ANALYTIC REVIEW

Pekka Puska, MD, PhD, MPolSc,
and Paresh Jaini, DO

The North Karelia Project: Prevention of Cardiovascular Disease in Finland Through Population-Based Lifestyle Interventions

Abstract: *The North Karelia Project was started in 1972 as a response to the high cardiovascular mortality among men in North Karelia, Finland's easternmost province. Prevalent cardiovascular disease risk factors in the province included elevated serum cholesterol, hypertension, and smoking. Through a sociobehavioral framework utilizing community-based interventions and national-level policy changes and legislation, the project targeted lifestyle changes as a means to alleviate cardiovascular disease risk factors. Diet recommendations included minimizing the use of saturated fats and decreasing salt intake. Another target of the project was to reduce the prevalence of smoking. As a result of the lifestyle interventions that continued beyond the initial 5 years of the project and then expanded to all of Finland, there were significant reductions in serum cholesterol levels, hypertension, smoking prevalence, and cardiovascular disease mortality. The North Karelia Project demonstrates that successful population-based lifestyle interventions serve as a sustainable public health solution to the growing chronic disease burden.*

Keywords: chronic disease; cardiovascular disease; prevention; lifestyle; population; diet; smoking

> "Despite the importance of treating chronic disease, only prevention has sustainable public health potential."

Introduction

In the 1960s, approximately 700 per 100 000 men aged 35 to 64 years old died of cardiovascular disease in Finland's easternmost province of North Karelia.[1] International statistics showed that Finnish men had the highest mortality from heart disease in the world at that time. Studies by Dr Ancel Keys and Martti Karvonen not only confirmed the high disease rates but also identified the following cardiovascular disease risk factors: increased serum cholesterol, elevated blood pressure, and smoking.[2] Further scientific evidence indicated that high consumption of dietary fats contributed to the increase in serum cholesterol and that salt intake contributed to the elevation of blood pressure.[3] In North Karelia, the general diet consisted of a high intake of salt and animal fats with minimal consumption of fruits and vegetables. Furthermore, the majority of men in the province smoked. In response to a local petition to decrease deaths from heart attacks, the North Karelia Project was launched in 1972 to serve as a population-based intervention focused on public health risk factor reduction and prevention of cardiovascular disease through lifestyle changes.

DOI:10.1177/1559827620910981. From Finnish Institute for Health and Welfare (THL), Mannerheimintie, Helsinki, Finland (PP), and John Peter Smith Health Network, Fort Worth, Texas (PJ). Address correspondence to: Pekka Puska, MD, PhD, MPolSc, Finnish Institute for Health and Welfare (THL), Mannerheimintie 166, Mannerheimintie, Helsinki 00300, Finland; e-mail: pekka.puska@thl.fi.

Project Evaluation and Framework

The original North Karelia Project ran from 1972 to 1977. Before launching the intervention, a comprehensive and carefully designed survey of a random population sample in North Karelia and a matched reference province, Kuopio, was implemented to assess the level of risk factors and other sociobehavioral determinants. After 5 years, an independent cross-sectional population survey was again carried out in North Karelia and Kuopio to assess changes. Other outcome measures included infarction and stroke registers, following World Health Organization (WHO) criteria and numerous other data sources. After the 5-year period ended, the interventions continued in North Karelia but were also expanded to all of Finland per request of national health authorities. Thus, the project was no longer a pilot study but instead became a national demonstration area. The project formally ended in 1997 after 25 years of implementation.

The primary strategy of the project focused on prevention rather than treatment. Despite the importance of treating chronic disease, only prevention has sustainable public health potential. Another consideration was to broaden the prevention strategy to an entire population. Given that North Karelia population's risk factor level was high, it was necessary to utilize community-wide interventions to target reduction of general risk factor levels in the population and not just high-risk individuals. Because the primary risk factors were related to lifestyle, especially diet and smoking, the main strategy was to modify lifestyle behaviors of the population through comprehensive community interventions. Lifestyle is strongly connected to culture and environment; therefore, it became necessary to initiate a sociobehavioral change in North Karelia where healthy lifestyle behaviors replaced unhealthy ones.

In regard to the application of community-based interventions, the project catalyzed, trained, and coordinated the work that was carried out by numerous community and nongovernmental organizations, including health centers, schools, the private sector, and media. The project provided evidence-based health education material and background information to the population through media to further reinforce the grassroots work taking place. At the national level, policy measures in the food industry and tobacco legislation took place. Figure 1 shows the theoretical sociobehavioral framework of the intervention.[4]

Risk Factor Reduction Through Lifestyle Change

Aim 1: Reducing Serum Cholesterol With Low-Fat Dietary Intake

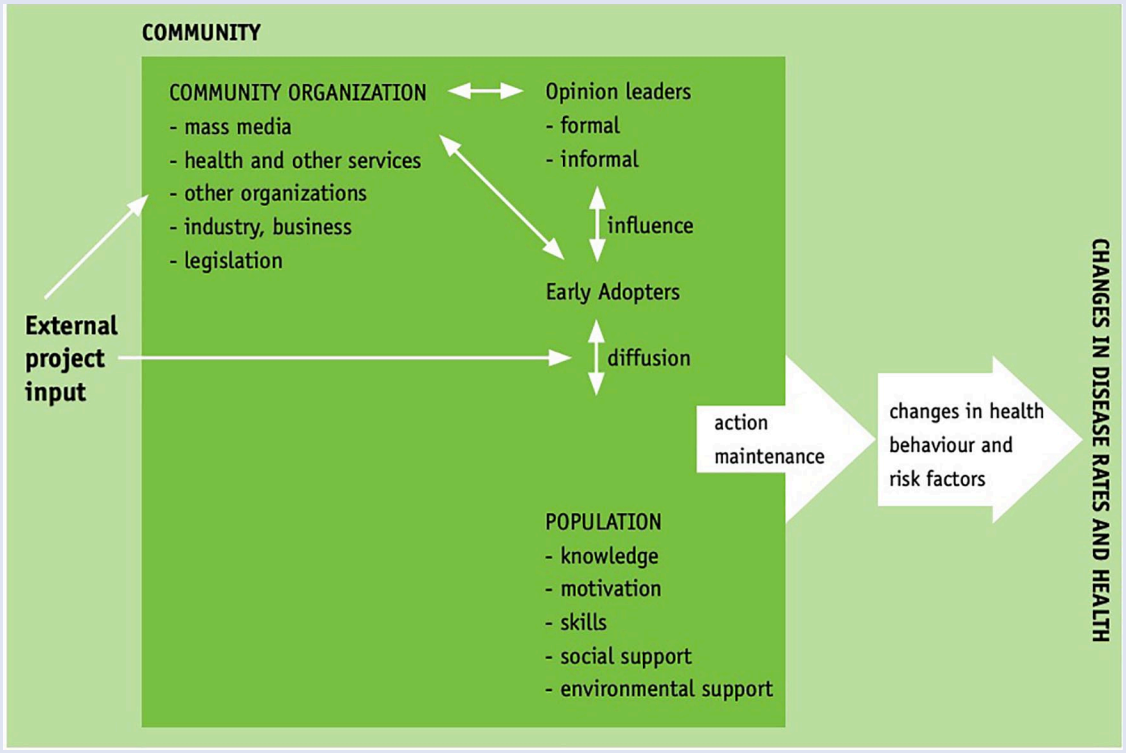
To reduce the cardiovascular risk factor of elevated serum cholesterol levels, the North Karelia project targeted dietary fat intake. The diet recommendation was to minimize the use of saturated fat products (ie, hard butters and margarines, high-fat and whole milk, and fatty meats) and transition to the use of products with low saturated fats and vegetable oils (ie, soft butters and margarines, vegetable oils, low-fat or nonfat milk, and lean fish, poultry, and meats). These nutritional messages were spread through community channels and activities. Between 1972 and 1977, more than 1000 newspaper articles were published on nutrition and other risk factors.[4] Furthermore, diet was discussed in more than 150 health education meetings and more than 300 local "parties of long life," where healthy food was cooked and served by local housewives associations to village members.[4] Hundreds of special training seminars were organized for health care workers, the general public, and mass catering personnel responsible for workplaces, schools, hospitals, and restaurants. After the initial 5-year period for the project, the government became more involved and developed policies that increased consumers' health consciousness through media campaigns and led to the food industry creating low-fat products. The mobilization of community members and local resources in addition to national health policies and initiatives led to major dietary changes. From 1972 to 2012, the use of butter on bread had dropped by approximately 80%, and the use of butter for cooking had dropped by approximately 50%.[4] Vegetable oils, such as rapeseed oil, and soft butters and margarines became the lower-fat alternative. As a result, serum cholesterol reduced by more than 20% in both men and women in North Karelia between 1972 and 2012.[4] The intake of saturated fats reduced from 20% to 12% in 2007 and increased from 2007 to 2012 to 14%.[4] Most of the decline in serum cholesterol was explained by dietary changes, with minimal contribution from statin use.

Aim 2: Controlling Blood Pressure With Low Dietary Intake of Salt

One of the key aims of the North Karelia project was to reduce the cardiovascular risk factor of hypertension. The framework of this intensive prevention and control program involved community-based activities that offered blood pressure detection and treatment. Blood pressure measurements were taken at all contacts with medical doctors or nurses, special measurement campaigns, and obligatory tuberculosis screenings. Individuals with elevated blood pressure were registered in the North Karelian hypertension register. These individuals were then invited at least annually to follow-up health examinations and were treated in local community primary health centers and special hypertension clinics run by public health nurses trained by project staff. At the national level, after the initial 5-year period, a special Salt Project was developed for health education regarding salt reduction in diet for the general public. Furthermore, the food industry reduced salt content in products and developed special mineral salts (with sodium replaced by potassium and magnesium). As a result, salt intake reduced in North Karelia from 13 to 9.5 g

Figure 1.

The community intervention model of the North Karelia Project.



among men and from 10 to 7.4 g among women.[4] This behavioral change had a significant beneficial impact on blood pressure because the mean systolic blood pressure in North Karelia decreased from 149 to 134 mm Hg and 153 to 127 mm Hg among men and women, respectively, from 1972 to 2012.[4]

Aim 3: Smoking Cessation

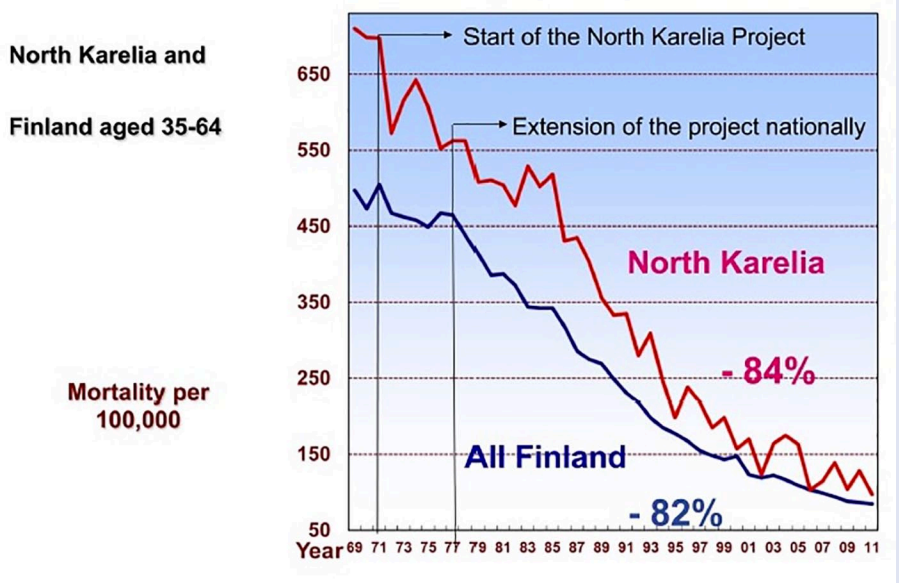
A third aim of The North Karelia Project was reduction of smoking prevalence as smoking is a major contributor to cardiovascular disease. Intervention activities involved health education through articles in the press, educational leaflets and pamphlets, posters, mass meetings, health services, and schools. Smoking cessation community groups were also developed and were led by a local public health nurse. Furthermore, nicotine replacement therapy was utilized. The leader of the North Karelia project was heavily involved in tobacco control legislation, which came into force with The Tobacco Act in 1977. This legislation banned tobacco advertisements, banned selling tobacco to individuals <16 years of age, mandated health warnings in cigarette packs, and restricted smoking in schools and public places. As a financial penalty, 0.5% of duty revenue from tobacco purchases were used for smoking cessation initiatives. After the initial 5-year project period, additional changes took place. There was a long-term series of television smoking cessation programming, a requirement for all workplaces to be smoke free, and an increase in tobacco purchase age from 16 to 18 years. School-based smoking cessation campaigns were also developed and targeted prevention of cardiovascular disease in teenagers. The smoking cessation initiatives reduced smoking during the first 10 years from 51% to 36% of the population in North Karelia, and this decline was significantly faster than in Kuopio.[4] National findings showed that the smoking rate among men was about 60% in the 1960s but then decreased to 16% by 2016.[4-6]

Reduction of Cardiovascular and All-Cause Mortality

During the initial 5-year period of the project, there were major dietary changes and reduction in smoking, which led to improved serum cholesterol levels and blood pressures. With increased national action, these changes and associated changes in serum cholesterol and blood pressure continued in North Karelia and began taking effect in all of Finland. In 2011, the cardiovascular disease mortality among middle-aged men was about 100 per 100 000 as compared with 690 per 100 000 before the project began.[2,4] From 1969 to 2011, the annual age-adjusted cardiovascular disease mortality reduced >80% among men 35 to 64

Figure 2.

Cardiovascular disease mortality in men from 1969 to 2011.



years old in both North Karelia and Finland (Figure 2).[4] It has been calculated that if the cardiovascular disease mortality had stayed at the preproject level until 2006, some 243 000 additional cardiovascular deaths would have occurred in the 35- to 75-year-old age group.[7] Separate analyses have also shown that approximately two-thirds of the reduction in cardiovascular disease mortality could be attributed to the target risk factors, especially serum cholesterol level, emphasizing the positive impact of lifestyle change.[8,9] Additional surveys showed that there was a substantial improvement in the subjective health of the population, and life expectancy had increased by about 10 years.[9-11]

Discussion

Currently, two-thirds of all deaths in the world are a result of noncommunicable chronic disease, with one-third of deaths being a result of cardiovascular disease.[12] These illnesses are commonly associated with unhealthy lifestyle behaviors, such as poor diet, physical inactivity, and substance use. With the growing disease burden, it is necessary that action be taken to improve health at the population level by targeting unhealthy lifestyle behaviors. The North Karelia Project is a powerful demonstration of how population-based changes in lifestyle and environment are the most effective way to sustain prevention of cardiovascular and other major noncommunicable diseases. The comprehensive community-based program in North Karelia, supported later by national-level health promotion and policy measures, led to dramatic positive lifestyle changes, reduction in cardiovascular disease and all-cause mortality, and increased life expectancy and also improved the subjective health of the population.

The project's success can be attributed to its focus on directly targeting lifestyle behaviors associated with cardiovascular disease risk factors of elevated serum cholesterol by limiting fat intake, hypertension by limiting salt intake, and smoking cessation. Furthermore, the project did not just focus on individual preventive measures among high-risk individuals but instead developed health promotion and policies that addressed the general public, regardless of risk level. Another feature that contributes to its success is implementation that went far beyond health services and providing health information. The project identified practical priority targets of change and provided change skills as well as social and environmental support. Its grassroots approach through local community organizations, schools, workplaces, and other training sites provided practice application of lifestyle changes. Utility of mass media through television, pamphlets, and newspaper articles helped increase consumer health, awareness, and education. National-level health policy and legislation affecting changes in the food industry and tobacco use also contributed to the successful outcomes of the 5-year project and thereafter.[12] Health had become the conversation of Finland.

The lessons learned in North Karelia and Finland have garnered international attention because it exemplifies the successful implementation of a population-based lifestyle intervention. The project has collaborated with multiple organizations, including the WHO, and it has contributed to the

WHO Global Strategy on Prevention and Control of Noncommunicable Diseases in 2000 and subsequent WHO strategies regarding diet, physical activity, substance use, and health.[13] Furthermore, North Karelia has been visited by numerous experts, health decision makers, and media representatives. The project's leaders have also served as expert consultants to many other countries.[4,14]

Currently, the growing evidence for the benefits of implementing lifestyle change initiatives is extremely strong, and numerous international and national strategies exist. Therefore, the main question is no more "what to do" but "how to do it." In other words, the main problem is the implementation gap, which is likely a result of the following obstacles: inertia in change, individual addictions, commercial interests, economic issues, and so on. To overcome the implementation gap, continued support from activists, expert institutions, and civil society organizations is needed. It should be noted that positive changes in lifestyles of the population are not the result of a single intervention measure or campaign. Instead, they represent social change process in the society, in which policies influence the population and population lifestyle changes influence policies. Monitoring of practical targets in the population and disseminating the results support practical changes. The aim is to make "the healthy changes the easy ones."

Authors' Note

Dr Pekka Puska, MD, PhD, MPolSc, is a professor, physician, and former member of the Finnish Parliament who served as the director and principal investigator of The North Karelia Project for 25 years. The project dramatically reduced annual cardiovascular disease mortality and improved general public health through lifestyle changes, making it a model for successful population-based lifestyle intervention. He is the recipient of the American College of Lifestyle Medicine's inaugural Dr Ancel Keys award, which recognizes an individual who has made significant contributions to public health research, practice, and policy.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical Approval

Not applicable, because this article does not contain any studies with human or animal subjects.

Informed Consent

Not applicable, because this article does not contain any studies with human or animal subjects.

Trial Registration

Not applicable, because this article does not contain any clinical trials. AJLM

References

1. Leppo K, Lindgren J, Ritamies M. Mortality trends in Finland in the 1960's. In: *Yearbook of Population Research in Finland XII*, 1971. Vammala, Finland: The Family Federation of Finland; 1972.
2. Keys A. Coronary heart disease in seven countries. *Am Heart Assoc Monogr.* 1970;29:211.
3. Keys A, Karvonen MJ, Fidanza F. Serum cholesterol studies in Finland. *Lancet.* 1958;2:175-178.
4. Vartiainen E. The North Karelia Project: cardiovascular disease prevention in Finland. *Glob Cardiol Sci Pract.* 2018;2018:13. doi:10.21542/gcsp.2018.13
5. Puska P, Tuomilehto J, Salonen J, et al. *Community Control of Cardiovascular Diseases: The North Karelia Project.* Copenhagen, Denmark: WHO Regional Office for Europe; 1981.
6. Ruokolainen O, Heloma A, Jousilahti P, et al. Thirty-eight-year trends of educational differences in smoking in Finland. *Int J Public Health.* 2019;64:853-860.
7. Salomaa V, Pietilä A, Peltonen M, Kuulasamaa K. Changes in CVD incidence and mortality rates, and life expectancy: North Karelia and National. *Glob Heart.* 2016;11:201-205.
8. Vartiainen E, Puska P, Pekkanen J, Tuomilehto J, Jousilahti P. Changes in risk factors explain changes in mortality from ischaemic heart disease in Finland. *BMJ.* 1994;309:23-27.
9. Puska P, Vartiainen E, Nissinen A, Laatikainen T, Jousilahti P. Background, principles, implementation, and general experiences of the North Karelia Project. *Glob Heart.* 2016;11:173-178.
10. Puska P, Vartiainen E, Laatiainen T, Jousilahti P, Paavola M. *The North Karelia Project: From North Karelia to National Action.* Helsinki, Finland: National Institute for Health and Welfare (THL); 2009.
11. Puska P, Bansilal S. The North Karelia Project. *Glob Heart.* 2016;11:171e266.
12. Institute for Health Metrics and Evaluation. *Findings From the Global Burden of Disease Study 2017.* Seattle, WA: Institute for Health Metrics and Evaluation; 2018.
13. World Health Organization. *Global Strategy on Diet, Physical Activity and Health.* Geneva, Switzerland: World Health Organization; 2004.
14. Puska P. Health in all policies—from what to how. *Eur J Public Health.* 2014;24:1.