AJKD

Narrative Review

Kidney Disease and the Westernization and Industrialization of Food

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The industrialization of food in the United States has led to lower prices, and families now spend a smaller percentage of their total income on food compared with past generations. The decline in prices for food commodities has led to sharp increases in food consumption, with average caloric intake in the United States now more than 500 calories higher per day compared to the 1970s. This increase in total food consumption has fueled the ongoing obesity epidemic, which in turn has likely played a role in the epidemic of end-stage renal disease during the last 2 decades. A close examination of dietary behaviors in the United States reveals high consumption of salt and animal protein, which negatively affects kidney disease progression. An interprofessional approach is necessary to address obesity, and studies are needed to identify best practices for integrating medical nutrition therapy into the long-term care of patients with chronic kidney disease.
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Holly Kramer, MD, MPH, was the Garabed Eknoyan Award recipient at the 2016 National Kidney Foundation Spring Clinical Meetings. This award was created to recognize an individual who has made exceptional contributions to promote the mission of the National Kidney Foundation in making lives better for people with kidney disease.

Let food be thy medicine…

Hippocrates

INTRODUCTION

In 2004, Susan Hou, a nephrologist who had been practicing several years, pointed out an alarming trend in our dialysis unit. Specifically, she noted the initiation of dialysis therapy in several morbidly obese women with diabetic kidney disease who were younger than 40 years. In the past, such patients were extremely rare, but at that point in time, our dialysis unit had several. My colleagues and I cared for these women and other young morbidly obese adults with end-stage renal disease (ESRD) over the next decade and watched them experience vascular access problems, line sepsis, menorrhagia, hospitalizations for pulmonary edema, calciphylaxis, and early death. A few patients underwent gastric banding procedures to secure access to the transplant wait list. However, after 1 year of weight loss, most patients gained back all the weight that they had lost and were never listed for transplantation. In 2006, we published a report documenting the obesity epidemic in the US ESRD population and showed that increasing trends in body mass index (BMI) among patients initiating dialysis therapy were outpacing the BMI increase in the age-matched US population.[1] During the past 10 years, the obesity epidemic has continued unabated, and currently 1 of 3 US adults is obese (BMI $\geq$ 30 kg/m^2) and approximately 1 in 20 adult males and 1 in 10 adult females are morbidly obese (BMI $\geq$ 40 kg/m^2).[2]

The industrialization of food with concomitant changes in the cost structure of foods during the past 3 decades has significantly contributed to the obesity epidemic and impeded public health efforts. Since the 1980s, healthier foods have become relatively more expensive compared with processed foods, and portion sizes for processed foods have increased disproportionately to healthy foods, fueling an obesity epidemic.[3] Obesity may be viewed as a complex system with multiple operating parts, such as individual behaviors (diet, physical activity, and selection of portion sizes), susceptibility factors (genetic variants, parental modeling, education, and income), and state and national policies that influence the cost and availability of healthy and nonhealthy foods. When an individual reaches an obese state, these operating parts continue to influence eating behavior and constrain the individual's efforts to move out of the obese state. For kidney disease, many elegant studies have demonstrated potential biological links with over- or underconsumption of certain dietary factors or dietary patterns and kidney disease incidence and progression.[4-14] Despite existing evidence, most

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practicing nephrologists do not prescribe calorie-restricted diets and encourage physical activity to manage moderate chronic kidney disease (CKD) in the setting of obesity; specific dietary changes are also usually not addressed.[15] This review discusses some of the historic aspects of the industrialization of food in the United States and the Western diet and examines a few specific aspects of the Western diet that may accelerate kidney disease progression.

THE INDUSTRIALIZATION OF FOOD AND THE GROWTH OF FARMING EFFICIENCY

The obesity epidemic has likely been one of several factors that drove the epidemic of ESRD during the 1990s and first decade of the 21st century.[16,17] The obesity epidemic started in the United States and remains largely rooted in Western dietary practices. Because the Western diet is characterized by high consumption of food products produced by factories, the terms Westernization and industrialization are often used interchangeably.[18] Here, Westernization refers to Western dietary habits that have evolved over time due to the industrialization of food within the United States during the past 60 years.

The United States has seen remarkable changes in agriculture during the past century and remains the most efficient producer of food in the entire world.[19,20] The industrialization of foods in the United States began during the early part of the 20th century with the introduction of synthetic fertilizers.[20] In the past, farmers relied on animal waste as fertilizer, but synthetic fertilizers greatly increased farming efficiency. In 1954, diethylstilbestrol was approved for use in cattle after studies demonstrated that diethylstilbestrol use led to leaner cattle and less carcass waste.[21] Diethylstilbestrol was removed from the market in the 1970s, but other anabolic agents for cattle, such as estradiol benzoate/testosterone propionate implants, were approved for steers and heifers as early as 1956, and anabolic agents continue to be used in livestock today.[21] Since the 1950s, antibiotics have also been given to animals to promote faster and more efficient growth.[22] In 1981, the Council for Agricultural Science and Technology, an umbrella organization composed of multiple member societies, including the American Society for Horticultural Science and the American Society of Animal Science, reported that livestock producers gain an average of $2.1 billion annually with the use of animal feed supplemented with penicillin and tetracycline.[23] Antibiotics increase the rate of weight gain, decrease the amount of feed required per pound of animal weight gain, and prevent disease.[23] The faster and more efficient growth of livestock with antibiotic use is thought to be mediated by altering the animal gut microbiome, which competes for the animal's nutrients. Inhibiting this gut microflora then helps the animal gain weight faster.[22,24]

Animal farming separated from crop farming during the latter part of the 20th century[25] to help farmers focus their efforts and remain competitive. The majority of animal farmers now specialize in a certain stage of the animal's life, rather than caring for the animals from birth until the final slaughter stage.[25] In addition, most livestock are now fed grains and supplements produced at other highly specialized farms, with livestock farmers no longer growing their own animal feed. Similarly, the consolidation of grain, fruits, and vegetable production has increased farming efficiency, with the majority of farms doubling in size over the past several decades across all states and commodities.[25] The majority of livestock are now raised on large incorporated farms rather than smaller farms (Fig 1). Although the number of small farms in the United States continues to increase, their share of the total market share of sold agricultural goods remains a very small fraction of total sales. During 2012, only 3.8% of all farms in the United States were large farms with more than $1 million in agriculture sales annually. However, sales from these large farms accounted for 66% of the total market value of all sold agricultural products and government payments during 2012 (Fig 2).[26] The consolidation of farms has had a strong impact on the agricultural workforce. During the early part of the 20th century, ~40% of the US workforce was employed in agriculture.

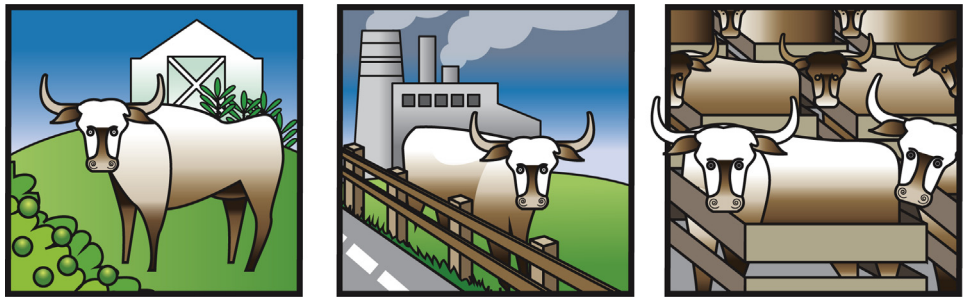

Figure 1. Cartoon depicts the consolidation of livestock farming that occurred in the United States during the end of the 20th century.