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Retrospectives
Edgar Sydenstricker: Household Equivalence Scales and the Causes of Pellagra

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This feature addresses the history of economic terms and ideas. The hope is to deepen the workaday dialogue of economists, while perhaps also casting new light on ongoing questions. If you have suggestions for future topics or authors, please contact either Beatrice Cherrier, CNRS & CREST, ENSAE-Ecole Polytechnique (beatrice.cherrier@gmail.com) or Joseph Persky, University of Illinois at Chicago (jpersky@uic.edu).

Introduction

The COVID-19 pandemic is not the first time that economists joined forces with epidemiologists to help tackle a major outbreak of disease. Indeed, one of the most successful collaborations just over a century ago involved the causes of the disease of pellagra. While pellagra is almost unknown today, it was endemic in some regions of Europe at least since the middle of the eighteenth century. By the early part of the twentieth century, it was spreading fast in the US South, especially in cotton-growing areas, with about 250,000 cases and 7,000 deaths annually (Bollet 1992). Its main symptoms were sometimes summarized as the three D's: dermatitis, diarrhoea, and dementia. Specifically, pellagra caused severe irritations of the skin (the name comes from the Italian for "sour skin") as well as digestive problems and mental disorders. Pellagra usually peaked in the spring and mainly affected poor

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people, but in the early twentieth century, its cause was unknown. Some claimed it was an infection, similar to diseases like tuberculosis and hookworm. Others argued it was caused by a dietary deficiency, like scurvy and beriberi.

Only in 1937 was the cause of pellagra identified specifically as a dietary deficiency of vitamin B-3, also called nicotinic acid or niacin (for a contemporary review of this discovery, see Elvehjem 1940). Twenty years earlier, a body of research by epidemiologists and economists, based on large-scale fieldwork and the collection of a substantial amount of economic data, established that pellagra was due to a dietary deficiency—although they were not able at that time to pinpoint exactly what. A central figure in this earlier research project was the economist Edgar Sydenstricker. One of the major analytical challenges in studying the economic and dietary causes of pellagra was how to compare across households with similar income levels, but different compositions of adults and children. While economists and other social scientists nowadays routinely apply equivalence factors to adjust household incomes when measuring and analyzing poverty, inequality, and other topics, this was not the case a century ago.[1] Although Sydenstricker did not originate the idea of household equivalence scales to make such comparisons possible, his research offered insights into the basis for such scales, how they might be designed, and their practical importance in contributing to the solution of a major public health issue.

Sydenstricker (1881–1936) had been born in China to missionary parents: his younger sister grew up to be the writer Pearl S. Buck. He moved to the United States in 1896 (for biographical information, see King 1936). He earned a Master of Arts degree at Washington and Lee University in 1902 and studied political economy at the University of Chicago from 1907 to 1908. He then worked for the US Commission on Industrial Relations, where he investigated the labor conditions in American industries. In 1915, he moved to the US Public Health Service, where he was hired as a statistician and did research on the health and socioeconomic status of workers in the New York garment industry as well as on health insurance systems.[2] In 1923 he spent a year at the League of Nations, and in 1928 he became Director of Research at the Milbank Memorial Fund. Throughout his career, Sydenstricker reported frequently about the results of his research on health issues. While working for the US Public Health Service, he published many of his papers in its official journal *Public Health Reports*. Lengthier studies, such as one on health insurance (Warren and Sydenstricker 1916) were published in the *Public Health Bulletin*

[1] Well-known examples of household equivalence measures include the OECD equivalence scale, the OECD-modified scale, and the square root scale (for example, https://www.oecd.org/els/soc/OECD-Note-EquivalenceScales.pdf).

[2] Much of Sydenstricker's work on labor conditions (which is mentioned in the Final Report and Testimony submitted to Congress by the Commission on Industrial Relations, 1916: Vol. I, 14, 22 and 163) was published independently by Lauck and Sydenstricker (1917). It also gave rise to an article in the *Journal of Political Economy* (Sydenstricker 1916).

series.[3] It was not long after his appointment in the US Public Health Service that Sydenstricker became involved in the research about pellagra.

Early Controversy over the Causes of Pellagra

In the early part of the twentieth century, pellagra was widely recognized as an urgent public health issue. In 1909, the US Public Health Service appointed a Pellagra Commission, the first National Conference on Pellagra was held, and the National Association for the Study of Pellagra was founded. In 1912, two wealthy businessmen—Robert M. Thompson and J. H. McFadden—donated a large sum of money for research on pellagra. This allowed what came to be called the Thompson-McFadden Commission to initiate a large-scale epidemiological study in six cotton mill villages in Spartanburg County, South Carolina. After two years of research, the commission came to the conclusion that there was very little evidence for a dietary deficiency theory. It argued that an analysis of location and distance patterns strongly suggested that pellagra was an infectious disease (Siler, Garrison, and McNeal 1914).

In contrast, the epidemiologist Joseph Goldberger (1874–1929), who in 1914 was put in charge of an investigation into pellagra by the US Surgeon General, was convinced that pellagra was caused by a dietary deficiency (Goldberger 1914a). To gather evidence, he set up experiments in an asylum in Georgia and in orphanages in Mississippi, which showed that dietary changes could produce a spectacular drop in pellagra prevalence (Goldberger 1914b; Goldberger, Waring, and Willets 1914; 1915). He also tried to discredit the view that pellagra was an infectious disease by attempting repeatedly, but unsuccessfully, to transmit the disease from pellagra victims to others, including himself and his wife (Goldberger 1916).

This evidence did not suffice to win the debate; the view that pellagra was an infectious disease persisted (Siler, Garrison, and MacNeal 1917a; 1917b). Goldberger therefore decided to launch an epidemiological study quite similar to the one undertaken by the Thompson-McFadden Commission—in effect, redoing the earlier study. The two surveys were not exactly the same (as explained in detail by Mooney, Knox, and Morabia 2014). For example, the set of cotton mill villages was altered: two of the six villages of the original survey were replaced by three other ones. In addition, much more care was given to the collection of data on food supplies, prices, and incomes at the village, household, and individual levels. For this study, Goldberger collaborated closely with George A. Wheeler (1885–1981), who was a doctor and a member of the US Public Health Service, and with Sydenstricker.

[3] Sydenstricker also published in economics and statistics journals (Sydenstricker and King 1921a; 1921b). After he joined the Milbank Memorial Fund, his book *Health and Environment* (Sydenstricker 1933) appeared in the Series of Monographs Prepared under the Direction of the President's Research Committee on Social Trends, initiated by Herbert Hoover and chaired by Wesley Clair Mitchell. In 1974, a selection of Sydenstrickers's public health papers was published under the title *The Challenge of Facts* (Sydenstricker 1974).

They published their findings in a series of papers (Goldberger, Wheeler, and Sydenstricker 1918; 1920a; 1920b; 1920c).

The Need for a Household Equivalence Scale

From a very early stage—even before the start of the Goldberger survey—Sydenstricker (1915, p. 3132) had drawn attention to the economic aspects of the issue when he alluded to "the possible relation of the incidence of pellagra to certain conditions of an economic character." He had first-hand knowledge of labor and industrial conditions. He was aware of the evidence that, in comparison to richer families, poor families spent a greater proportion of their family income on food, and that the per capita consumption of milk, eggs, and meat tended to rise with income. Moreover, he pointed out that the typical wage earner in the South had less purchasing power than the one in the North, and that in certain communities of the South the food supply was often limited.

Sydenstricker supervised the collection of the income data in the context of Goldberger's 1916 survey on pellagra in the textile mill communities of South Carolina. Two issues were crucially important: obtaining reliable estimates of total household incomes and making an appropriate adjustment for household composition. They used the cotton mill payroll records to supplement and verify the data on self-reported income (Goldberger, Wheeler and Sydenstricker 1920c, pp. 2680–1). It soon became obvious, however, that socioeconomic status was much more varied than household income, as the size and composition of households varied markedly. The authors wrote (pp. 2682–3),

> The average total annual cash income of all of the families for which income data were secured was about $700, and relatively few had annual incomes of over $1,000. Thus the range of total income was relatively small and the families were, from this point of view, fairly homogeneous. They differed, however, very markedly in size and with respect to the age and sex of their members. Manifestly it was improper to classify, for example, a family whose half-month's income was $40, and was composed of only a man and his wife, with one whose half-month's income was also $40, but was composed of a man, his wife, and several dependent children.

The question was how to compare families with different age-sex compositions. Previous studies examining the epidemiology of pellagra such as Jobling and Petersen (1917) had used per capita income as a measure of socioeconomic status. Although Goldberger, Wheeler, and Sydenstricker (1920c, p. 2683) acknowledged that dividing household income by the number of persons was better than making no adjustments at all, they argued that the use of per capita income remained inaccurate because it entirely neglected differences in age and sex: "It appeared advisable,

therefore, to employ a common denominator to which the individuals of both sexes and of all ages could be reduced in order to obtain a more accurately representative method of expressing the relative size of the families to be compared."

This search for a common denominator was the starting point of Sydenstricker's work on the development and use of equivalence scales, which would enable him to assess how the incidence of diseases like pellagra varied by socioeconomic status. For the derivation of equivalence scales, Sydenstricker collaborated with Willford I. King, who joined Sydenstricker at the US Public Health Service in 1917 before taking up a position at the National Bureau of Economic Research in 1920. King had been instructor and assistant professor of political economy at the University of Wisconsin, where he also earned his PhD (as reported in *New York Times* 1962).[4]

The three articles Sydenstricker and King published in 1920 and 1921 spell out how their research is connected to the pellagra studies and what they wanted to achieve. Their main motivation was to study the association between poverty and ill-health in a quantitative way (Sydenstricker and King 1920, p. 2830). Family income as such was too crude a measure: it ignored differences in size and differences in composition (sex and age) of different households. Per capita income was an improvement, but nevertheless they regarded it as being "subject to a high degree of error" (Sydenstricker and King 1921a, p. 583) and so saw the need to develop a more refined measure of socioeconomic status. The alternative they proposed was to express the size and composition of different families into comparable units and then to divide each family's income by the corresponding number of units. Sydenstricker and King acknowledged that this procedure was not new; for earlier examples, they referred to the work of the Englishman David Davies at the end of the eighteenth century, the German Ernst Engel in the nineteenth century (who suggested the name "quet" for the units, after the Belgian statistician Adolphe Quetelet), and the Englishman Seebohm Rowntree. In the United States, a household equivalence scale had been developed by Wilbur Olin Atwater, the American chemist who allegedly introduced the word "calorie" into US English (Hargrove 2006). Through experimentation, Atwater examined the amount of energy contained in different types of foods and calculated estimates of the number of calories that needed to be consumed by persons of different ages and gender to sustain life (Carpenter 1994). With the Atwater scale, the size of the family could be expressed in Adult Male Units, using males over the age of 16 that have the highest calorie needs as the reference point. It was by dividing household income by the number of Adult Male Units that Sydenstricker and his associates classified families according to income in

[4]King (1915) had previously published a study on the distribution of income and wealth in the United States. While working with Sydenstricker, he simultaneously wrote a review of a study on disabling sickness by Sydenstricker, Wheeler, and Goldberger (1918) in the *American Economic Review* (King 1919). This article clearly shows that King shared many of Sydenstricker's views on the relationships between income and health and on the necessity to adjust income for household composition.

their analysis of the incidence of disabling sickness (Sydenstricker, Wheeler, and Goldberger 1918).

However, Sydenstricker and King (1920, pp. 2834–5) were not completely satisfied with the Atwater scale. They argued that the number of units had to also take into account the needs for nonfood items, and that these might be different from the needs for food. They wrote:

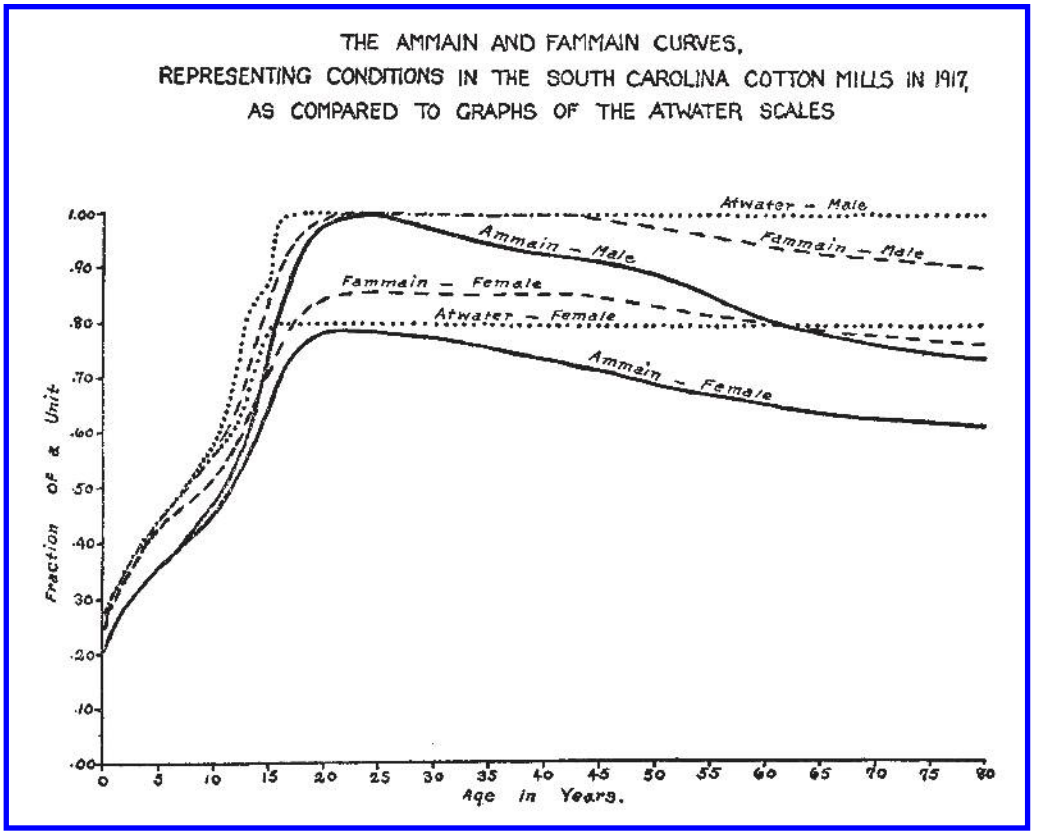
> [T]he assumption in the use of this scale was that the expenditures for individuals varied according to sex and age in the same proportion as their food requirements. The assumption was by no means as accurate as could be desired . . . Accordingly, it was determined to use as the basis for classifying families a unit which would express as far as possible the relative differences in all economic wants among persons of different sexes and ages.

In 1917, they had a new opportunity to collect data in the context of the ongoing pellagra surveys. The design of the new survey was modified to remedy some of the weaknesses of the 1916 survey; for example, no information had been collected in the 1916 version of the survey on home-produced food. The household expenditure data were then analyzed to detect differences in expenditure patterns according to sex and age, with the aim of measuring more accurately the relative well-being of different families. As described in Sydenstricker and King 1920, p. 2835),

> In analyzing the data the problem was found to consist of two parts: First, the derivation of correct curves showing food expenditures, and, second, the obtaining of similar curves for other expenditures. The reason that this division of the problem was necessary lay in the fact that the food used, including that purchased and that produced at home, was recorded only for the family as a whole, and it was entirely impracticable to secure separate records for individuals. On the other hand, expenditures for such articles as clothing, medical care, tobacco, amusement, etc., might actually be estimated for the different individuals in the family.

Because their analysis was based on observed expenditures rather than on calculations of food requirements, they decided to use a new name for the unit of their adjusted scale. They settled on the *fammain,* short for *food for adult male maintenance*. For the derivation of the fammain, they used the food expenditure records of about 1,500 families. To analyze the nonfood expenditures, they needed complete household expenditure records, and these were not so readily available. On the basis of budget data of about 140 families, they nevertheless derived a scale representative for the differences in total expenditure according to age and sex. The unit of that scale was called the *ammain*, short for *adult male maintenance*. While the main purpose of the fammain equivalence scale was to

Figure 1
Comparison of Different Scales Undertaken by Sydenstricker and King



Source: Sydenstricker and King (1921b, p. 850).
Notes: The Atwater scales for male and female are shown with dotted lines. The fammain scales for male and female are shown with dashed lines. The ammain scales for male and female are shown with solid lines.

enable a comparison of the food supplies of different families, the goal of the ammain equivalence scale was to allow a much broader comparison: it took into account all household expenditures and was meant as an instrument to measure how well-off families actually were.

A comparison of the Atwater, fammain, and ammain scales is reproduced in Figure 1. All of the measures show a similar rising pattern through childhood, culminating in a peak around age 18—although the peak is higher for males than for females. Having the peak for men happen at 1.0 arises out of the construction of the figure. At that point, the Atwater scale remains constant for the rest of the lifespan. However, Sydenstricker and King found that the values of the fammain and ammain scales tended to decline for older adults, with the ammain values (that is, all expenditures, not just food) falling faster. Sydenstricker and King were

convinced that these two scales, derived from observed household expenditure data, were more accurate than the Atwater scale, which was based on estimated calorie requirements. On the whole, however, the numerical values of the different scales are relatively similar.

Using Equivalent Income to Understand the Cause of Pellagra

Although Sydenstricker and King used the data from the pellagra surveys to calculate their fammain and ammain scales, the scales were not applied in the pellagra studies of Goldberger, Wheeler, and Sydenstricker (1918; 1920a; 1920b; 1920c). Sydenstricker probably thought that the methodology needed further testing and refinement before it could be put into practice. In the conclusion of their methodological paper in the *Quarterly Publications of the American Statistical Association*, Sydenstricker and King (1921b, p. 856) wrote that they presented their study "with a full realization that it is only a beginning and not a finality in this field." Sydenstricker's cautious stance explains why, in the pellagra studies done by the US Public Health Service, equivalent incomes were calculated using the Atwater scale. Goldberger, Wheeler, and Sydenstricker (1920c, p. 2683) said they did so in "the absence of a better common denominator for this purpose . . . The assumption is by no means as accurate as could be desired," they wrote, but "a scale based on food requirements alone is obviously very much more accurate than one omitting any consideration whatsoever of the number, sex, and age of the individuals composing the families."

Even when equivalent incomes were estimated with this imperfect device, the analysis of the data revealed that pellagra and equivalent income were highly correlated. The table shown in Figure 2 indicates that both the crude incidence rate of pellagra (based on raw data) and the rate adjusted for age and sex differences are characterised by a strong association with the level of equivalent income. This is one of the rare occasions when Sydenstricker and his coauthors (p. 2686) quantified the degree of correlation: "Upon the basis of the average half-month income per adult male unit for each of the income classes and the corresponding pellagra rate per 1,000 persons, the Pearsonian coefficient of correlation is -0.91 ± 0.05."

Moreover, comparisons between households with and without pellagra revealed striking differences in dietary habits. For a list of food items, Goldberger, Wheeler, and Sydenstricker (1920a, pp. 669–72) calculated the available supply in grams per adult male unit. To highlight the differences, they set the quantity of the average diet for nonpellagra households of the highest income class equal to an index number of 100, as shown in Figure 3. They then compared the diet of this group of households to those of three other groups of households: nonpellagra households of the lowest income class, pellagra households of the lowest income class, and households with at least two cases of pellagra. These calculations indicated which food items might be associated with the incidence of pellagra. In the pellagra households with low-income levels, the quantities consumed of goods to the left-hand side of the

Figure 2
Pellagra Incidence per Income Class

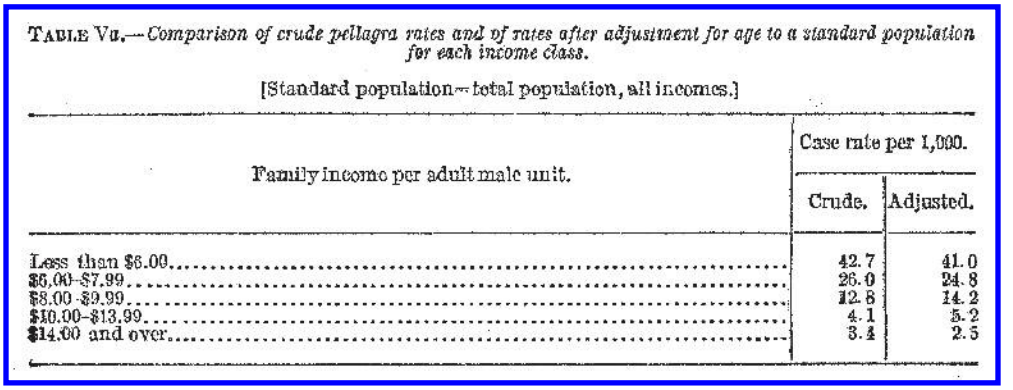


TABLE VII.—*Comparison of crude pellagra rates and of rates after adjustment for age to a standard population for each income class.*

[Standard population—total population, all incomes.]

Family income per adult male unit.	Case rate per 1,000.	
	Crude.	Adjusted.
Less than $6.00	42.7	41.0
$6.00–$7.99	26.0	24.8
$8.00–$9.99	12.8	14.2
$10.00–$13.99	4.1	5.2
$14.00 and over	3.4	2.5

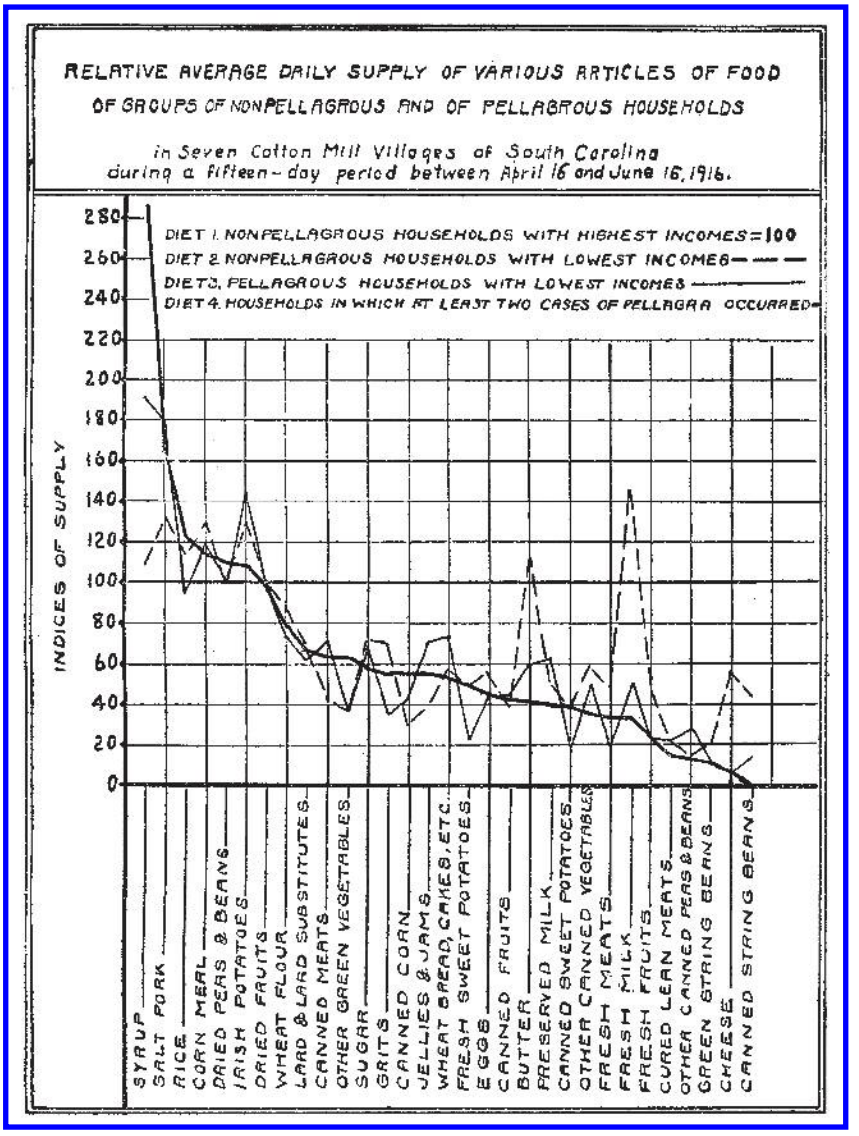
Source: Goldberger, Wheeler, and Sydenstricker (1920c, p. 2687).
Note: Since the authors found that the incidence of pellagra varied according to age, they recalculated the incidence rates for each income class assuming that every class had the same age distribution. A comparison of the crude and adjusted incidence rates shows that the steep income gradient is not a result of the difference in age distribution between the income classes.

figure, like syrup, salt pork, rice, and corn meal, were actually higher than in the nonpellagra high-income households. However, in nonpellagra households with low-income levels, the consumption of "the group comprising the animal protein foods, namely, the lean meats, milk, butter, cheese, and eggs" was clearly higher than in pellagra households. These foods are all major sources of dietary niacin—vitamin B-3. The authors did not know that specific detail, but they nonetheless wrote (p. 681) that "the freedom from pellagra of the nonpellagrous households can be considered as significantly associated with a more liberal supply from but this one group of foods."

Based on this data, Goldberger, Wheeler, and Sydenstricker (1920a, p. 702) argued that their findings constituted "additional evidence of the controlling influence of diet in the prevention and the causation of the disease." They arrived at the conclusion that while pellagra was negatively associated with socioeconomic status, this was due primarily to differences in the diet of low- and high-income households. The few cases occurring in higher income households were likely explainable by them having a diet that was similar to the diet of those at risk of pellagra in low-income households. The clear connection between equivalent income and pellagra incidence also meant that economic conditions such as areas of poverty or cycles of booms and busts, which affect incomes via changes in prices, wages and employment levels, were bound to influence the incidence rates of the disease (Goldberger, Wheeler, and Sydenstricker 1920c, pp. 2709–10).

Although the US Public Health Service applied the Atwater scale rather than the fammain and ammain scales in the analysis of the pellagra survey data, the use of *any* equivalence scale, albeit an imperfect one, was crucially important to

Figure 3
Diet Comparisons



Source: Goldberger, Wheeler, and Sydenstricker (1920a, p. 677).
Notes: For nonpellagrous households with the highest incomes, the quantity per person of each food listed on the horizontal axis is indexed to equal 100. For nonpellagrous families with lowest incomes, the quantity of each food is shown by the wide-dashed line. For pellagrous families with lowest incomes, this is shown by a solid line, and for families with at least two cases of pellagra by a bold line.

provide evidence for the dietary deficiency theory and to highlight the relevance of economic factors. It was instrumental to stratify the prevalence of the disease and to study patterns of food consumption. The analysis showed both dramatic variation

in the prevalence of the disease—like a 16-fold difference in the rates of pellagra between the lowest and highest equivalized income categories—as well as considerable variation in diet across these income categories. Such evidence was central to the US Public Health Service making the case that pellagra, rather than being an infectious disease, was linked to some type of dietary issue (later identified as low levels of niacin) and strongly associated with poverty.

Two caveats to these findings are worth noting. First, while some epidemiologists have sought to reanalyse both the work of the Thompson-McFadden Commission and that of the US Public Health Service, such efforts are limited by not having access to original individual level data (Mooney, Knox, and Morabia 2014). Hence, it is difficult to now isolate the contribution of using equalized income over other measures of socioeconomic status in helping illuminate the causes of pellagra at this time. Although it is worth noting that previous epidemiological studies such as Jobling and Petersen (1917) used per capita income, they did not find the same level of correlation between income and cases of pellagra and in fact reached opposite conclusions regarding its cause (that is, incorrectly finding that pellagra was an infectious disease).

Second, the pellagra fieldwork undertaken by the US Public Health Service involved by design a largely homogenous sample and this involved excluding some occupations (like mill managers) as well as African American families. Marks (2003) has argued that Sydenstricker, in focusing his effort on understanding patterns of disease by income, ignored important racial and gender health disparities, which have been examined by a later generation of economists (for example, Myrdal 1944; Muller 1990).

What Can We Learn from Sydenstricker's Contributions Today?

Sydenstricker and King (1921a, p. 593) emphasized the potential uses of their equivalence scale:

> The advantages of reducing family income to a per ammain basis are obvious and striking. By this process all families are made readily comparable as to income, entirely regardless of their respective age and sex compositions or of the number of persons composing them. This mode of procedure substitutes precise for haphazard methods, brings order out of chaos, and, in fact, offers the first plan which really permits of the income classification of all of the families in any locality with any reasonable degree of precision.

They suggested that "the Bureau of Labor Statistics, the Treasury Department, or some other interested branch of the government derive official ammain scales based upon an average representing all classes of the population."

In practice, however, there was only modest use of the newly developed ammain scale. Wiehl and Sydenstricker (1924) applied it in the analysis of the incidence of

disabling sickness in a range of cotton mill towns of South Carolina, using data from the second wave of the pellagra survey of 1917. This was a follow-up study on a previous analysis by Sydenstricker, Wheeler, and Goldberger (1918), which used data from the more restricted first wave of the pellagra survey of 1916 and applied the Atwater equivalence scale. It is not possible to compare the two studies directly, because they report patterns of disease across different income groups, but the results from both studies show a strong gradient in disease prevalence across income groups within these communities. In addition, Sydenstricker, King, and Wiehl (1924) employed the ammain scale in a study of life cycle variations in the income of wage earners. King (1925) referred to the scale in a paper on the measurement of income and wealth.

In Sydenstricker's time, the US Public Health Service invested in additional fieldwork to collect economic data that could be used to construct more refined equivalence scales. While Sydenstricker and the Public Health Service in subsequent years continued to focus on the relationship between income and health, simpler measures such as per capita income were often regarded as sufficient (Perrott, Collins, and Sydenstricker 1933, p. 1256). As time went on, even the idea of using data on income for the study of disease fell into disuse by public health researchers. As one prominent example, the massive Framingham Heart study was set up by the US Public Health Service in the late 1940s with dedicated funding from Congress to look at the potential causes of heart disease (Mahmood et al. 2014). However, household income was not collected as part of the original Framingham study (Oppenheimer 2005, p. 608). Only information on educational attainment and place of residence was gathered. Apparently, the concern was that asking participants about income might offend them and hence compromise the collection of predominantly clinical data, which was seen as the main purpose of the study (Dawber et al. 1959). Not being able to stratify cardiovascular risk by socioeconomic factors such as income has had a legacy, as the risk-prediction tools developed from Framingham data have been shown to under-predict cardiovascular risk in low-income and less-educated populations (Fiscella, Tancredi, and Franks 2009).

According to Krieger and Fee (1996), the reorganisation of the US Public Health Service and other federal agencies as well as changing attitudes during the Cold War explain why the focus of public health research shifted away from quantifying socioeconomic status. Less attention was paid to the measurement of income gradients and to the use of equivalence scales. For example, the second and third wave of the National Health Examination Survey (Roberts 1973) makes no adjustment for household size or composition when looking at the gradient across income. Many recent summaries of the National Health and Nutrition Examination Survey (NHANES), the most recent incarnation of the health examination surveys, do not report disparities by income at all (for example, Aguilar et al. 2015). A number of recent epidemiological studies do not often use equivalent income and instead rely on measures such as education and occupational class (for example, D'Errico et al. 2017).

Meanwhile, household equivalence scales are often used in the economics literature, although their shape has changed from the research of a century ago.

Among economists and other social scientists, the ammain scale did find its way into other applications, such as Alvin Hansen's (1922) analysis of inflation during the First World War. A search of Google Scholar indicates that Sydenstricker and King's *Journal of Political Economy* article (1921a) has just four citations. Their article in the *Quarterly Publications of the American Statistical Association* (Sydenstricker and King 1921b) received more attention: 118 citations due to its extensive analysis by the sociologist William F. Ogburn (1931) and a discussion by Milton Friedman (1952). Although Friedman (p. 13) very much appreciated "their excellent article," he noted that their approach has two difficulties: it is not always possible to allocate expenditure to individual family members, and some expenditures (like rent) are in the form of "overhead costs," which are fixed and thus will vary by the number in the family. Friedman (p. 14) also raised what he saw as a fundamental problem in obtaining such a scale: in order to determine if families are "equally well off," you need to have a measure of each individual's expenditure requirements. This he regarded as a "vicious circle: we cannot get a satisfactory ammain scale unless we have one to begin with."

A modest rehabilitation of the methodological research of Sydenstricker and King can be found in the work of the economist Sigbert Prais. Although Prais (1953, p. 792) developed his methods for estimating equivalence scales from family budgets without previously knowing their work, he noted that his approach had "many formal analogies with the method of Sydenstricker and King given in a fundamental paper written in 1921 which dealt with many of the problems of principle and practice encountered in this work, but which was virtually ignored in the subsequent literature." Therefore, the work of Sydenstricker and King can be regarded as anticipating the Prais-Houthakker model for measuring equivalence scales (Prais and Houthakker 1955; Muellbauer 1980; Barten 1987).

As Lewbel and Pendakur (2018) have noted, equivalence scales have found a wide range of applications in economic research: assessing the extent of poverty and inequality, calibrating the level of social benefits, measuring the costs of raising children, and so forth. By contrast, they have rarely been used in modern epidemiological studies. We feel that it is time to learn some lessons from history and to adopt Sydenstricker's broader approach in studies attempting to understand public health issues. More generally, involving economists in the data collection and analysis of large epidemiological studies could provide greater insights into the causes and potential interventions to address a wide range of diseases.

■ *This paper is based on work previously presented at the 43rd Annual Meeting of the History of Economics Society (Duke University 2016) and at the 24th Annual Conference of the European Society for the History of Economic Thought (University of National and World Economy, Sofia, 2021). A paper dealing more generally with Sydenstricker's work has recently been published by the European Journal of the History of Economic Thought (Clarke and Erreygers 2022).*

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