Sozial- und Präventivmedizin Médecine sociale et préventive 1988; 33: 217–222

A Pilot Study of Community Cholesterol Screening

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Introduction

In 1984 the NIH Cholesterol Consensus Conference panel recommended the evaluation of population cholesterol screening [1]. This recommendation was based on two important observations. First, it was known from population surveys that hypercholesterolemia affects a considerable proportion of the U.S. population [2]. Secondly, the results of randomized clinical trials had demonstrated that available treatment of hypercholesterolemia was effective in reducing the risk of coronary heart disease [3, 4, 5].

In addition, pilot studies of large-scale cholesterol screening could now be undertaken, since automatic analyzers measuring total plasma cholesterol in capillary blood samples provide a fast, inexpensive, safe and generally accurate screening method [6, 7].

In order to examine the feasibility and the impact of a community cholesterol screening program, we wanted 1) to test the acceptability of community cholesterol screening, 2) to characterize the population responding to a screening program with regard to distribution of total plasma cholesterol, life style, and medical history, and 3) to evaluate the effectiveness of the screening by assessing measures taken by individuals at risk and by their physicians.

Methods

Population and Setting

Free cholesterol screening was offered to a Southern California community after limited advertisement (local media, newspapers). The screening took place in a shopping mall, during one weekend, for a total of 7 hours. In that time, 429 volunteers had their cholesterol measured (an average of about 1/min). We used three automatic Reflotron® analyzers, each operated by a trained person who also obtained the participant's capillary blood sample. In the three minutes until test results were available, screenees answered a self-administered questionnaire, including a short knowledge test about cholesterol, diet, and heart disease.

Questionnaire

The questions asked were designed to assess the respondents' socio-demographic data (sex, age, education), their medical history (diabetes, hypertension, heart attack, high cholesterol and use of medication), as well as their health-consciousness (diet, exercise and smoking habits). The knowledge test was composed of four "true/false" questions on the association of dietary cholesterol with plasma cholesterol elevation and the risk of coronary heart disease.

Cholesterol Risk Categories

Cholesterol risk categories were defined according to age specific NIH Consensus Conference cutpoints, as shown in Table.

Table. Age specific NIH cholesterol consensus conference classification of total plasma cholesterol levels in adults (1).

NIH Consensus conference cholesterol cutpoints for adults

	Risk categories				
Age	Recomm.	Average	Moderate	High	
20–29	< 180	180–200	> 200	> 220	(mg/dl)
30–39	< 200	200–220	> 220	> 240	
≥40	< 200	200–240	> 240	> 260	
			75–90th	90+th	
			Percentile of the LRC Prevalence Study (1979)		

Follow-up

Any participant whose cholesterol was ≥ 220 mg/dl was advised to see a physician for repeat testing and evaluation. Within three months after the screening, we conducted a telephone follow-up of these screenees. Using a standardized interview, we assessed whether they had seen a physician, and whether the physician had confirmed an elevated cholesterol level, recommended diet change, or prescribed medication. Persons who had shown no intention to seek medical advice were asked to indicate their reasons. Information on dietary change was obtained by asking whether changes had been made prior to or in response to the screening, and with or without a physician's recommendation.

Statistical Methods

The statistical package of the Social Sciences [8] was used for data analysis. Age-adjustment of rates was performed by the direct method, the total study population serving as the standard. The Mantel-Haenszel Chi Square procedure [9] was used for significance testing of age-adjusted rates.

Differences in age-adjusted mean cholesterol levels between different risk factor categories were tested by analysis of covariance.

Results

Despite limited advertising, cholesterol screening proved to be popular. Participation rates were limited only by manpower and machines. Some participants

waited over an hour for their turn, and many more were turned away at the end of the designated time period.

Population

As shown in Figure 1a slightly more than half (54.8%) of the 429 participants were women, who were similar in mean age (58.3 years) to men (57.3 years).

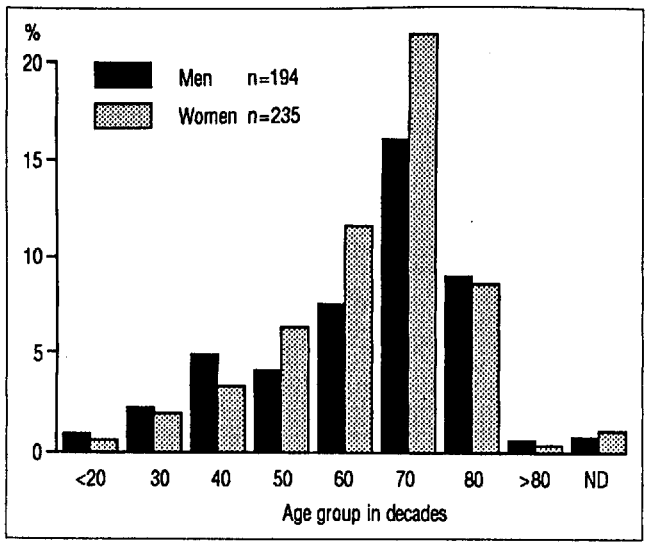

Fig. 1a. Age and sex distribution of the screened population. Information on age was missing for 7 persons (ND = not defined).

Screenees were predominantly white (95.9% white, 0.5% black, and 3.6% other). In Figure 1b the screened population is characterized by variables selected from the questionnaire.

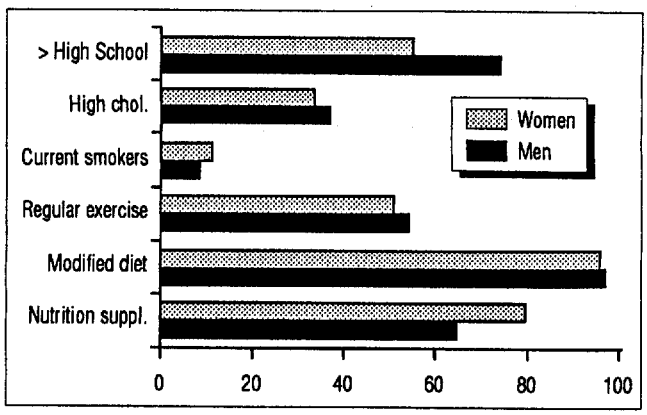

Fig. 1b. Selected health related characteristics of the screened population given as age-adjusted rates/100. Information as obtained by questionnaire relates to education beyond High School level (>high school), a history of high cholesterol prior to the screening (high chol.), smoking (current smoking), exercise habits (regular exercise, at least three times a week), health modified diet (salt restriction, high fruit, high fiber intake), and nutritional supplements (vitamins, fiber, calcium or trace elements).

73% of men and 54.5% of women reported education beyond the high school level, the sex difference was highly significant, ($p < 0.001$). The vast majority (96.1% of men and 94.8% of women) reported to observe a health-modified diet (salt restriction, high fiber intake, or fruit enriched diet). Many indicated to take nutritional supplements, such as vitamins, fiber or trace elements (64.1% of men, 79% of women). Only 8.3% of men and 10.3% of women reported current cigarette smoking. A reported history of elevated plasma cholesterol (36.0% of men and 32.9% of women) was significantly more frequent in men and women with a history of myocardial infarction or a history of hypertension ($p = 0.01$ and $p = 0.002$ in men; $p = 0.03$ and $p = 0.03$ in women). Reported previous hypercholesterolemia was also more common in men reporting restricted egg consumption and ex-smoker status ($p = 0.032$ and $p = 0.02$). Performance on the diet-heart disease questionnaire was similar in men and women with and without recommended total plasma cholesterol levels. Less than a third of screenees gave correct answers to questions on sources of dietary cholesterol and the impact of saturated fats.

Distribution of Plasma Cholesterol Levels

Figure 2 displays mean cholesterol levels by age group and sex.

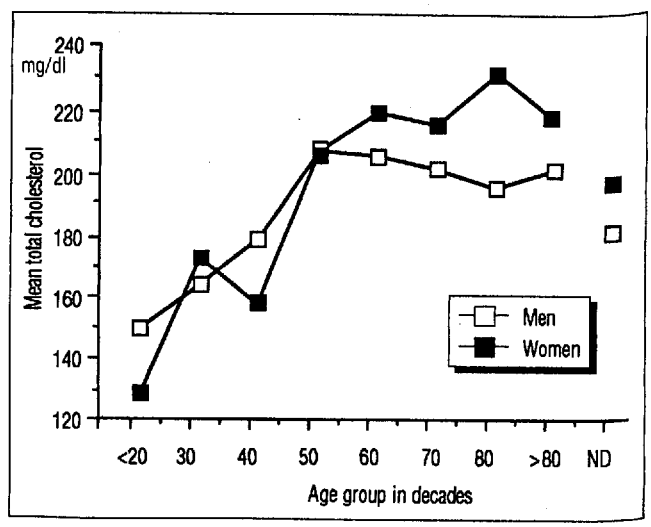

Fig. 2. Sex specific distribution of mean total plasma cholesterol by age decades (ND = not defined).

An increase in mean cholesterol with age was more pronounced in women than in men. Over the age of 50, women had higher mean cholesterol levels than men. Women 20–29 years had also slightly higher mean cholesterol levels than men in this age group. (Two women with cholesterol measurements above the recommended level were pregnant, one in the age group 20–29 years and one in the age group 30–39 years).

Mean cholesterol was 201.9 mg/dl for the total screened population. Measurements ranged from

108 mg/dl to 448 mg/dl. Accounting for age, women had significantly higher mean cholesterol than men (208.8 mg/dl vs. 193.4 mg/dl; $p < 0.001$). Mean cholesterol was significantly higher in men and women with than without a prior history of high cholesterol (205.7 vs. 186.4 mg% in men, 230.8 vs. 198.3 mg% in women; $p \leq 0.001$). We found no significant association of mean cholesterol with alcohol consumption, smoking behavior, exercise or diet habits, level of education or performance on the "knowledge test" in men or women. There was no association with exogenous estrogen use in women.

Yield of the Screening

Using NIH Consensus Conference cholesterol cutpoints, 48% of all screenees were in the recommended cholesterol category, 32% had average risk levels, 10.0% were in the moderate and 10% in the high risk category (Fig. 3).

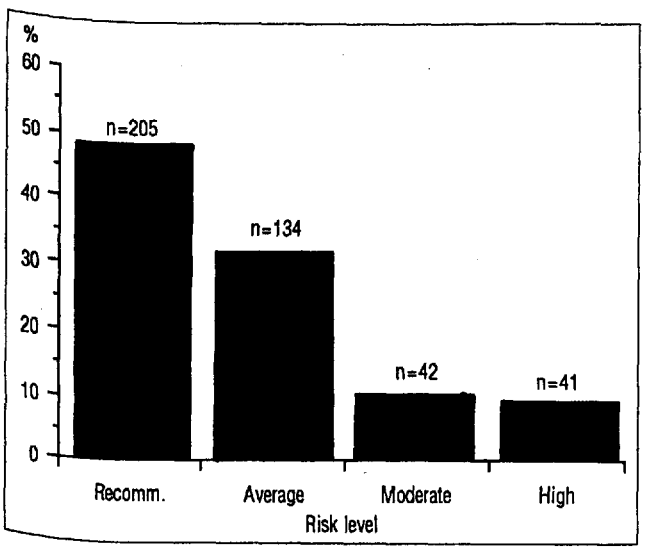

Fig. 3. Distribution of cholesterol (TC) risk categories in the screened population according to NIH Consensus criteria. Screenees with missing information on age (n=7) were not classified.

40.5% of screenees with moderate and 65.8% of those with high risk TC levels had a prior history of cholesterol elevation. The proportion of newly detected hypercholesterolemia in the total population (moderate and high risk categories without a prior history) was only 39/422 or 9.2%.

Follow-up

More than 95% of screenees who had been advised to see a physician could be followed by telephone interview. The total group of 138 was stratified into two subgroups by plasma cholesterol elevation: modest = 220–239 mg/dl and pronounced = 240+ mg/gl (Fig. 4).

Screenees with pronounced TC elevation more often saw a physician (37% vs. 25%), made or intended to

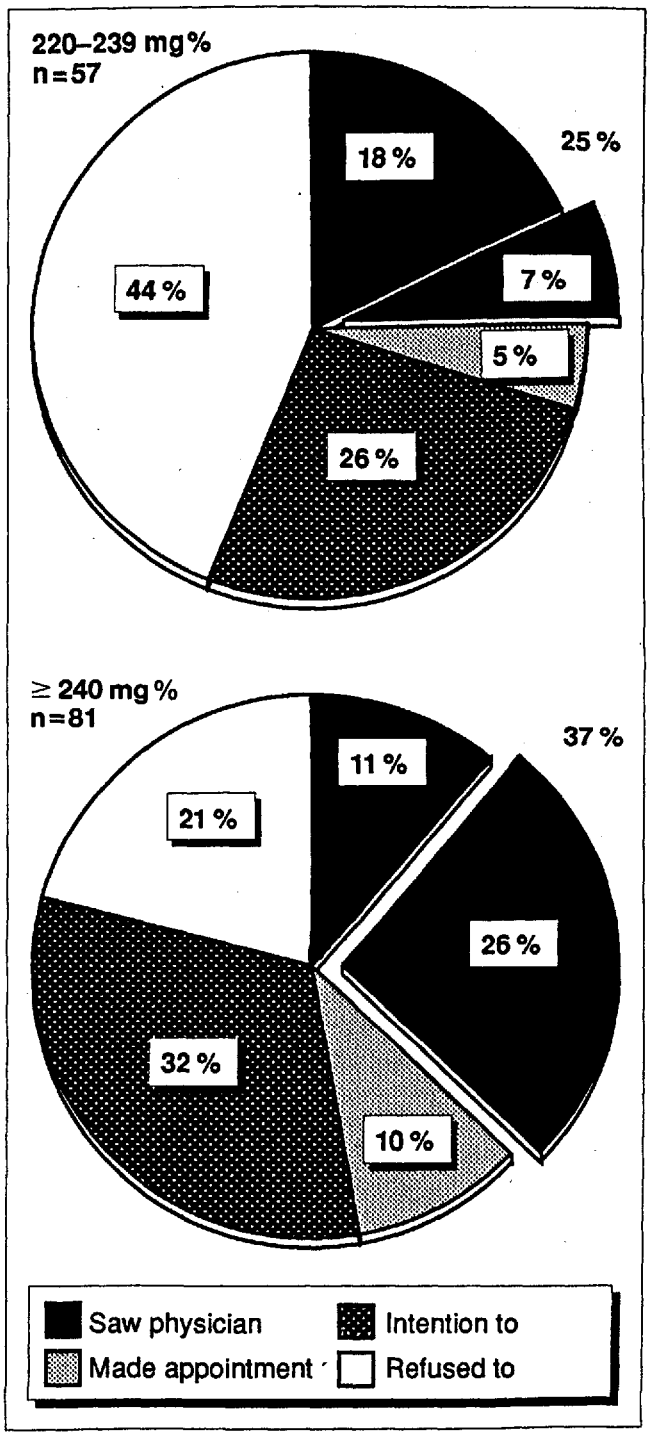

Fig. 4. Compliance of screenees in seeking medical advice as assessed by the follow-up interview. The total group is substratified into two subgroups by degree of cholesterol elevation. The detached parts of the pie graphs represent for each group the proportion of screenees who saw a physician and whose cholesterol elevation was confirmed by the physician.

make an appointment. Physicians were also much more likely to confirm cholesterol elevation in this group. Of all screenees with pronounced TC elevation 26% consulted a physician and were eventually confirmed to have high cholesterol, as opposed to only

7% in the group with modest TC elevation. Among screenees who saw a physician, 9 of 30 screenees with pronounced TC elevation, and 10 of 14 of those with modest cholesterol elevation were told not to be concerned. Overall 32% of screenees followed-up were compliant in seeking medical advise and of these 57% were confirmed "hypercholesterolemic" by their physicians. Most common reasons of refusal to see a physician were: "no concern about plasma cholesterol at all" (51%) and "feeling capable to control the problem by life-style changes". Physicians recommended diet modification to nearly all screenees with confirmed TC elevation, and compliance with this recommendation was 100%. Two persons were additionally prescribed medication, and both reported not taking their medication when asked at the phone follow-up. Of all screenees who had a telephone follow-up, 55 or 39.8% reported having modified their diet in response to screening, the majority (43 or 78%) without having been advised by a physician.

Discussion

The feasibility of public cholesterol screening was documented in our pilot study, but effectiveness was less satisfactory for several reasons.

Based upon the NIH Consensus criteria of moderate and high risk cholesterol levels, hypercholesterolemia was less prevalent in our study population than predicted by the Lipid Research Clinics (LRC) prevalence study [2]. Mean TC levels at all ages were also lower than those determined by the LRC prevalence study, although they followed the same age and sex-specific pattern [2]. These findings probably reflect selection of a particularly health-conscious population; for example, a proportion far below the US average were current cigarette smokers [10]. Aside from the inevitable self-selection of volunteers, the screening site, a shopping center that serves predominantly middle-class Caucasians, may have contributed to this effect. Given the fact that over 32% of all screenees already had a medical history of cholesterol elevation, intervention bias is also likely to play a role. Probable overrepresentation of known hypercholesterolemia clearly compromised the yield of the screening, since the condition was *newly* identified in less than half of a overall 20% of hypercholesterolemic screenees.

The screening obviously attracted an older population (76% of participants in our study were over 50 years of age), a selection effect that has been previously observed [11]. Since after the age of 50, total plasma cholesterol appears to be less predictive of coronary heart disease than HDL or the TC/HDL ratio [12, 13], the lack of a simultaneous measurement of HDL has to be considered a major limitation of the current screening method.

Even in this health-conscious population, only a third of all screenees with cholesterol measurements at 220+ mg/dl were compliant with the advice to consult a physician. The majority apparently felt capable of making diet changes without professional advice. The success of this effort in the face of their limited knowledge about diet and heart disease, particularly with regard to impact of saturated fats on plasma cholesterol, is questionable.

The observation that many physicians still do not treat patients according to current recommendations is confirmed by previous studies [11, 14], and a recent NIH survey [15]. We made no attempt, however, to assess the criteria used by individual physicians to categorize referred patients' blood cholesterol levels. In some cases repeat testing predictively gave lower results. The most important cause of such differences is intra-individual variation of cholesterol measurements [16]. In addition, although automatic cholesterol measurements have been observed to be in good agreement with results of conventional methods, there is a tedency toward lower readings [7]. Under such circumstances, however, we would expect an underestimation rather than an overestimation of hypercholsterolemia. For whatever reason, be it the arbitrary judgement of individual physicians or lack of consistency of cholesterol measurements, confusion of a substantial proportion of screenees seeking medical advice after having been "labeled as hypercholesterolemic" is alarming and the least desirable outcome of a screening program. Even for those cases of confirmed cholesterol elevation, the quality of advice and long-term monitoring of patients escapes our knowledge. Lack of time and financial reimbursement for counseling services, limited education on nutrition, reluctance to delegate services to other health professionals, such as dietitians, and personal health attitudes have been observed previously to limit physicians' preventive activities [17–21]. The effectiveness of cholesterol screening programs is greater when imbedded in a community education and intervention program integrating the local physicians [22].

On the basis of a single TC measurement, we felt obliged to extend our recommendation of repeat testing and further evaluation at a physician's office to everybody with TC measured 220+ mg/dl. This arbitrary decision reflects the dilemma of finding an ideal cutpoint as a screening basis. The majority of our study population, even screenees with recommended cholesterol levels, had at least one nonlipid risk factor for coronary heart disease (data not shown). Observations on clustering of coronary risk factors and their synergistic interaction in the pathogenesis of coronary heart disease [23, 24, 25] draw attention to a comprehensive management of individual coronary risk patterns.

Summary

We tested the feasibility and effectiveness of population cholesterol screening in a California shopping center. Total plasma cholesterol (TC) was measured in 429 adults from capillary blood samples, using automatic analyzers (Reflotron®). A self-administered questionnaire was used to ascertain demographic variables, lifestyle, and knowledge about cholesterol and heart disease. According to NIH Consensus Conference criteria, 20% of all screenees showed moder-

ate or high risk TC levels, but over half of these had a history of hypercholesterolemia prior to testing. Follow-up of all screenees with TC levels at 220 mg/dl and greater revealed that 32% had been compliant with our advice to contact their physician. Physicians expressed no concern in 71% of those with TC elevation of 220–239 mg% and in 30% of those with TC levels 240+ mg%. Of all participants, 40% reported dietary changes in response to the screening; 78% of this group, however, made changes without a physician's advice. In our experience community cholesterol screening is popular and feasible. Efficacy, however, must be improved by better education of physicians and the public.

Résumé

Screening de masse du cholestérol dans une communauté

Nous avons étudié, dans un centre commercial californien, la possibilité de faire un screening de masse du taux de cholestérol plasmatique total (TC), ainsi que l'efficacité d'une telle démarche. Les TC de 429 adultes ont été mesurés par analyseur automatique (Reflotron®) à partir d'échantillons de sang capillaire. Chaque participant a rempli lui-même un questionnaire nous permettant d'établir des variables telles que la répartition démographique, le style de vie et la conscience générale de la relation entre le taux de cholésterol et l'ischémie cardiaque. Selon les critères du NIH (NIH Cholesterol Consensus Conference, 1985) 20% des participants ont montré des TC de risques modérés à élevés, mais plus de la moitié de ce groupe avait déjà une histoire d'hypercholestérolémie avant le test. Une interview téléphonique trois mois plus tard de toutes les personnes ayant un TC supérieur à 220 mg/dl a révélé que seuls 32% ont suivi notre conseil de consulter un médecin. 71% des patients ayant un taux entre 220 et 239 mg/dl et 30% de ceux ayant un taux de 240 mg/dl et plus n'ont pas été considérés comme cas sérieux par les médecins traitants. Parmi la totalité des participants, 40% ont annoncé des changements dans leur diète à la suite du test. Cependant, les 78% de ce groupe l'ont fait sans le conseil d'un médecin. Cette expérience nous montre que s'il est facile et même populaire de faire un screening de masse du TC dans une communauté, l'efficacité d'un tel test doit être améliorée par l'éducation du public et des médecins.

Zusammenfassung

Cholesterin-Screening – eine Pilotstudie

Die Effektivität von Cholesterin-Screening mit automatischen Messgeräten (Reflotron®) wurde in einer Pilotstudie in Südkalifornien überprüft. Plasma-Gesamtcholesterin wurde innerhalb von drei Minuten in Kapillarblutproben bestimmt. Von jedem Teilnehmer wurden gleichzeitig anhand eines standardisierten Fragebogens soziodemographische Daten, Lebensgewohnheiten (z.B. Rauch- und Ernährungsverhalten) sowie eine Kurzanamnese erhoben. Eingefügte «Testfragen» zur Beziehung zwischen Nahrungscholesterin und koronarer Herzkrankheit sollten den Informationsstand der Teilnehmer veranschaulichen. Nach Einteilung der gemessenen Cholesterinwerte in die durch das NIH (NIH Cholesterol Consensus Conference, 1985) empfohlenen altersspezifischen Risikokategorien fanden sich unter insgesamt 429 untersuchten Erwachsenen im Alter von 17–81 Jahren (mittleres Alter 58 Jahre) 20% mit Werten der mittleren und hohen Risikogruppe. Bei mehr als der Hälfte hatte ein erhöhter Cholesterinspiegel eigenen Angaben zufolge bereits vor dem Screening vorgelegen. Allen Teilnehmern mit Messwerten über 220 mg/dl wurde empfohlen, weitere medizinische Betreuung zu suchen. Nach drei Monaten wurde über ein standardisiertes Telefoninterview in Erfahrung gebracht, welche Massnahmen tatsächlich ergriffen worden waren. Danach hatte etwa ein Drittel unserem Rat Folge geleistet, wobei sich die konsultierten Ärzte in 71% der Fälle mit Cholesterinwerten von 220–239 mg% und in 30% der Fälle mit Werten von 240 mg% und darüber nicht besorgt zeigten und ihren Patienten anrieten, sich nicht beunruhigen zu lassen. 40% der Teilnehmer gaben während des Interviews an, ihre Ernährung auf das Screening hin umgestellt zu haben; 78% in dieser Gruppe unternahmen die Änderung nach eigenem Gutdünken und nicht auf ärztliche Empfehlung. Nach unserer Erfahrung wird Cholesterin-Screening auf Gemeindeebene von der Bevölkerung gut aufgenommen und ist leicht durchführbar. Seine Effektivität erfährt jedoch durch Selektion der Teilnehmer und durch ihre unzureichende Weiterbetreuung Beinträchtigung. Um Cholesterin-Screening wirksam in die Prävention koronarer Herzkrankheit einzubeziehen, bedarf es gezielter Information von Ärzten und Öffentlichkeit.

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This research was supported in part by a grant from Boehringer-Mannheim and presented at the 23. Wissenschaftliche Jahrestagung der Deutschen Gesellschaft für Sozialmedizin, Augsburg, F.R.G., September 1987.

Christa Scheidt-Nave is a Research Fellow supported by a fellowship from the Deutscher Akademischer Austauschdienst (DAAD).

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