



# Pellagra in the United States: A Historical Perspective

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**ABSTRACT:** Pellagra was in existence for nearly two centuries in Europe before being recognized in the United States, where it was first reported in 1902. Over the next two decades, pellagra occurred in epidemic proportions in the American South. Poverty and consumption of corn were the most frequently observed risk factors. Since the exact cause and cure of pellagra was not known, a culture of “pellagraphobia” formed among the public. Patients were shunned and ostracized. The medical community implicated spoiled corn as the cause of pellagra, which had economic repercussions for agriculturists. Joseph Goldberger, MD, of the United States Public Health Service eventually solved the secret of the malady: faulty diet. Goldberger was able to prevent and induce pellagra by dietary modification, a landmark event in the annals of medicine, nutrition, and epidemiology. His work and the social history of that period are reviewed.

PELLAGRA, a systemic disease of niacin deficiency, was not recognized in the United States until the beginning of the 20th century. Don Gasper Casal, a Spanish court physician, first described pellagra in 1735.<sup>1,2</sup> Casal noted the malady among poor peasants of Asturias and called it “*mal de la rosa*,” because all the affected patients had the typical reddish and glossy rash on the dorsum of the hands and feet. Francois Thiery, a French physician, published the first description of pellagra in 1755.<sup>1,2</sup> He had learned about *mal de la rosa* from Casal during his visit to the Asturias in 1750. Casal’s description of pellagra was published 3 years after his death, in 1762.<sup>2</sup>

Francesco Frapoli, an Italian physician, first used the term “pellagra” in 1771.<sup>1,2</sup> Pellagra in the local Italian vernacular meant “rough skin,” denoting the rough skin dermatitis of the pellagrins. Earlier, Casal had been puzzled as to the origin of pellagra and had asked, “Is the cause of this disease to be sought in the heavens, that is in the condition of the atmosphere, or in the constitutions, or in the diet of the patients?”<sup>2</sup> Casal had observed that pellagrins were all poor, subsisted mainly on maize, and rarely ate fresh meat.<sup>2</sup> Indian corn or

maize was introduced to Europe from the New World after the 15th century.<sup>3,4</sup> As a crop, corn was easy to grow and soon became the staple cereal of the European poor. Pellagra remained endemic for nearly two centuries among the maize eaters of southern Europe.

The first case of pellagra in the United States was reported in 1902.<sup>5</sup> Soon pellagra began to occur in epidemic proportions in states south of the Potomac and Ohio rivers.<sup>6</sup> The pellagra epidemic lasted for nearly four decades. It was estimated that there were 3 million cases and 100,000 deaths due to pellagra during the epidemic.<sup>4</sup> The exact cause of pellagra was not known. The patients felt ostracized and were shunned. The social stigmatization was similar to that of the present day epidemic of acquired immunodeficiency syndrome.<sup>4</sup> Joseph Goldberger of the US Public Health Service solved the secret of the malady of pellagra. Goldberger’s epic work and the social history of the pellagra epidemic in the United States are reviewed.

## EPIDEMIC IN THE SOUTH

In 1902, H. F. Harris, MD, an Atlanta physician, reported the first case of pellagra in the United States.<sup>5</sup> The patient was a poor Georgia farmer, who had always eaten a diet in which Indian corn was a staple and had had a recurrent, debilitating warm-weather sickness for nearly 15 years. Each spring, he became anorectic and lost weight. Typically, blisters erupted

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on his arms and legs, and he had extreme melancholia with suicidal ideation. The symptoms worsened during the summer and abated with the onset of cool weather. Despite adequate therapy of a coexisting hookworm infestation and treatment of pellagra with arsenic and iron, there was no sustained improvement. The patient was advised to move to a cooler climate and to avoid eating decomposed corn. In the years to follow, poverty and consumption of corn were the most frequently observed risk factors among pellagrins.

In 1906, George H. Searcy, MD, studied and reported an epidemic of pellagra among the hospitalized patients of Mount Vernon Hospital for the Colored Insane (Mount Vernon, Ala).<sup>7</sup> Of the 88 cases, 80 were female patients, the mean age was 34 years, and the case fatality rate was 64%. Most of the patients had been in good physical health before hospitalization. Two thirds had been in the hospital for more than a year. None of the nurses attending the patients were affected, despite handling the patients and sleeping in the halls near the wards. The main difference between the patients and their nurses was in the diet. The patients consumed a monotonous corn-based diet, while the nurses ate a nutritious and varied diet. Searcy was aware of the literature implicating consumption of damaged corn as the cause of pellagra among the Europeans. Hence, Searcy blamed the consumption of moldy and spoiled corn as the cause of the devastating epidemic. A sample of the cornmeal consumed at Mount Vernon Hospital was tested in a laboratory of plant pathology in Washington, DC, and was found to be unsuitable for human consumption.<sup>7</sup>

Soon after Searcy's report from Alabama, pellagra began to occur in epidemic proportions in several other mental institutions in the neighboring southern states. In 1909, an outbreak of pellagra was observed at the Peoria State Mental Hospital (Peoria, Ill). Occurrence of pellagra as far west as Illinois surprised most physicians,<sup>8</sup> and the pellagra epidemic was not confined to the mental institutions. The epidemic was seen in orphanages, cotton mill villages, and urban and rural areas.<sup>8</sup> Sir William Osler had stated in his first six editions of *The Principles and Practice of Medicine* (1892 to 1907) that pellagra had not been observed in the United States.<sup>2</sup> It is possible that pellagra could have been endemic among the vulnerable populations but had not been recognized. In a retrospective survey of physicians who had

entered practice before 1903 in Spartanburg, SC, Wheeler<sup>9</sup> found that nearly 50% of the 62 practitioners surveyed had seen cases similar to pellagra before 1906. In that study, the earliest observed case of pellagra-like illness was in 1885. Wheeler speculated that "out of respect for authority" the previous generation of physicians did not venture to diagnose pellagra, since it was considered nonexistent in the United States. Babcock<sup>8</sup> reviewed the case records of the South Carolina Hospital for the Insane and concluded that pellagra-like illness existed among the inmates as early as 1834.

To the American physician and public alike, pellagra was a mysterious disease. The exact cause or cure for pellagra was not known. In Europe, pellagra had been in existence for nearly two centuries. Europeans had recognized the association of corn and the occurrence of pellagra. Although it had been opined that lack of some nutrient in corn caused pellagra, the commonly held opinion was that consumption of spoiled corn was responsible for pellagra. The "spoiled corn" theory proponents ascribed to pellagra the toxins liberated from mold infestation of corn, similar to the cause of ergotism by toxins in moldy rye.<sup>4</sup>

James Woods Babcock, MD, superintendent of the South Carolina Hospital for the Insane, was one of the pioneers in the study of pellagra in the United States.<sup>10</sup> In 1908, Babcock traveled to Italy with South Carolina Senator Tillman and visited several hospitals for pellagrins. Babcock returned convinced that "Italian pellagra" was similar to the cases of pellagra in the American South. On his return, Babcock studied the cases of pellagra among the inmates of his hospital and became a well-known pellagra consultant locally and nationally. Babcock organized the first National Conference of Pellagra in Columbia, SC, during November 1909. The conference was well-attended and well-received by the media. The conference strongly implicated corn, especially spoiled corn, in the etiology of pellagra.<sup>8,11</sup>

Indictment of corn created significant economic repercussions for agriculturists.<sup>8</sup> Corn was the main cash crop across the country. The southern states blamed the mechanized harvesting techniques of the western farmers for the spoilage of corn.<sup>12</sup> In the South, corn was a relatively minor crop, and the farmers could afford to follow the traditional method of harvesting, where the whole fodder with the ears was pulled out and allowed to dry thoroughly before the husking of the corn.<sup>8,12</sup>

In the West, increased production of corn and a concomitant shortage of labor led to the use of mechanical harvesters. In the mechanical method, the machine cut the corn stalks with the corn ears and made them into shocks, which prevented proper drying of the corn ears and readily encouraged the growth of fungus.<sup>8,12</sup> Several of the southern states passed corn inspection laws. The Georgia State Board of Health issued a warning to the public about the danger of consumption of western corn.<sup>8</sup> As corn was facing the wrath of a frustrated medical and lay community, several other factors were proposed to cause or predispose people to the development of pellagra. Other staple dietary constituents of the southerners, such as cottonseed oil and sugar cane, were implicated.<sup>8</sup> Pellagra was deemed infectious by many and potentially heritable by some.<sup>8</sup>

The pellagra epidemic created a culture of "pellagraphobia."<sup>13</sup> Patients were shunned as "lepers" and ostracized.<sup>8</sup> The diagnosis of pellagra resulted in social isolation and despair for the affected. Some hospitals refused admission to pellagrins. Isolation of hospitalized pellagrins originated in Tennessee and became common practice in other southern states.<sup>8</sup> The unsuspecting patient was offered a plethora of unpleasant, illogical, and quixotic therapeutic options. Arsenic, salvarsan, calcium sulfide, iron, strychnine, quinine, autoserotherapy, partial appendectomy, and static electric shock were some of the prescribed therapies for pellagra.<sup>8,14</sup>

#### SEARCH FOR CAUSE AND CURE

In 1912, the pellagra malady was at its peak. An estimated 25,000 cases of pellagra had been diagnosed since 1907, with a mortality rate of 40%.<sup>15</sup> Despite widespread pellagraphobia, a sincere plea for help came from all quarters. The US Public Health Service and the privately funded Thompson-McFadden Pellagra Commission began to study the pellagra problem.

The Thompson-McFadden Pellagra Commission<sup>16</sup> surveyed over 5,000 people living in a pellagrous area of Spartanburg County, SC, and found no relationship between diet and occurrence of pellagra. Most pellagrous patients lived in cotton mill villages. Women between the ages of 22 and 44 years, children between the ages of 2 and 10 years, and elderly people were the most frequently affected. Pellagra was uncommon among children younger than 2 years of age, postpubertal ado-

lescents, and active men. Cases of pellagra were seen in clusters. In 80% of pellagra cases, close contact to a preexisting case could be established. The researchers attributed such clustering to an unknown infectious agent transmitted from person to person by an unknown mechanism.

C. H. Lavinder, MD, headed the United States Public Health Service investigations.<sup>17</sup> However, attempts to establish the basis of an infectious etiology by animal experiments were unsuccessful. R. M. Grimm, MD, did the field survey for the Public Health Service. He studied 25 southern communities: 3 coal mine districts in Kentucky, 7 cotton mill villages in South Carolina, and 15 sharecropping communities in Georgia.<sup>8</sup> These initial epidemiologic observations established the association of poverty and poor sanitation with occurrence of pellagra.

Pellagra was stripped of its mystery and myth by Joseph Goldberger. Born in Hungary in 1874, he emigrated with his parents to the United States at 7 years of age. He grew up in New York City's East Side, started a college education in civil engineering, then transferred after 2 years to study medicine at Bellevue Hospital Medical College.<sup>18</sup> After graduation in 1895, Goldberger attempted private practice for a few years. Unsuccessful and bored, he joined the US Public Health Service in 1899. Goldberger found enough challenge and excitement in his new career. By sheer hard work, he was able to establish a name for himself as an astute clinical epidemiologist. It was that reputation that led him to the pellagra problem. Surgeon General Rupert Blue invited Goldberger to head the Public Health Service's pellagra investigations in February 1914.

In 1914, the commonly held opinion was that pellagra was an infectious and communicable disease. Goldberger was not biased by the preexisting opinions. He arrived with a perceptive and a receptive mind. Within 3 months of beginning his investigations, Goldberger convincingly hypothesized the epidemiology of pellagra. By observation and review of the literature, he concluded that pellagra was a dietary disease and not an infectious disease.<sup>19</sup> His supposition was based on the fact that pellagra occurred only among the inmates of mental institutions and not among the nurses and attendants who had cared for those inmates. The difference between the two groups was in the diet. The nurses and attendants' diet was varied and better. The patients' diet was pre-

dominantly based on vegetables and cereals and lacked fresh animal foods. Goldberger was also aware that pellagra was a rural disease associated with poverty, occurring in people who consumed a monotonous “3-M diet” of *meat* (fatback), cornmeal, and molasses. Despite not knowing the true dietary cause of pellagra, Goldberger suggested that increased consumption of fresh meats, eggs, and milk could be preventive. Soon, Goldberger was able to prevent and induce pellagra by dietary modification.

Goldberger chose two orphanages in Jackson, Miss, and a Georgia state sanitarium to conduct pellagra prevention studies.<sup>20</sup> Pellagra had been endemic in these institutions for several years. The diets at the three institutions were modified with a liberal intake of fresh animal foods and legumes beginning in September 1914. The following spring, there was only one case of recurrence among the 172 pellagrins from both the orphanages, and no new cases of pellagra occurred. In the Georgia sanitarium, after dietary modification there was no recurrence of pellagra among the 72 pellagrins, though the recurrence rate was 50% among controls. During the study period, the sanitary conditions of the orphanages and the asylum remained unchanged. With these studies, Goldberger was convinced that pellagra was a preventable dietary malady.

Goldberger’s next human experiment was more innovative and radical. With the promise of pardon from Governor Earl Brewer of Mississippi, 12 convicts were recruited from the Rankin Farm of the Mississippi State Penitentiary to participate in a study.<sup>21,22</sup> The hypothesis was that pellagra is inducible in previously healthy men by consumption of a monotonous cereal-based diet. The subjects were healthy white men. None had pellagra. All other persons living at the farm were observed as controls. The subjects were housed in a clean building and segregated from other convicts. They were expected to work but had shorter work periods and fewer work hours. During the first 10 weeks of the study, there was no difference in diet or life-style between the subjects and the controls. During the second phase of the study, for 6 months, the diet was markedly different for the study subjects. They were given a monotonous diet, which was of low caloric and protein value. Of the 12 volunteers, 11 completed the study. Upon completion, 6 of 11 had pellagra. There were no cases of pellagra among the controls. With the success of the Rankin Farm experiments,

Goldberger had cured, prevented, and induced pellagra by dietary manipulation.

Goldberger’s simplistic and convincing approach to pellagra was not acceptable to southern physicians and politicians.<sup>8</sup> Implication of the “3-M faulty diet” causing pellagra shifted the focus on the existing poverty in the South, which hurt southerners’ pride. Pellagra had come during the era of the microbiologists. Infectious cause had been ascribed to several illnesses. The role of insect vectors in the transmission of malaria and yellow fever had been established.<sup>23-25</sup> Hence, it was only fashionable for the critics of Goldberger to think that pellagra was a transmissible infectious illness. To prove to his critics that pellagra was not transmissible, Goldberger exposed 16 volunteers, including his wife, to blood, urine, feces, and epidermal scales of pellagrous lesions, and pellagra did not develop in any of the volunteers.<sup>26</sup> Now Goldberger was even more convinced that pellagra was due to a faulty diet and was linked to the prevailing economic conditions in the South.

The next phase of Goldberger’s work involved establishing the socioeconomic epidemiology of pellagra. Seven cotton mill villages in South Carolina were chosen. The entire population was screened for pellagra, and meticulous dietary data for all households were collected. Pellagrous households had restricted intake of animal protein.<sup>27</sup> There was no association with consumption of corn or sanitary conditions to development of pellagra.<sup>28</sup> Pellagrous households were all poor.<sup>29</sup> The poverty and diet of those affected could be linked to cotton. Cotton was the king among the cash crops, and the sharecroppers and tenant farmers cultivated cotton at the expense of other crops. Lack of diversification and the speculative nature of cotton prices during the depression made the tenant farmer and the sharecropper vulnerable to poverty, poor diet, and pellagra.<sup>18</sup> Goldberger had now concluded that pellagra was a socioeconomic malady, and its occurrence in epidemic proportions in the South reflected the extent of southern poverty.

Such a conclusion touched the nerves of the prideful southerners and caught the attention of President Warren Harding.<sup>8</sup> Harding responded by promising legislative action and wrote to the surgeon general, “Famine and plague are words almost foreign to our American vocabulary, save as we have learned their meaning in connection with afflictions of lands

less favored and toward which our people have so many times displayed large and generous charity. . . . The nation could not wait a single day to take action. It must save its own."<sup>8</sup> Such a statement from the president angered the southern public and politicians. In protest, the citizenry of a Georgia city telegraphed their senator, "When this part of Georgia suffers from a famine the rest of the world will be dead."<sup>8</sup> The political backlash from the South dampened President Harding's enthusiasm for solving the problem.

The year was 1921; it was 7 years since Goldberger had started his pellagra research. He now began in earnest to study the pellagra-preventive action of various foods and to identify the specific nutritional deficiency that was etiologic for pellagra. Goldberger and Tanner<sup>30</sup> speculated that pellagra was due to amino acid deficiency. They showed resolution of skin lesions in pellagrins treated with cysteine and tryptophan. However, supplementation of good-quality proteins such as soy and casein failed to cure pellagra; but a diet supplemented with dried yeast and poor in protein was dramatically effective in achieving cure.<sup>31,32</sup> They concluded that a dietary factor independent of protein was effective in prevention of pellagra. They called it the "pellagra-preventive factor" (P-P factor). Goldberger and his coworkers found dogs to be an ideal animal model for the study of pellagra by showing that black tongue in dogs was similar to pellagra in humans. By 1926, on the basis of animal experiments, Goldberger and his colleagues concluded that P-P factor was the heat-resistant part of "water soluble vitamin B."<sup>33</sup> Goldberger found dried yeast to contain the highest amount of pellagra-preventive vitamin. In 1927, on Goldberger's recommendation, the American Red Cross distributed dried yeast to Mississippi flood victims and successfully prevented a pellagra epidemic.<sup>8</sup> The Mississippi flood experience convinced Goldberger that pellagra in the South was preventable only if the prevailing agricultural practices and economic conditions were to change.<sup>34</sup> He recommended abandoning the cotton monoculture, keeping home gardens for fresh vegetables, and owning milking cows for fresh milk as ways to eliminate the pellagra problem.

Despite his quest to delineate the exact nature of the P-P factor, Goldberger did not succeed; he died of cancer in 1929. The scientific community pursued the search for the isolation of antipellagra factor across the world. In 1937, Conrad A. Elvehjem, an agricultural

chemist at the University of Wisconsin, found nicotinic acid to be highly effective for curing black tongue in dogs.<sup>35</sup> Soon clinical trials followed and confirmed that nicotinic acid (niacin) was indeed the elusive P-P factor.

#### ERADICATION OF PELLAGRA

Pellagra was a rural disease among the sharecroppers, tenant farmers, and cotton mill workers of the South. Its occurrence in epidemic proportions was linked to the economic depression of the times and the monoculture of cotton cultivation. Depression meant less money for food and subsistence on an inadequate diet. The cotton monoculture and nonexistent animal husbandry resulted in a lack of locally produced food. Along with poverty, corn was the common denominator among pellagrins in the United States and Europe. Corn had been the staple diet among the natives of Mexico and Central America for several centuries without causing pellagra. Why had corn suddenly become pellagrigenic in United States and Europe? The answer to the problem lay in the methodology of corn processing, cooking, and milling.<sup>36</sup> The natives of Mexico and Central America had always soaked the corn in alkali before cooking. The alkali treatment liberates the bound niacin in corn, thereby enhancing the niacin content of the diet to the point of being protective against pellagra. The process of degerming in the preparation of cornmeal became feasible with the development of the Beall degerminator in 1905.<sup>36</sup> The process of degermination reduces the niacin content of corn and could have precipitated the development of pellagra among a vulnerable population.

Public awareness campaigns, agriculture diversification, change of food habits, and food fortification with nicotinic acid were all responsible for the eradication of pellagra in the South.<sup>8</sup> The recommendation of the Food and Nutrition Board regarding the enrichment of bread and flour with thiamine, niacin, and iron was endorsed by the members of the baking and milling industries in 1941.<sup>37</sup> Soon the food fortification program played a crucial role in eliminating pellagra. The consumption of enriched flour and bread ensured that the dietary intake of niacin and thiamine was adequate, thus ensuring the prevention of pellagra and beriberi. Pellagra was truly conquered in the American South during the Second World War.<sup>38</sup> Paradoxically, there was relative prosperity during the war. The economy improved,

there were more jobs, and almost everyone had an income. The wartime rationing also made the people conscious of eating high-quality food. By 1945, pellagra had become extinct in the South, and the pellagra producing 3-M diet of southerners had become a relic of the past.

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