

## **The Legacy of Ancel Keys**

### **Basic Sciences**

- Physiology of fishes**
- Osmotic control in fishes**
- High altitude adaptation in humans**
- Renal function**
- Cardiac output**

### **Applied physiology**

- Body composition in fat, bone, muscle and water**
- Body mass index ( Wt/Ht squared)**
- Response to heat, cold, semi-starvation**
- Recovery from starvation**
- Survival ration "K-ration."**
- Lipid metabolism**

### **Nutrition, food composition, production, preparation, eating patterns.**

- Role of vitamins**
- Role of dietary fats and fatty acids, CHO, fiber, cholesterol on blood cholesterol levels (Keys Equation) 2S-P**
- Diet composition and serum cholesterol level**
- The Mediterranean Diet**
- Trans fats, LP fractions**

### **Research methods**

- Regression equations in medical science**
- Multi-disciplinary, inter-disciplinary, team research on major health issues.**
- Comfort across laboratory, clinical, population research as needed**
- Lipid chemistry. Body composition. BMI, Skinfolds.**
- Surveys, The ECG in population studies, cohort studies**
- Metabolic ward feeding studies. Cross-over experiments**
- Recruitment, consent, privacy, PR, communications**

### **Epidemiology. Prevention, Public Health**

- Chronic disease (non-communicable diseases)**
- "Father" of Cardiovascular disease epidemiology**
- Pioneer researcher on the causes and prevention of heart attack**
- Obesity and risk and survival.**
- Risk factor paradigm, single, multi-factor risk**

### **Ancel Keys controversy today**

- Who is questioning the science, where, and why?**
- What is the normal progress and change in science?**
- What is motivated by commerce ("food journalists" serving ag industry)?**
- Ask: What are they selling? What is the evidence? Where are the publications?**
- Changing scene in nutrition: Reductionism to nutrients. Foods. Eating patterns. The whole culture.**

**Artifacts: Articles; K ration, photos, 1928 articles, Biol of Starvation monograph; Exhibit. Archive E1;H3;Q4;Cube box2;Ci VHS;S.Crow**



## The Cardiovascular Disease (CVD) History Archive

Division of Epidemiology and Community Health, School of Public Health, University of Minnesota

A collection of historical documents from major studies by the Laboratory of Physiological Hygiene (LPH or "the Lab") and its successor, the merged Division of Epidemiology, from 1940 to 1990



### 1942-45 — Army Quartermaster studies

The LPH tests of human responses to heat, cold, stress, and diet aided the development of U.S. military policies and supplies, including the "K-Ration," the standard survival ration used during World War II.



### 1943-46 — The 'Minnesota experiment' on starvation

This LPH study of responses to and recovery from semi-starvation among volunteer conscientious objectors led to the development of optimal re-feeding regimens for the starving people of Europe. Findings were published by the University of Minnesota Press in 1950 in a two-volume monograph, *The Biology of Human Starvation*.



### 1947-1981 — The Minnesota Business and Professional Men Study

Also known as the "CVD Study," this was the first prospective study of traits during health and future risk of heart attack among a cohort of 300 middle-aged Minnesota executives. Diet, blood cholesterol, blood pressure, and tobacco use were found to be predictive. The study was eclipsed, however, by early major findings from the much larger Framingham Heart Study.



### 1950-65 — Studies of the physiology and health effects of exercise

LPH researches proved the debilitating effect of bed rest, established maximum oxygen consumption (MVO<sup>2</sup>) as the gold standard for measuring work capacity, redefined "fitness" and its measurement with graded sub-maximal exercise, and demonstrated the complexities in assessing the influence on health of physical activity during work and leisure.

### 1955-65 — The Keys Equation

An equation derived from controlled feeding experiments indicated that saturated fatty acids raised blood cholesterol level (TSC) twice as much as polyunsaturated fatty acids lowered it. The "Keys Equation" predicts change in TSC from a given change in dietary fats and cholesterol, providing sound evidence for current recommendations on healthy eating patterns.



### 1952-56 — Keys-White and the origins of international comparisons

Informal studies during world travels by physiologist Ancel Keys and cardiologist Paul Dudley White produced suggestive evidence that traditional diet and TSC were related to the population burden of heart attack, confirming Keys's early diet-heart hypothesis. These led to the formal study of cultural differences in heart-disease rates in the Seven Countries Study.

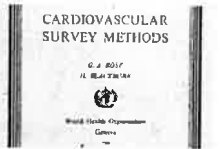
### 1957-present — The Seven Countries Study

This long-term study of 12,000 men in fourteen cohorts and seven countries contrasting in diet compared individual risk within cohorts and population risk among cohorts, leading to the concept of "sick and well populations" and to current public health strategies of CVD prevention.



### 1957-65 — U.S. Railroad Employees Study

LPH researchers examined active and sedentary rail workers "on the job" in a Pullman car laboratory, and followed their experience to find lower heart-attack rates in the active workers. The findings of this observational study were confounded, however, by railway policy that concentrated workers with disease and disability in sedentary occupations.



### 1957-present — Methodological advances in CVD population studies

The LPH developed methods for CVD surveys and trials, including: the WHO manual, *CVD Survey Methods*; quantitative measures of body composition by skin-folds thickness and underwater weighing; the Keys Equation and field methods for measuring diet and serum lipids; improved definition of clinical end-points; the Minnesota Code for classifying the electrocardiogram; fitness testing by a graded stress test; exercise electrocardiography, and a Leisure-time Activity Survey.



### 1972-present — National clinical trials in CVD prevention

The Division played major roles in national trials of risk-modification, including the Hypertension Detection and Follow-up Program, the Multiple Risk Factor Intervention Trial (MRFIT), and the Diet-heart Pilot Study. These trials produced hard evidence that CVD-prevention--on an individual basis as well as in groups--is possible through interventions on behavior and biologic risk characteristics, providing the base for preventive cardiology and public health programs.

### 1979-present — The Minnesota Heart Survey (MHS)

This first research effort in CVD surveillance used hospital surveillance for heart-attack and stroke rates, and conducted recurrent sample surveys of risk factors and cardiac care in the Greater Twin Cities over thirty years. It found a continuing decline in heart-attack death rates due to improved levels of risk factors and health behavior in the population--thus, public health--and to innovations in medical care. The MHS was early to detect a leveling-off of the decline in stroke mortality rates and a rise in congestive heart failure rates, a decline in cigarette-smoking, and a rise in overweight and obesity.

### 1980-90 — The Minnesota Heart Health Program (MHHP)

This decade-long intervention program for modifying personal and community risk factors demonstrated the application of heart-attack prevention and health-promotion programs in six Midwest communities of differing size, and showed the difficulty of assessing their effects in a rapidly changing health environment. MHS and MHHP provided the institutional base, faculty, staff, skills, administration, and model programs for the Division's growth and wider academic contributions.