistics department. Over the following decades, Reed focused on developing statistical methods for epidemiological studies. He changed the department's name to "Statistics Department," dropping "Biometry" and "Vital Statistics." The statistical practices taught in the department also shifted: Pearl's experiments had been aimed at discovering statistical laws through biology, whereas Reed used statistical models to define or explain a phenomenon related to a given population's health conditions. The changes Reed made to the department can be explained in part by his collaboration with Wade Frost, a former USPHS staff member and the director of the JHSPH's epidemiology department since 1919. Welch had originally recruited Frost to teach public health administration and fieldwork methods. Since 1925, Reed and Frost had worked together, using mathematical formulae to explain the life cycle of epidemics and the results of public health fieldwork.

The Great Depression left its mark on Reed and Frost's statistical work, as it substantially decreased the endowment revenue upon which the JHSPH had relied since its founding and forced the school to compete with other public health schools for public funding.[42] The JHSPH also had to meet the government's pressing need for community health workers to work with the ever-growing number of people driven into poverty.

40 John Schapiro, "Memorandum: School of Hygiene and Public Health, Baltimore," June 14, 1922, RF/1.1/200/186/2231, Rockefeller Archive Center.
41 Murphy, *The Economization of Life*, 3.
42 Karen Kruse Thomas, *Health and Humanity: A History of the Johns Hopkins Bloomberg School of Public Health, 1935–1985* (Baltimore, MD: Johns Hopkins University Press, 2016), 15–16.

In 1932, in collaboration with the Baltimore City Health Department, the JHSPH launched the Eastern Health District, a public health system serving 60,000 inhabitants.[43] Reed and Frost's departments were put in charge of conducting census surveys and field investigations in the District, in partnership with the US Census Bureau and the USPHS, to collect birth, death, and morbidity statistics.[44] The statistical practices of the JHSPH were thus closely connected to public health fieldwork of all sorts. For example, Reed and Frost were also associated with the center for syphilis research at Johns Hopkins. This center combined clinical and laboratory work with fieldwork in the Eastern Health District and later became the leading institute in syphilis studies and education.[45]

Classes in the biostatistics department under Reed's directorship continued to cover both the administration and research aspects of statistics. The courses can be loosely divided into five categories: vital statistics registration; mathematics of rates and probability; trends and forecasting raw materials; hospital statistical registration; and epidemiological research.[46] The core curriculum remained identical under Reed, with some minor additions to the elective courses on offer: Statistical Analysis of Small Samples (1938–1940); Genetics (1942–1943, 1946–1947); Dynamics of Population Growth (1944–1946); and Statistical Methods for Laboratory Research (1951–1952).[47]

[43] Johns Hopkins School of Hygiene and Public Health, "The Johns Hopkins University School of Hygiene and Public Health Announcements for 1934–1935," 1934, 12, Welch Medical Library, Johns Hopkins University & Medicine.

[44] Ibid.

[45] Parran and Ferrand, "Report to the Rockefeller Foundation on the Education of Public Health Personnel"; Thomas, *Health and Humanity*, 38–9.

[46] Johns Hopkins School of Hygiene and Public Health, "The Johns Hopkins University School of Hygiene and Public Health Announcements for 1934–1935," 28–9, Welch Medical Library, Johns Hopkins University & Medicine.

[47] Johns Hopkins School of Hygiene and Public Health, "The Johns Hopkins University Circular: School of Hygiene and Public Health Catalogue Number 1938–1939," 1938, 32, Welch Medical Library, Johns Hopkins University & Medicine; "The Johns Hopkins University Circular: School of Hygiene and Public Health Catalogue Number 1939–1940," 1939, 33, Welch Medical Library, Johns Hopkins University & Medicine; "The Johns Hopkins University Circular: School of Hygiene and Public Health Catalogue Number 1942–43," 1942, 36, Welch Medical Library, Johns Hopkins University & Medicine; "The Johns Hopkins University Circular: School of Hygiene and Public Health Catalogue Number 1946–1947," 1946, 31, Welch Medical Library, Johns Hopkins University & Medicine; "The Johns Hopkins University Circular: School of Hygiene and Public Health Catalogue Number 1944–1945," 1944, 32, Welch Medical Library, Johns Hopkins University & Medicine; "The Johns Hopkins University Circular: School of Hygiene and Public Health Catalogue Number 1945–1946," 1945, 31, Welch Medical Library, Johns Hopkins University & Medicine; "The Johns Hopkins University: School of Hygiene and Public Health Catalogue Number 1951–1952," 1951, 47, Welch Medical Library, Johns Hopkins University & Medicine.

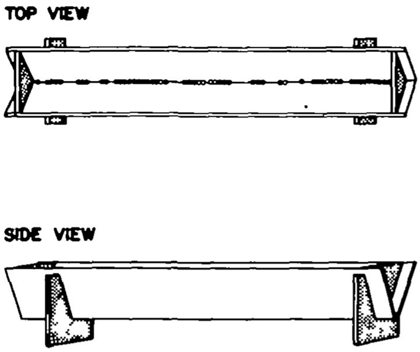

Figure 2.3 Wooden trough representing an isolated community in the Reed–Frost model.
Paul E. M. Fine, "A Commentary on the Mechanical Analogue to the Reed-Frost Epidemic Model," *American Journal of Epidemiology*, 1977, vol. 106, no. 2, 91, by permission of Oxford University Press/ Society for Epidemiologic Research.

The biostatistics department also provided courses co-taught by the epidemiology department. In fact, one of the most important models for explaining the cycle of an epidemic began as one of Reed and Frost's teaching aids. In 1930, the two men designed an analogue mechanical device to serve as "a stochastic simulation of epidemiologic phenomena with non-biological material."[48] The device, later known as the Reed–Frost model, simulates the life cycle of an epidemic within an isolated community. The model (see Figure 2.3) consists of a wooden trough representing an isolated community and balls of different colors representing inhabitants of different immunity status (case, susceptible, immune, and contact neutralizer). By pouring balls randomly into the trough and recording their changes in status (e.g. a susceptible placed next to a case would become a case, whereas a case would become immune no matter what it was placed next to), the model showed students how the number of cases might change over the course of an epidemic.[49] The Reed–Frost model combines the probabilistic tradition of using a container full of different colored balls with epidemiological knowledge about disease transmission and immunity after epidemics. It is also representative of Reed and Frost's statistical practices: instead of conducting biological experiments using mice or flies to construct statistical regularities, as

[48] Paul E. M. Fine, "A Commentary on the Mechanical Analogue to the Reed-Frost Epidemic Model," *American Journal of Epidemiology* 106, no. 2 (1977): 88.
[49] Ibid., 91.

Pearl had done, their work used statistical theory to simulate epidemiological events.

Because the JHSPH's diverse student body included public health officers and researchers from foreign countries, Reed and Frost's teaching aid and their statistical practices became well known in public health schools both in the United States and abroad, despite the fact that the two men never published on their trough-based model.[50] In their 1939 report to the Rockefeller Foundation, public health experts Thomas Parran and Livingston Ferrand praised Reed and Frost's work as "the greatest contribution of Johns Hopkins," because it had made epidemiology the "integrating factor" that united several public health disciplines.[51] As Karen Kruse Thomas has illustrated, the duo's statistical method remained influential during World War II and the postwar years. During the war, the biostatistics department became the JHSPH's major source of financing. Reed, along with Margaret Merrell (who earned her ScD degree from the department in 1930 and was immediately hired as a faculty member), had supervised the research design for penicillin trials and provided statistical expertise to the USPHS and the United States Army Surgeon General during the war.[52] When the war came to an end, the department's influence was visible through its network of alumni, many of whom occupied important positions within the WHO, thus pioneering public health statistical practices across the world.

Biostatistics Graduates Bring Mathematical Statistics to Public Health Organizations

The JHSPH became an internationally recognized institution not only thanks to the Rockefeller Foundation's generous financial contribution, but also because of the Foundation's policy of sending public health officers to Baltimore for short- and long-term training. From the outset, the school was in charge of organizing four-week courses for health officers in the United States.[53] Officers from American health administrations with different job titles – including "statistician-accountant," and "registrar" – traveled to Johns Hopkins to receive

[50] Fine, "A Commentary on the Mechanical Analogue to the Reed-Frost Epidemic Model," 97.

[51] Parran and Ferrand, "Report to the Rockefeller Foundation on the Education of Public Health Personnel," 64.

[52] Thomas, *Health and Humanity*, 44.

[53] Raymond Pearl, "Laboratory Work in Vital Statistics for Intensive Course for Health Officers," 1920, JHUSH O.D. Corres Gaertner-Int 1917-1921/3/a/3/Int./nov. 8-dec. 8 1920, Johns Hopkins Medical Archives.

statistical training.[54] In 1935, the introduction of the Social Security Act set minimum hiring criteria for American public health officers, which led to even more of them being trained at the JHSPH.[55]

From the beginning, the school organized special courses for foreign fellows selected by the Rockefeller Foundation. This mechanism proved to be quite influential. Most statistical fellows would go on to hold important positions in international organizations or research institutes in their home countries. For instance, Spanish statistician Marcelino Pascua went to work for the LNHO after the Spanish health administration failed to offer him a position in 1927. He later worked for the WHO during its early years.[56] Chidambara Chandrasekaran, from India, was recruited by the Population Division within the Social Affairs Section of the United Nations in 1950 directly after his training.[57] The JHSPH also admitted Rockefeller Foundation officers who were pursuing studies in public health, including Fred Soper, an authority on malaria control programs, who led the Pan American Health Organization from 1947 to 1959, and Frederick Russell, the director of the Rockefeller Foundation's International Health Division (formerly the IHB, the name having changed in 1927) during the interwar years.[58] This diverse and impressive student body developed into an international network of public health and statistical experts. Occupying high-level positions in international organizations and national health authorities, these Johns Hopkins alumni formed a chain that linked different health organizations together, enabling them to communicate with one another in a standardized statistical language.

If, to use Theodore Porter's term, quantification is a technology of distance,[59] the making of that distance – abstracting reality into numbers – was never straightforward. The actors who oversaw the fitting of realities into numbers encountered resistance from other experts who had experienced the true situation on the ground. The latter competed with statistical experts for authority when it came to interpreting the numbers, and, as we will see, the statistical experts did not always win. The stories of Persis Putnam and Yves Biraud (also known as Yves-Marie Biraud) are a case in point. These two statisticians, both trained

[54] Parran and Ferrand, "Report to the Rockefeller Foundation on the Education of Public Health Personnel," 9.
[55] Thomas, *Health and Humanity*, 16.
[56] "Fellowship Card: Marcelino Pascua," n.d., RG10.2, Rockefeller Archive Center.
[57] "Fellowship Card: Chidambara Chandrasekaran," n.d., RG10.2, Rockefeller Archive Center.
[58] Fee, *Disease and Discovery*, 79.
[59] Porter, *Trust in Numbers*, ix.

in the JHSPH statistics department in the early 1920s, had to compete with other experts for the authority to interpret data. By the mid-1920s, Putnam was the statistician at the IHB/IHD and Biraud at the LNHO. Their interactions with their non-statistician colleagues are illustrative of the distance separating mathematical statistics from policy-making within the international health organizations in the 1920s.

Putnam joined the IHB in New York following her graduation from the JHSPH biostatistics department with a dissertation entitled "Sexual differences in pulmonary tuberculosis," completed under Reed's direction.[60] She then served as the first and only statistician at the IHB/IHD from 1927 until her retirement in 1948. She was responsible for analyzing reports using statistical methods and invalidated several officers' field reports on malaria control campaigns using Pearson's chi-squared test of significance, a method for gauging possible sampling errors. For example, when reviewing Lewis Hackett's report on a malaria control campaign that involved spraying Paris Green in Italy, Putnam showed that the difference in malaria prevalence rates between the campaign area and other areas was probably due to sampling errors. She further remarked that, owing to the lack of historical records on malaria prevalence rates in the unsprayed areas, the usefulness of the campaign had yet to be demonstrated.[61] She concluded her report by suggesting the establishment of a control group by collecting data from areas in Italy where no malaria program had been implemented. In making this suggestion, Putnam applied mathematical statistical reasoning to an IHB/IHD public health campaign.

As John Farley has chronicled, Putnam's doubts were eventually assuaged as Hackett continued to accumulate data and incorporated control areas into his malaria fieldwork in Sardinia.[62] Hackett and Putnam subsequently co-authored articles on malaria control programs in Italy. However, they continued to face the problem of lack of control data, as inhabitants of the control areas complained, leading the IHD to eventually implement measures in those areas as well.[63]

Putnam's analysis translated fieldwork data into organized scientific language and presented a vision of reality that was independent of the perceptions of officers in the field. This sometimes led to conflict.[64]

[60] "Biofile of Persis Putnam," n.d., Room102/Unit 117/Shelf 4/Box5, Rockefeller Archive Center.

[61] Persis Putnam, "Malaria in Italy: A Statistical Review of Dr. Hackett's Reports," 1927, RG1.1/751/7/81, Rockefeller Archive Center.

[62] Farley, *To Cast Out Disease*, 120.

[63] Ibid., 121–2.

[64] Ibid., 112.

Though Putnam influenced fieldwork methods by encouraging the use of control areas, it remains questionable how much weight her analysis really carried in determining overall disease control measures at the IHB/IHD. Nothing in the archives indicates any changes being made after Putnam invalidated the results of field reports. For example, the IHD carried on with its Paris Green spraying campaign in Italy even after Putnam had pointed out that there was no direct correlation between the drop in the malaria prevalence rate and the spraying.[65] Putnam's work with the IHB/IHD suggests that, although she was given the position of statistician and put in charge of conducting statistical analysis, the power of statistical analysis did not prevail over other considerations.

Yves Biraud, another alumnus of the JHSPH biostatistics department, was a statistical consultant who used mathematical statistics to evaluate a Bacillus Calmette–Guérin (BCG) vaccination experiment in Algeria at the request of the LNHO. As Clifford Rosenberg has documented, Biraud's role was to examine the data collection procedure and carry out a statistical analysis to determine the efficacy of the BCG vaccine.[66] Just as Putnam had observed of Hackett's work, Biraud found that the rule of mathematical statistics invalidated the observations of the experts who had undertaken the campaign. The vaccine's inventor, Camille Guérin, was displeased, as Biraud disqualified the experiment for not being randomly sampled and for lacking a control group. Just as Hackett had done in Italy, Guérin was forced to adjust his fieldwork into a randomized experiment, following which the LNHO's committee of statisticians – led by Biraud – approved the vaccine.[67] The BCG review launched Biraud's career within the international health organizations. He was later enlisted by the LNHO to compile epidemiological information, and he continued to work there until the end of World War II. When the war ended, Biraud was transferred to the WHO as part of the LNHO's epidemiological intelligence service and acted as the main designer of the WHO's statistical work, for which other alumni of the JHSPH biostatistics department were recruited.[68]

While Biraud and his group were at the helm of the WHO's statistical practices, the JHSPH was continuing to train the next generation of public health officers. When the IHD fellowship program dwindled in

[65] Ibid., 120–1.

[66] Clifford Rosenberg, "The International Politics of Vaccine Testing in Interwar Algiers," *The American Historical Review* 117, no. 3 (2012): 671–97.

[67] Ibid.

[68] See: "Fellowship Card: Yves Biraud," "Fellowship Card: Marie Cakrtova," "Fellowship Card: Marcelino Pascua," "Fellowship Card: Satya Swaroop," n.d., RG10.2, Rockefeller Archive Center.

1951, the WHO and the US State Department became the major sponsors of fellowships that sent foreign students to study at the JHSPH.[69] This contributed to an increase in the proportion of foreign students at the school, which grew from 20% during the interwar period to 33% after World War II.[70]

The JHSPH biostatistics department transformed Pearson's biometry tradition into applied epidemiological research and lent credence to the use of mathematical statistics for public health research and administration. Most crucially, the department educated a cohort of health statisticians from both inside and outside of the United States, providing a statistical workforce for international health organizations and health authorities across the world. These health statisticians, who had all received the same training, were involved in vital statistics collection, data tabulation, and analysis of fieldwork statistics. Their manner of conducting statistical collection and analysis laid the foundation for statistics to become the lingua franca of public health organizations at different levels throughout the world. Although statistics had gained legitimacy in public health research, the implementation of this shared language was forced to reckon with diverse contexts. The case of interwar China, a major destination of Rockefeller funding, epitomizes how JHSPH-trained experts adapted and innovated statistical practices to fit one such context.

Advance Science or Save the Country?

In 1922, John B. Grant, having worked for a year at the Rockefeller-funded PUMC as an associate professor of pathology, drew up a plan to establish a public health department at the college. At the time, the Chinese mainland was divided into nine military cliques and lacked a strong central government, let alone a national health system. Only a few sporadic public health initiatives had been implemented, either with the help of foreign powers (usually in treaty ports), military strongmen (such as Yuan Shikai, who established the Beiyang Military Medical Academy in Tianjin in 1902, based on a Japanese model), or missionary associations (such as the Young Women's Christian Association and the Chinese Christian Association, which organized the Joint Council for Public Health Education starting in 1920). Most regulations were nothing more than pieces of paper and had little lasting impact on the local population. Grant, a JHSPH-trained specialist who had worked on hookworm

[69] Thomas, *Health and Humanity*, 162–3.
[70] Ibid., 173.

control campaigns in the coal mines of Hunan from 1917 to 1919, called on the Rockefeller IHB to provide funding to establish a public health department at the PUMC.[71]

Grant's design for the department – which emphasized statistics – was undoubtedly inspired by his training at the JHSPH from 1919 to 1920. He had been in Pearl and Reed's biostatistics class, and he kept vivid memories of studying epidemiology with Wade Frost.[72] In Grant's training, biostatistics had been used in conducting biological research, whereas epidemiology had mainly been concerned with developing practical knowledge about epidemic control measures.[73] Generally speaking, Grant valued epidemiology more than biostatistics, since, in his view, epidemiology took community health into account. He complained of being unable to grasp Pearl's lectures and recalled that, as a physician, he had often been shocked by Pearl's doctoral students, who applied the statistical regularity underlying the behavior of flies and mice to human beings.[74]

It is therefore unsurprising that, when devising his public health department at the PUMC, Grant did not seek to implement Pearl's research methods. Instead, he devoted considerable energy to constructing a system for collecting vital and health statistics using methods proposed by Arthur Newsholme, the former principal officer of the United Kingdom Local Government Board and a visiting professor at the JHSPH. It was during his years at the JHSPH that Grant became familiar with Newsholme's statistical methods, which focus mainly on administrative work. In his book *The Elements of Vital Statistics* (1923), Newsholme laid out a comprehensive review of the statistical practices that should be used by health administrations.[75] In contrast to Pearl's mathematical statistics and curve-fitting methods, Newsholme focused on descriptive statistics collected by health administrations, and dedicated only four out of fifty-one chapters to the statistical study of causation.[76]

Grant followed Newsholme's teachings and placed the collection of statistics at the center of his work at the PFHS. Also in line with

[71] Du Lihong, "Zhidu kuosan yu zaidihua: Lan Ansheng zai Beijing de gonggong weisheng shiyan, 1921–1925 [Institutional Diffusion and Localization: John B. Grant's Public Health Experiments in Beijing, 1921–1925]," *Zhongyang Yanjiuyuan jindaishi yanjiusuo jikan [Bulletin of the Institute of Modern History Academia Sinica]*, no.86 (2014): 1–47.

[72] Oral History Research Department, Columbia University, "Reminiscences of Dr. John B. Grant (Vol. 1)," 1961, 108, RF/13/1/1, Rockefeller Archive Center.

[73] Ibid.; Fee, *Disease and Discovery*, 133.

[74] Oral History Research Department, Columbia University, "Reminiscences of Dr. John B. Grant (Vol. 1)," 104.

[75] Arthur Newsholme, *The Elements of Vital Statistics in Their Bearing on Social and Public Health Problems* (London: George Allen & Unwin, 1923).

[76] Newsholme, *The Elements of Vital Statistics*, 503–51.

Newsholme's views, Grant did not consider the aim of statistical collection to be the construction of a model for wider application, but rather a means of evaluating the economic feasibility of public health actions.[77] Tellingly, Grant often used business metaphors when describing public health actions. As cited by Du Lihong, a PFHS report noted that public health administration needs statistics to assess its efficiency just as business needs accounting to assess its profit.[78] Grant stressed the importance of public health administration in his designs for both the PUMC public health department and the PFHS. In close collaboration with the department, PFHS would implement public health administration and vital statistics collection in a selected area.

Grant's designs for the PUMC public health department and the PFHS illustrate his vision for how public health research should be conducted in China: by applying scientifically proven theories on Chinese soil. Grant's conception of a Chinese public health school was distinctly different from that of the JHSPH designers. He had no ambition of making universal scientific advances and instead focused on applying existing discoveries to the Chinese context. According to Grant, what was needed in China was not "adding the missing sentences" to explanations of diseases but rather accumulating data to adapt fundamental facts to Chinese fieldwork.[79] He had observed first-hand the absolute lack of epidemiological data regarding disease occurrence in China. To advance scientific research, it was of crucial importance for a medical school to obtain data from local communities.[80] Therefore, Grant's blueprint for the PFHS involved gathering field data in Beijing, based on which the PUMC department of public health could tailor its research and training to Chinese conditions.[81]

Although Grant placed great importance on public health administration, he had good reason to hide this preference from his sponsor, the IHB of the Rockefeller Foundation. The IHB had been increasingly focused on scientific research ever since Frederick Russell had replaced Wickliffe Rose as director in 1923.[82] Also, the Rockefeller Foundation did not place

77 Oral History Research Department, Columbia University, "Reminiscences of Dr. John B. Grant (Vol. 2)," 1961, 159, RF/13/2/2, Rockefeller Archive Center.
78 Translated from: Du Lihong, "Zhidu kuosan yu zaidihua," 36.
79 John B. Grant, "Utilization of a Health Center," December 3, 1923, 3, CMB.Inc/75/528, Rockefeller Archive Center.
80 John B. Grant, "A Proposal for a Department of Hygiene for Peking Union Medical College," 1923, 42, CMB.Inc/75/531, Rockefeller Archive Center.
81 Grant, "Utilization of a Health Center," 3; "A Proposal for a Department of Hygiene for Peking Union Medical College," 42.
82 Farley, *To Cast Out Disease*, 6.

much importance on public health actions in China, as the Foundation's officers believed that political instability there made it impossible for the government to take over public health work.[83] In order to gain the IHB's financial support, Grant framed the PUMC public health department and the PFHS as serving to advance public health science, and provided few details on the administrative aspect. In his first proposal, submitted in 1923, Grant began by mentioning the need for a department of public health, given the rapid advancement of preventive medicine in recent years.[84] Grant was brief in discussing public health actions but stressed their scientific value. Nonetheless, Grant's first attempt failed. At the time, the IHB was concerned about the rapid growth of the PUMC's budget.[85] Grant repeatedly assured IHB officers that the university's total budget would not exceed $10,000,[86] and in 1924, his second proposal, submitted during a visit to the United States, was finally accepted.[87]

There is, however, a telling discrepancy between Grant's appeals to the IHB and articles published by his Chinese collaborators. Whereas Grant presented scientific research as a key function when discussing his proposals with the IHB, in articles published in Chinese medical and public health journals, his collaborators discussed the department and the PFHS in terms of "saving the country." For example, Jin Baoshan (also known as P. Z. King, Chin Pao-Shan), once an employee of the PFHS and later the director of the National Health Administration (1940–7), underscored the point that calculating birth and death rates could save China and that public health activities could prevent the waste of life, thus helping build a stronger nation.[88] Reflecting the nationalist sentiment of the time, Jin wrote in one of his articles:

> There are several ways to save the country, because China has many problems. … And then there is the problem of public health – the most central of China's weaknesses. … Civilized countries in Europe and America, thanks to their developed medical sciences and well-equipped public health systems, have a higher average life expectancy. Their populations will serve [society] longer.[89]

[83] Lei, *Neither Donkey nor Horse*, 55–8.
[84] Grant, "A Proposal for a Department of Hygiene for Peking Union Medical College," 2.
[85] Victor Heiser, "Memorandum on Grant's Plan for a Hygiene Program for the P.U.M.C. Submitted by Him October 8th," March 5, 1924, 1, CMB.Inc/75/531, Rockefeller Archive Center.
[86] Oral History Research Department, Columbia University, "Reminiscences of Dr. John B. Grant (Vol. 1)," 128.
[87] Du Lihong, "Zhidu kuosan yu zaidihua," 22–4.
[88] Jin Baoshan, "Beijing zhi gonggong weisheng [Beijing's Public Health]," *Zhonghua yixue zazhi [National Medical Journal of China (Shanghai)]* 12, no.3 (1926): 253–61.
[89] Translated from: Jin Baoshan, "Weisheng yu jiuguo [Public Health and Saving Country]," *Weisheng yuekan [Health Monthly]* 4, no.1 (1934): 2.

According to Jin, lowering the mortality rate through public health administration was key to the country's future. He had indicated in an earlier article that "the only aim of public health administration is to protect the health of the population and reduce the mortality rate."[90] In considering a lower mortality rate as the fundamental aim of public health administration, Jin paved the way for statistical practices becoming essential to Chinese public health administration.[91]

Statistical practices related to birth and death numbers were always presented as being at the center of the new department's responsibilities, no matter the target audience. Specifically, Grant and Jin both stressed the importance of statistics, either for advancing science by gathering data in China or for increasing life expectancy through public health administration. Since its founding in 1925, the PFHS carried out activities that were closely intertwined with the collection and publication of statistics.

Designing a Dialect: The Chinese List of Causes of Death

The PFHS employed physicians, nurses, sanitary inspectors, and clerks and provided basic medical care to inhabitants living in a specific district (home to 58,605 people) with the aim of decreasing the mortality rate there.[92] The Station's first major undertaking was to establish a birth- and death-reporting system. That system did not arise in a vacuum: as Yang Nianqun has shown, prior to the founding of the PFHS, the management

[90] Translated from: Jin Baoshan, "Xiwang yu Beijing weisheng dangju zhe [Plea to the Peking Public Health Authority]," *Zhonghua yixue zazhi [National Medical Journal of China (Shanghai)]* 14, no. 5 (1928): 4.

[91] Grant and his associates were not the only public health experts to adopt different rhetorical strategies for different audiences. Wu Liande, who contributed to controlling the 1910 plague epidemics in northern Manchuria and who served as a Chinese representative to the LNHO, also adopted mixed rhetorical strategies when advocating that foreign powers should transfer maritime quarantine authority to the Republic of China's government. When communicating with foreign powers, Wu presented a Chinese takeover of maritime quarantine authority in terms of the Chinese government's efforts to implement up-to-date public health administration. Vis-à-vis the Chinese public, however, Wu presented the takeover as a matter of Chinese sovereignty. (Yang Xiangyin and Wang Pong, "Minzu zhuyi yu xiandaihua: Wu Liande dui shouhui haigang jianyiquan de hunhe lunshu [Nationalism and Modernization: The Mixed Discourse of Wu Liande Regarding the Takeover of Maritime Quarantine]," *Huaren huaqiao lishi yanjiu [Journal of Overseas Chinese History Studies]*, no. 1 (2014): 51–60.)

[92] John B. Grant, "Second Annual Report, Peking Health Station,1926–1927," 1927, 16, RF/5/3.601J/219/2735, Rockefeller Archive Center; Bullock, *An American Transplant*, 145.

of births and deaths in the district had been the responsibility of traditional midwives and feng shui masters (*yin yang shen*), whom the inhabitants called upon to organize rituals signifying the arrival of a newborn or the death of a family member.[93] This meant that only midwives and feng shui masters were kept abreast of the total number of births and deaths. Despite the legal requirement for every household to report births and deaths to the municipal police, this was seldom followed.

The establishment of the PFHS, which was subordinated to the police, changed the situation. With police support, the PFHS obtained the backing of the local authorities to roll out a new vital statistics collection system in the district selected. By introducing a stricter law, under which required deaths had to be reported at the police station in order to obtain permission for burial, and by working to discredit traditional midwives and feng shui masters, the PFHS gradually integrated itself into the local social net and eventually became the main organization handling the inhabitants' birth and death information.[94] Through its partnership with the municipal police, the PFHS was informed as soon as a birth or death was reported by inhabitants. The PFHS then sent its medical staff to carry out a home visit to establish the cause of death or verify the condition of the newborn.[95]

This statistical collection system depended on an interpersonal network that Grant and his collaborators fostered with the municipal police. Grant and one of his students at the PUMC, Fang Yiji (Fang I-Chi, I. C. Fang), used informal channels to obtain political backing for their public health measures.[96] Grant also offered internships with the title of "political appointee" to candidates recommended by Chinese officials in order to consolidate his relationship with the local authorities.[97]

The PFHS's statistical work also involved an effort to align Chinese vital statistics with international standards. Grant and his colleagues Huang Zifang (Huang Tse-Fang), of the Central Epidemic Prevention

93 Yang Nianqun, "'Lan Ansheng moshi 'yu minguo chunian Beijing shengsi kongzhi kongjian de zhuanhuan."

94 Here I rely mostly on two scholarly accounts: ibid.; Yang Nianqun, "Minguo chunian Beijing de shengsi kongzhi yu kongjian zhuanhuan [Birth and Death Control and the Transformation of Space at the Beginning Years of the Republic of China]," in *kongjian jiyi shehui zhuanxing*: "xin shehui shi" yanjiu lunwen jingxuan ji *[Space, Memory, Transformation of Society]: Compilation of New Social History Papers* (Shanghai: Shanghai People's Publishing House, 2001).

95 Jin Baoshan, "Beijing zhi gonggong weisheng."

96 Fang later became one of the directors of the PFHS and was personally acquainted with the chief of the municipal police. Oral History Research Department, Columbia University, "Reminiscences of Dr. John B. Grant (Vol. 2)," 191.

97 Ibid., 205.

Bureau, and Xu Shijin (Hsu Shih-Chin), of the PUMC, worked to adapt the ICD into the Chinese language. Their efforts went beyond translation, as they also endeavored to cross-reference Chinese lay terms with the ICD's medical vocabulary. The trio estimated that it would take two generations to fully implement the ICD, which comprised over 200 rubrics.[98] They therefore focused on creating a list of causes of death for use in China that had only twenty rubrics; this made it longer than the Indian list (eight rubrics) and shorter than that used in Japan (sixty-one rubrics).[99]

Previously, causes of death had been reported using either a vague descriptor such as "stomach ache," "skin trouble," or "eye trouble," or with etiological terms drawn from Chinese medicine such as "witchy wind," "seasonal wind," or "lung weakness": neither type was very useful to foreigners seeking to understand the health situation in China.[100] To decrypt commonly used lay terms and make them fit the ICD rubrics, the PFHS carried out a year-long field survey. Over the course of 1925, PFHS physicians registered every reported death using both ICD terms and the terms used by the deceased's relatives to describe the cause of death.[101] A total of 104 lay terms were recorded for the 116 deaths that occurred that year, with some terms recurring more than once. Based on these results, Grant, Huang, and Xu drew up a list of twenty-five rubrics (hereafter, "the Chinese list").[102] They further double-checked the reliability of the Chinese list by keeping notes on which terms inhabitants used to describe their relatives' causes of death and by asking physicians to check those terms against the ICD using the Chinese list. It turned out that 90% of causes of death were correctly reported using the Chinese list.[103]

The reporting system put in place by the PFHS faced resistance from local inhabitants despite the legal requirements.[104] At first, police officers were responsible for reporting the causes of death provided by feng shui masters or relatives of the deceased, following a check by a PFHS

[98] John B. Grant, T. F. Huang, and S. C. Hsu, "A Preliminary Note on Classification of Causes of Death in China," *National Medical Journal of China (Shanghai)* 13, no. 1 (1927): 2.

[99] Ibid., 2.

[100] Ibid., 5–6.

[101] Oral History Research Department, Columbia University, "Reminiscences of Dr. John B. Grant (Vol. 1)," 67.

[102] Oral History Research Department, Columbia University, "Reminiscences of Dr. John B. Grant (Vol. 2)," 199; Grant, Huang, and Hsu, "A Preliminary Note on Classification of Causes of Death in China," 16–19.

[103] Grant, Huang, and Hsu, "A Preliminary Note on Classification of Causes of Death in China," 2–3.

[104] Yang Nianqun, "'Lan Ansheng moshi 'yu minguo chunian Beijing shengsi kongzhi kongjian de zhuanhuan," 106–9.

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physician.[105] It took less than a year for the PFHS staff to realize that most people did not report births and deaths to the police. The PFHS was forced to opt for a more direct approach: its staff carried out home visits in every household in the district and communicated with coffin dealers to collect death numbers. From 1927 onwards, sanitary inspectors were also put in charge of reporting births and deaths to the PFHS,[106] thus reducing the role played by the police. Statistical practices became more and more standard and health inspectors/statisticians gained broader responsibilities within the PFHS. In 1931, six years after the PFHS was founded, its staff concluded – by comparing their numbers with those of feng shui masters and coffin dealers – that "the reporting of adult deaths was not far from complete."[107]

Overarching Quantification at the PFHS

Despite local resistance to statistical collection, quantification work quickly expanded within the administration of the PFHS. This trend can be observed in the Station's annual reports: the first included only mortality rates, the socioeconomic situation of the dead, and the types of medical services they had received; the fifth annual report, however, quantified every aspect of the PFHS's work in numerous tables setting forth the quantity of every public health service provided.[108] For example, in the fourth annual report, published in 1929, visits by public health nurses were categorized in detail with pie charts (see Figure 2.4) that broke down visits by the type of service provided.[109]

The PFHS's annual reports were published in both Chinese and English, and were not only sent to the Rockefeller Foundation headquarters in New York but also made available to Chinese public health officials. As Theodore Porter has rightfully observed, when community ties are weak, numbers can inspire trust through their mechanical objectivity, i.e. when it can be shown that numbers have been collected according to certain rules.[110] In the case of the PFHS, the community

[105] Grant, "Second Annual Report, Peking Health Station, 1926–1927," 13.
[106] I. C. Fang, "Annual Report on Vital Statistics and Communicable Diseases Control for the Year 1928–1929," 1929, 4, CMB.Inc/67/470, Rockefeller Archive Center.
[107] Li Tingan, "The Sixth Annual Report of the Peking First Health Station, 1930–1931 – Annual Report of Vital Statistics and Communicable Diseases Control," 1931, 17, CMB.Inc/67/472, Rockefeller Archive Center.
[108] Peking First Health Station, "The Fifth Annual Report of the Peking First Health Station, 1929–1930," 1930, CMB.Inc/67/471, Rockefeller Archive Center.
[109] Peking First Health Station, "The Fourth Annual Report of the Peking First Health Station, 1928–1929," 1929, 89, CMB.Inc/67/470, Rockefeller Archive Center.
[110] Porter, *Trust in Numbers*. See page 4 for Porter's discussion of mechanical objectivity.

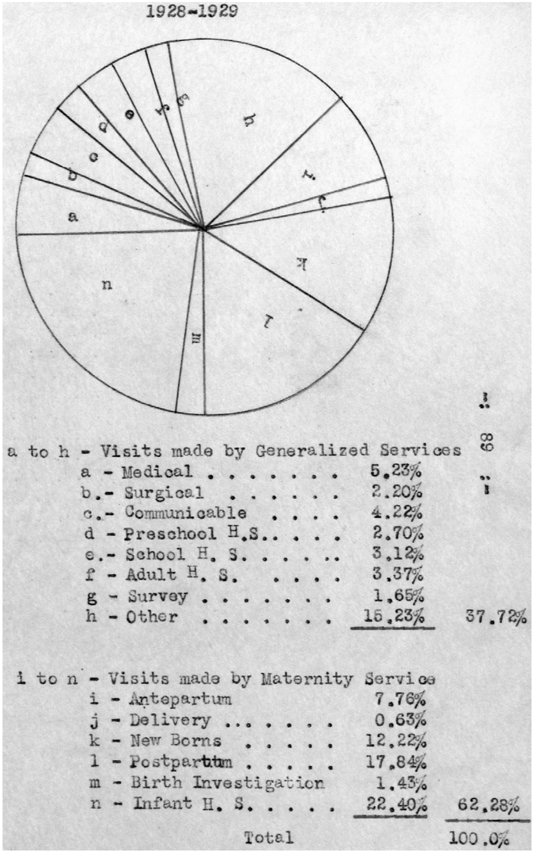

Figure 2.4 Pie chart of visits by Peking First Health Station public health nurses (1928–1929).
Peking First Health Station, "The Fourth Annual Report of the Peking First Health Station, 1928–1929," 1929, 89, CMB.Inc/67/470, Rockefeller Archive Center, 89. Courtesy of Rockefeller Archive Center.

in question was the Rockefeller Foundation, the municipal police in Beijing, and the PUMC staffers. This was indeed a group of actors who did not have much in common in terms of methods and training. The authors of the PFHS reports therefore had to rely on numbers to inspire trust in their readers, some as far off as New York, some 11,000 kilometers away.

The report writers tailored the way they presented numbers to their intended audience. For instance, in the English version of the fifth annual report, Grant used the appraisal form promoted by the APHA

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	1929-1930	1928-1929	1927-1928
Administration (100)[x]	95	46	78
Statistics (40)	32	29	33
Laboratory (25)	22.3	20	20
Communicable Disease Control (135)	21.6	20	0
Sanitation (230)			
Water (70)	20.3	16	20
Sewage (60)	10	5	5
Foods & Beverages (40)	0	0	0
Sanitary Inspection (40)	36	40	10
Refuse (20)	9.3	17	15
Control of Medical Practice (60)	22.8	12	0
Health Education (10)	7.3	5	5
Medical Relief (170)	xx 163	xx 170	110
Practice of Medicine (130)	108	115	38
Personal Hygiene (55)	26.6	30	30
Preventive Medicine (40)	18.8	17	23
Recreation (5)	3.6	0	3
Special Activities	61.8	17	15
	658/1000	559/1000	403/1000

x - Figures in brackets are standard values in the City Public Health Appraisal form by John B. Grant and P. Z. King.

xx - This increase is solely due to redistricting of the city Wards whereby the Peiping Union Medical College Hospital was included in the Demonstration District.

Figure 2.5 Health appraisal of the Peking First Health Station (1927–1930).
Peiping Health Demonstration Station, "The Fifth Annual Report of the Peiping Health Demonstration Station for the Year Ending June 30, 1930," 7. Courtesy of Rockefeller Archive Center.

to summarize the PFHS's activities (see Figure 2.5). Specifically, the APHA form attributed 1,000 points to all functions considered necessary for a public health service (such as home visits and school health education).[111] In the United States, experts were asked to evaluate the public health administration in each community by giving scores to

[111] For the history of APHA appraisal forms and their transfer to Europe, see, e.g.: Lion Murard, "Atlantic Crossings in the Measurement of Health: From US Appraisal Forms to the League of Nations' Health Indices," in *Medicine, the Market and the Mass Media: Producing Health in the Twentieth Century*, edited by Virginia Berridge and Kelly Loughlin (London: Routledge, 2004), 19–54; Lion Murard, "La santé publique et ses instruments de mesure: des barèmes évaluatifs américains aux indices numériques," in *Body Counts: Medical Quantification In Historical And Sociological Perspectives/La Quantification Médicale, Perspectives Historiques et Sociologiques*, eds. Gerard Jorland, Annick Opinel, and George Weisz (Montreal: McGill-Queen's University Press, 2005), 266–93.

every item on the form. The APHA also organized competitions, in which communities were invited to compete for the best score, with funding awarded to the winning community. Just as the PFHS had worked to adapt the ICD, Grant and Jin adapted the APHA appraisal form for "large Chinese cities."[112] The form became a central piece of reporting, as Grant opened the fifth annual report by stating that the PFHS had made major progress, citing an improvement in the appraisal score (see Figure 2.5).[113] By using an adapted APHA appraisal form, Grant and Jin were clearly addressing an English-speaking readership acquainted with American public health work. However, the way the form was presented raised more questions than it resolved, as there was no mention of the scoring criteria, except for a simple note that the scores had been decided by three clerkship students from the PUMC.[114] Tellingly, Grant and Jin did not include the form in the Chinese version of the report.[115]

Grant's management style was another factor behind the overarching quantification employed at the PFHS. As Du Lihong has documented, Grant ran the PFHS like a business: facilities and human resources were allocated with the aim of achieving optimal health returns.[116] Another telling example of Grant's strategy was his decision not to focus on tuberculosis control. He argued that tuberculosis was closely related to overall economic conditions, whereas gastrointestinal diseases responded more "readily to the influence of public health measures."[117] Seeking to maximize the PFHS's impact as quickly as possible, Grant left tuberculosis on the sidelines of the Station's agenda.

Though quantitative rationale was quickly taken up in the PFHS's annual reports, such numbers-based arguments were generally simple and brief, as in the appraisal form described above. Because no extended social surveys had actually been conducted, the report writers could only speculate as to the reasons behind changes in mortality rates. All of the Station's statistics were purely descriptive, with no way to tell if changes were mathematically significant (the standard set by Grant's teachers at

112 John B. Grant, "Third Annual Report of the Peking Health Demonstration Station, for the Year Ending June 30, 1928," 1928, 3, RF/5/3.601J/219/2736, Rockefeller Archive Center.
113 Peiping Health Demonstration Station, "The Fifth Annual Report of the Peiping Health Demonstration Station for the Year Ending June 30, 1930," 1.
114 Peiping Health Demonstration Station, 7.
115 Peking First Health Station, "Beiping shi gonganju diyi weisheng qu shiwusuo diwunian nianbao [The Fifth Annual Report of the Metropolitan Police Department's First Health Station]," 1930.
116 Du Lihong, "Zhidu kuosan yu zaidihua," 36.
117 Lei, "Habituating Individuality," 253.

Johns Hopkins).[118] Despite the intentions behind Grant's design, statistical practices slowly became disassociated from policy at the PFHS. As Li Tingan (Lee Ting-An) – another graduate of the PUMC public health department who later earned his medical degree at Harvard – showed in the 1932 PFHS annual report, statistical practices were a routine task with no strategic implications. Inspectors were aware of missing reporting of births and deaths and more initiatives were needed to improve the situation.[119]

Mathematical Statistics and the PUMC Statistical Laboratory

Grant was aware of the limitations of his statistical knowledge. He therefore convinced the China Medical Board, the Rockefeller agency that sponsored the PUMC, to fund a fellowship for one of his staff to learn statistical techniques in the United States. Grant had another reason for wanting to improve statistical practices: unlike at the JHSPH, there was no consensus at the PUMC as to the need for a public health department, and Grant had to defend the department's existence. The PUMC placed great emphasis on medical science, and Grant decided that statistical skills would be the public health department's *raison d'être.* He proposed that the department should have a statistician who oversaw statistical analysis for all research conducted at the PUMC.[120] Grant believed that the possibility of conducting statistical research would attract students to choose public health as their specialization.[121]

In 1927, Grant wrote to Gist Gee, the Rockefeller Foundation's adviser in China,[122] to request that a fellowship in biostatistics be established. In his letter, Grant stressed the growing demand for statistical analysis, both from PUMC medical researchers and from the Chinese public health administration. Citing the partnership between the JHSPH

118 Sun Yun Chen, "Sixth Annual Report of the Peiping Health Demonstration Station, for the Year Ending June 30, 1931 – Annual Report of Vital Statistics and Communicable Diseases," 6; I. C. Yuan, "The Seventh Annual Report of the Department of Hygiene and Public Health in Cooperation with the Peiping Health Demonstration Station for the Year Ending June 30, 1932 – Annual Report of Vital Statistics and Communicable Disease Control," 1930, 3, CMB.Inc/67/471, Rockefeller Archive Center.

119 Li Tingan, "A Critical Study of the Work of the Health Station First Health Area, Department of Public Health, Peiping for the Years 1925–1931 with Suggestions for Improvement," January 1932, 37–9, Peking Union Medical College Archives.

120 John B. Grant, "Subject: Statistician," December 6, 1927, 1, CMB.Inc/77/541, Rockefeller Archive Center.

121 Ibid., 1.

122 On Gee's work in China, see: William Joseph Haas, *China Voyager: Gist Gee's Life in Science* (Armonk, NY: M.E. Sharpe, 1996).

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biostatistics department and the Johns Hopkins University hospital, Grant claimed that "much of medical knowledge is the result of accumulation of day-by-day data subjected to careful analysis": having a statistician in the public health department, Grant argued, would likewise be essential for interpreting the medical records accumulating at the PUMC hospital. Like his teachers Pearl and Reed, Grant asserted that a true statistician should not merely collect statistics – which could be done by a clerk – but should also be able to interpret the numbers.[123] Grant hoped that the future Rockefeller fellow, having acquired statistical knowledge under Pearl and Reed at the JHSPH, would become an authority on medical statistics and develop statistical practices for both research and administration.[124]

The Rockefeller Foundation accepted Grant's quest for a fellowship as well as his choice of candidate: Yuan Yijin (I. C. Yuan), a PUMC graduate employed at the PFHS. Grant mentioned that Yuan had "a mathematical trend in a somewhat judicial and philosophical mind, a liking for the abstract combined at the same time with a practical outlook," which would make him a good public health statistician.[125] In 1929, Yuan was awarded a two-year fellowship to study statistics at the JHSPH.

Yuan's training in the United States was no different from that of his contemporaries. His curriculum was co-designed by Grant and Reed and comprised two parts: coursework in biostatistics research, and an internship in public health administration. He spent most of his stay working with Reed in the statistical laboratory of the JHSPH. Following Reed's lead, Yuan familiarized himself with mathematical theories, such as calculus and the law of probability, and learned how to operate IBM counting and sorting machines. For his administrative training, Yuan spent a summer interning in Albany, New York, where he gained knowledge about the routine work of collecting vital statistics and the importance of enforcing legislation on birth and death registration.[126] Yuan obtained a Certificate of Public Health after one year and a Diploma of Public Health at the end of the second year of the fellowship.[127]

Reed had designed a third-year curriculum to train Yuan's capacity for "tak[ing] an applied problem and translat[ing] it into its mathematical

123 Grant, "Subject: Statistician," 2.
124 Ibid., 2.
125 Ibid., 2.
126 I. C. Yuan, "To Miss Eggleston," November 17, 1929, CMB.Inc/77/541, Rockefeller Archive Center.
127 W.S.C., "Interviews," February 26, 1929, CMB.Inc/77/541, Rockefeller Archive Center.

statement," an ability needed for pursuing a PhD.[128] Reed explained that once Yuan was fully trained, he could finish his dissertation by focusing on a specifically Chinese problem upon returning home.[129] Yuan was equally ambitious in terms of advancing his mathematical knowledge. He wrote to Grant insisting that he was not satisfied with being the mathematical consultant that Grant had first envisioned; instead, he wished to become a researcher specializing in human biology and the mass phenomena of diseases.[130]

Despite Reed and Yuan's pleas, however, Grant and Roger Greene, the acting director of the PUMC, refused to extend the fellowship for a third year, stating that China was in urgent need of a public health statistician.[131] The IHD's director, Frederick Russell, sided with Grant and Greene. This rejection reflects the kind of science accorded priority by Rockefeller officers in China. When consulted by Grant, Russell agreed that Yuan should return to China and be oriented toward specifically Chinese problems.[132] Unlike Reed, who was focused on epidemiological theory, Grant and Greene preferred applied science: the kind of science in which research results could be directly applied to Chinese policymaking in order to improve health conditions in the country. As Grant had explained in his memorandum when seeking to establish a department of public health, it was not about "adding the missing sentences" to proven facts but testing proven facts to determine public health strategies that were adapted to China.[133]

Yuan's return home in 1931 marked the beginning of a new era of health statistical practices in China. He established the first statistical laboratory with an IBM computing system, with funding from the China Medical Board. Yuan prepared a memo to Grant setting forth the extensive scope of a statistician's work, from introducing statistical methods to medical research, to organizing hospital records, to teaching clerks and staff about the chi-squared test, probability, and correlation.[134] Yuan's

[128] Lowell J. Reed, "To Grant," January 29, 1930, CMB.Inc/77/542, Rockefeller Archive Center.
[129] Lowell J. Reed, "To Miss Eggleston," January 28, 1930, CMB.Inc/77/542, Rockefeller Archive Center.
[130] I. C. Yuan, "To Grant," July 1, 1930, CMB.Inc/77/542, Rockefeller Archive Center.
[131] John B. Grant, "To Reed," July 3, 1930, CMB.Inc/77/542; "To Heiser," June 27, 1930, CMB.Inc/77/542, Rockefeller Archive Center.
[132] Grant. "To Heiser," June 27, 1930.
[133] Grant, "Utilization of a Health Center," 3.
[134] I. C. Yuan, "To Grant: Memorandum of the Scope of Work of a Medical Statistician," March 18, 1930, 3, CMB.Inc/77/542, Rockefeller Archive Center. On the IBM purchase: Rollin C. Dean, "To Greene: Tabulating Equipment," April 22, 1931, CMB. Inc/77/542, Rockefeller Archive Center.

view of the statistician's role was very much in line with Reed's. Accordingly, Yuan was involved in teaching, research, and public health administration at the PFHS.

Yuan's contribution to research was also similar to Reed's. He collaborated with other departments at the PUMC, such as physiology and biochemistry, to conduct statistical analysis on the numbers collected during their experiments. One of Yuan's most famous publications was his statistical analysis – conducted for Robert Lim of the physiology department – of research on acidity variation in the gastric juice of pouch dogs. Yuan also planned to perform statistical analysis on mouse colony research conducted by the biochemistry department. Coincidentally – or perhaps ironically – just as with Pearl's project at the JHSPH, the study in question was cut short by a fire that killed a quarter of the mice in the colony.[135]

In terms of administration, Yuan served first as a consultant then as a core staff member at the PFHS, where he made efforts to implement mathematical statistics. Yuan was disappointed that the vital statistics collected at the Station were merely descriptive and did not pass statistical tests based on the laws of probability. Arguing that investigations should be more "mathematical" as medical science advanced,[136] Yuan unified various statistical surveys and hired four extra statistical investigators,[137] two of whom were responsible for compiling statistical tables.[138] Yuan's responsibility also extended to administrating the entire Station's statistical work: he was responsible for reviewing the statistics in annual reports and deciding upon scores on the APHA appraisal form with Grant.[139]

Yuan's teaching responsibilities were overarching. He organized statistical training for medical students at the PUMC and statistical investigators at the PFHS. He also taught mathematical statistics to students specializing in sociology at Yenching University,[140] which not only was at

135 I. C. Yuan, "The Eighth Annual Report of the Peking First Health Station, 1932–1933 – Annual Report of Medical Statistics," 1933, 15, RF/5/3.601J/220/2741, Rockefeller Archive Center.

136 Ibid., 1.

137 The names and the educational level of these statistical investigators remain unknown. However, they were personally trained by Yuan at the PFHS before undertaking their duties.

138 I. C. Fang, "The Eighth Annual Report of the Peking First Health Station, 1932–1933 – Annual Report of Vital Statistics and Communicable Diseases Control," 1933, 25, RF/5/3.601J/220/2741, Rockefeller Archive Center.

139 Li Tingan, "The Sixth Annual Report of the Peking First Health Station, 1930–1931 – Annual Report of Vital Statistics and Communicable Diseases Control," 6.

140 Peking First Health Station, "The Ninth Annual Report of the Peking First Health Station, 1933–1934," 1934, 22–3, CMB.Inc/67/473, Rockefeller Archive Center.

Figure 2.6 The first cohort of Peking First Health Station sanitary inspectors, photographed in front of the Peking Union Medical College. Peking First Health Station, "The Third Annual Report of the Peking First Health Station, 1927–1928," 1928, 26–7, RF/5/3.601J/219/2736, Rockefeller Archive Center. Courtesy of Rockefeller Archive Center.

the center of the Chinese Social Survey Movement in the 1920s but also collaborated with the Rockefeller Foundation's China Program in the 1930s with the aim of rebuilding Chinese society through agriculture, economic measures, public health, and social work.[141]

Yuan's statistical practices at the PFHS came up against similar hurdles to those faced by his predecessors. Local inhabitants were reluctant to collaborate with sanitary investigators from the PFHS, who often presented themselves as authorities in the streets of Beijing, wearing uniforms very similar to those worn by the military (see Figure 2.6).

[141] For more on the Chinese Social Survey Movement, see, e.g.: Lam, *A Passion for Facts*. For historiographies regarding the Rockefeller Foundation's China Program, see, e.g.: Frank Ninkovich, "The Rockefeller Foundation, China, and Cultural Change," *The Journal of American History* 70, no. 4 (1984): 799–820; Socrates Litsios, "Selskar Gunn and China: The Rockefeller Foundation's 'Other' Approach to Public Health," *Bulletin of the History of Medicine* 79, no. 2 (2005): 295–318.

Locals remained skeptical. This conflict between the investigators and the local population came to a head when a street fight broke out in 1934:[142] two newspaper vendors were yelling in the street when a statistical investigator named Yin intervened. Yin wanted to remove one of the two vendors from the street, but the latter did not obey, which turned into a fight involving Yin. The episode made it clear that Yin, though merely a statistical investigator, considered himself as something like a policeman. The street vendors certainly did not recognize his authority to intervene. The episode is emblematic of the disconnect between statistical workers and the populations they were investigating. Humorous popular sayings were also circulating in Beijing that recounted locals' reactions to the inspectors. Nearly all started with inspectors asking routine questions, such as if someone was ill in the family. Such questions were considered inappropriate, disturbing locals and leading them to poke fun at the inspectors or even threaten them, causing them to flee the premises.[143]

Although Yuan's service at the PFHS ended with the Japanese invasion in 1937, he continued to work as a statistical specialist for the rest of his career: he was the head of the epidemiology division of the Central Field Health Station during the war, then worked as a researcher at Academia Sinica, eventually going on to become the WHO's statistical expert on tuberculosis.[144] His career path is illustrative of the increasingly central role of statistics in public health research and administration in China.

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When one juxtaposes the work of the JHSPH and that of the PUMC, a complete picture of the circuit through which statistical practices in research were transferred between the United States and China emerges. This circuit had a number of significant features. First, there

142 Beijing Bureau of Health, "Beiping shi weishengju guanyu Bai Liude Wang Wei erming ouda benju tongji yuan Yin Zhijie qing yifa chengjie [Peiping Bureau of Health's Appeal Concerning Disciplining Bai Liude and Wang Wei for Their Assault on its Statistician Yin Zhijie]," December 27, 1934, J181-021-29355, Beijing Municipal Archives.

143 Yu Xinzhong, "Fuza xing yu xiandaixing: wan Qing jianyi jizhi yinjianzhong de shehui fanying [Complexity and Modernity: Social Reactions Toward the Establishment of Quarantine Measures in the Late Qing Dynasty]," *Jindaishi Yanjiu [Modern Chinese History Studies]* 188, no. 2 (2012): 56–7.

144 Over the course of his career, Yuan worked in: Czechoslovakia, Poland, Syria, Israel, Malta, Tunisia, Ecuador, Austria, Morocco (and Tangier, an autonomous city at the time), Greece, and Yugoslavia (WHO, "Bureau de Recherches sur la Tuberculose (Copenhague)," November 10, 1952, 36, EB11/12, WHO Library).

were clear differences of opinion regarding the definition of public health science. The JHSPH biostatistics department prioritized using mathematical statistics for biological research (1917–1925) and later epidemiological research. At the PUMC, however, statistical practices were used to collect quantified data in China and then apply and adapt proven scientific facts to the Chinese context. Public health science at the PUMC was pursued purely in the interest of improving the health of the Chinese population. Grant thus launched statistical collection at the PFHS – a public health administration station – instead of establishing a mouse colony or using census data, as Pearl and Reed had done. The PFHS rolled out a vital statistics reporting system within its jurisdiction, and its experts worked to adapt established standards, such as the ICD and the APHA appraisal form, to the Chinese context.

The second important feature of the circuit of transferal was the time interval involved. The transfer took place in two stages, led first by Grant and then by Yuan. The two men studied at the same institution but almost ten years apart, and so had distinctly different visions of biostatistics. Grant rejected Pearl's focus on biological research and instead adhered to Newsholme's statistical practices; his major focus was on setting up a statistical reporting system. In contrast, when Yuan arrived at the JHSPH, Pearl had left the biostatistical department, and Yuan was trained by Reed in his statistical laboratory. Yuan spent two years studying mathematical statistics and their applications to medical and public health research. When Yuan returned to China, his practices came to be implemented at the PFHS. As the following chapter will show, however, Grant's statistical practices had already spread to other provinces – his students had begun to occupy important positions in public health administrations throughout China.

This brings us to the third feature: both schools spread their statistical practices via their alumni. At the JHSPH, Reed's influence survived World War II and was taken up at the WHO, whereas Grant's views on statistics were spread by his students at the PUMC. The students of both schools, having learned to speak the language of statistics, later became public health officials in various public health administrations. As previously discussed, statistical experts in New York, Geneva, and Beijing either competed with other experts for interpretative authority or faced resistance from those being surveyed. Nevertheless, numbers were gaining ground in fieldwork and reporting. As the case of the PFHS shows, collecting and reporting numbers had become routine for field researchers, despite the difficulties they encountered on the ground.

The differences in how statistics were used at the two schools reflect how – despite being a sort of lingua franca used by actors with similar training – statistics were nonetheless used differently depending on experts' conception of scientific research. In the end, the two schools' plans to use statistics to orient public health programs were only partially implemented. In the following chapters, I will describe other circuits through which statistical practices were implemented with different sponsors, as well as the ways in which graduates of the JHSPH and the PUMC deviated from what they had been taught.