Relationship between 28-year food consumption trends and the 10-year global risk of death due to cardiovascular diseases in the adult Warsaw population

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A b s t r a c t

Background: Diet plays an important role in the aetiology of cardiovascular (CV) disease. SCORE risk charts are popular and simple tools for the assessment of the global risk of CV death.

Aim: To evaluate food consumption trends in the adult Warsaw population in 1984–2012 and to establish their relationship to the 10-year global risk of death due to CV diseases.

Methods: Nutrient intake and CV risk factors were assessed in independent representative samples of the Warsaw population in the Pol-MONICA projects (in 1984, 1988, 1993, and 2001) and the WAW-KARD project (in 2012). Overall, these surveys included 3404 men and 3446 women aged 35–64 years. The global CV risk was calculated using the SCORE risk chart for high-risk European regions. On the basis of the collected data, trends of dietary intakes and the SCORE risk values in the years 1984–2012 were estimated by linear and nonlinear regressions and correlations.

Results: Over the period of 28 years (1984–2012), a significant decrease in the SCORE risk (by 20% in men and by 35% in women) was seen, accompanied by significant changes in the dietary habits of the Warsaw population. Declining trends (an exponential model) were noted for total energy, total fat, cholesterol, and added animal fat intake. Intake of saturated fatty acids decreased until 2001 and increased thereafter (a second degree polynomial regression model). These changes in the dietary habits of the Warsaw population correlated with the SCORE risk values. Significant correlations were noted for total energy, total fat, and dietary cholesterol intake in both sexes, and animal fat and saturated fatty acid intake in men, with the correlation coefficients ranging from 0.85 to 0.98.

Conclusions: A significant reduction in the SCORE risk was seen in the Warsaw population in 1984–2012, which was associated with positive dietary changes. However, an unexpected decrease and reversal of the favourable trends in the structure of fat consumption occurred in the last decade.

Key words: diet, food consumption, cardiovascular mortality, SCORE risk

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INTRODUCTION

Multiple studies provided strong and consistent evidence of an association between nutrition and the risk of cardiovascular disease (CVD). The underlying metabolic mechanisms have also been elucidated. The most important dietary factors contributing to cardiovascular (CV) risk include high saturated fatty acid (SFA) intake with low intake of polyunsaturated fatty acids (PUFA), high intake of trans fatty acids, cholesterol, animal fat and sodium, and low intake of vegetables, fruits, fish, and fibre [1–4].

Global 10-year risk of CV mortality (SCORE) is a health status parameter of much prognostic value, as it reflects added

and synergistic effects of several risk factors on the likelihood of death [5]. This risk may be reduced by lifestyle modification including optimisation of nutrition. Some subjects also require drug therapy for reduction of risk factors [6].

Data on nutrition and CV risk factors in the Warsaw population collected in 1984–2012 during subsequent phases of the Polish part of the Monitoring of Trends and Determinants in Cardiovascular Disease study (Pol-MONICA) and the WAW-KARD (*Warszawskie Badanie Stanu Zdrowia Populacji*) study allowed evaluation of long-term trends for intake of various nutrients and the global risk of mortality. These data allowed answering the question whether nutrition changes at the population level were associated with the SCORE risk.

The aim of the study was to evaluate food consumption trends in the adult Warsaw population in 1984–2012 and to establish their relationship to the 10-year global risk of death due to CVD.

METHODS
Study population
We evaluated independent representative samples of the Warsaw population aged 35–64 years that were studied under the Pol-MONICA project (1254 men and 1298 women in 1984, 682 men and 699 women in 1988, 721 men and 739 women in 1993, and 420 men and 423 women in 2001), and the European Health Examination Survey_Joint Action (EHES_JA) and the WAW-KARD study (327 men and 287 women in 2012). The EHES_JA project was a pilot study conducted as a part of the WAW-KARD program.

The sampling frame for the first three screenings (in 1984, 1988, and 1993) were the electoral registers, and the Universal Electronic System for Registration of the Population (PESEL, *Powszechny Elektroniczny System Ewidencji Ludności*) was used for the fourth and fifth one (in 2001 and 2012). Conventional CV risk profile was evaluated in all respondents based on questionnaires, laboratory data, anthropometric parameters, blood pressure measurement, and evaluation of nutrition according to the international guidelines on epidemiological studies. Detailed data on the methods used, data collection, and measurements were presented in previous reports from the Pol-MONICA and EHES_JA/WAW-KARD studies [7–10].

Nutrition
In all screenings, nutrition was evaluated by 24-h dietary recall. Using individual questionnaires that provided data on the type and quantity of foods eaten, and Polish tables of food composition and nutritional value, the average nutritional value of diet in particular study years was calculated. Due to changing economic situation in the country, rapid growth of the food industry, food import, and introduction of many new, previously unknown products, data were calculated using three editions of food nutritional value tables from the years as close as possible to the study years [11–13]. This approach allowed better adjustment between data provided by these tables and the types and quality of food products available on the market at the time when particular diet assessments were performed.

To evaluate nutrition, we selected these parameters which may affect CV risk factors. We analysed the total energy intake and intake of such nutrients as total fat, saturated, monounsaturated, and PUFA, and cholesterol. We also evaluated the intake of vegetables, fruits, meat and cold cuts, added animal fat, and added plant fat. For further analyses, we selected only those nutrients and products which showed significant trends over 28 years.

Ten-year global risk of CV mortality
Individual CV mortality risk was calculated using the SCORE risk chart for high-risk European regions [5]. This risk score was developed on the basis of long-term prospective European studies that included more than 200,000 subjects. The SCORE risk is calculated based on evaluation of five risk factors: age, gender, systolic blood pressure, total cholesterol, and smoking. Subjects receiving treatment for diabetes or with blood glucose level ≥ 7 mmol/L, as well as those with a history of myocardial infarction or coronary artery disease event were categorised to the highest risk group.

Statistical methods
Analysis of covariance (general linear model) with adjustment for age, season, and smoking was used to determine mean values of the nutritional factors in the study years (1984, 1988, 1993, 2001, and 2012). Based on the mean values obtained by polynomial or exponential interpolation, a regression model was estimated for selected nutritional parameters in 1984–2012. The criterion for the choice of the model was the value of the coefficient of determination (R-square).

The global mortality risk was calculated using the SCORE model individually for each respondent, and then mean SCORE risk values were calculated separately for men and women.

Associations between mean nutritional parameters (only those with significant temporal trends) and mean SCORE risk values were evaluated using the correlation coefficient. Statistical analyses were performed using the SAS package, version 9.2; p ≤ 0.05 was considered statistically significant.

RESULTS
A significant reduction in the global CV mortality risk was observed in the adult Warsaw population over the analysed period of 28 years. Compared to 1984, the mean SCORE risk in 2012 reduced by about 20% in men and about 35% in women. Temporal trends of the SCORE risk are shown in Figure 1.

Over the same time, beneficial changes of some nutritional parameters were also noted, with a reduction of total energy intake, and the intake of total fat, cholesterol, and
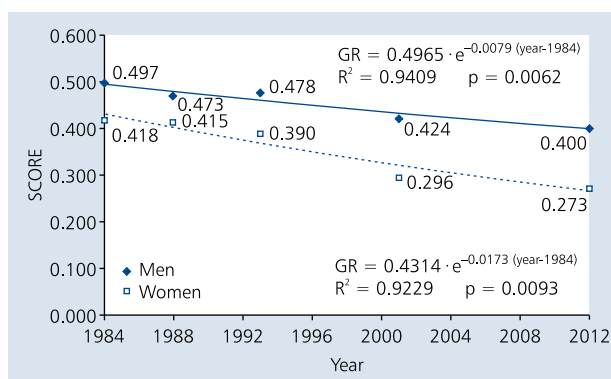
Figure 1. Trends for the 10-year global risk of cardiovascular mortality (SCORE) in the adult Warsaw population over 28 years
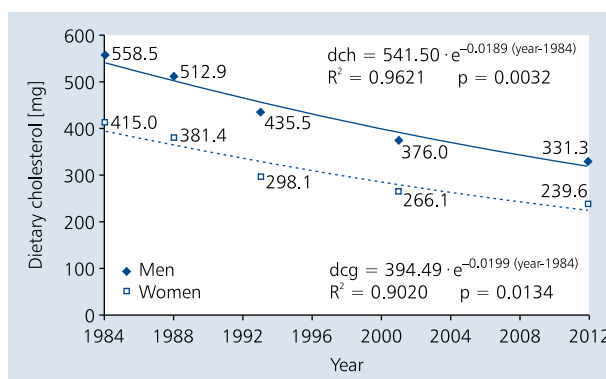

Figure 2. Trends for the average total energy intake in the adult Warsaw population over 28 years

Figure 3. Trends for the total fat intake* in the adult Warsaw population over 28 years; *total fat included both visible fat (e.g. in butter, margarines, etc.) and hidden fat (e.g. in meat, cold cuts, dairy products, etc.)

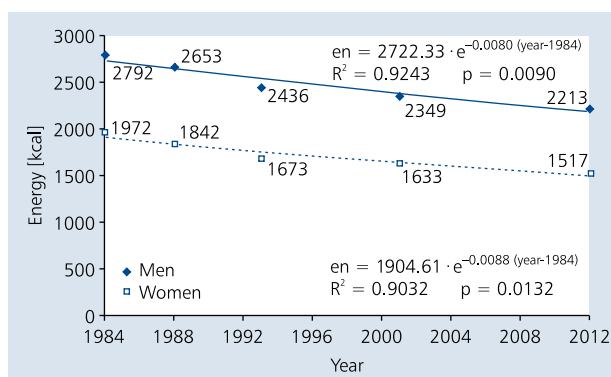**Figure 4.** Trends for cholesterol intake in the adult Warsaw population over 28 years
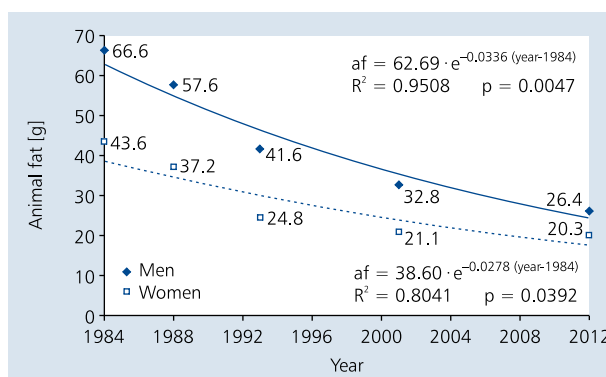

Figure 5. Trends for added animal fat intake* in the adult Warsaw population over 28 years; *added animal fat included butter, cream (converted into butter, conversion ratio 0.25), and lard used for cooking and spreading onto bread
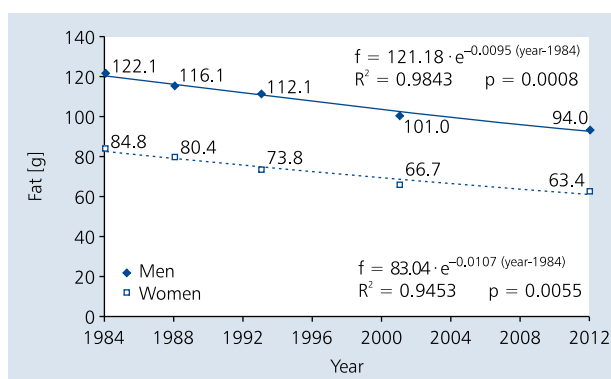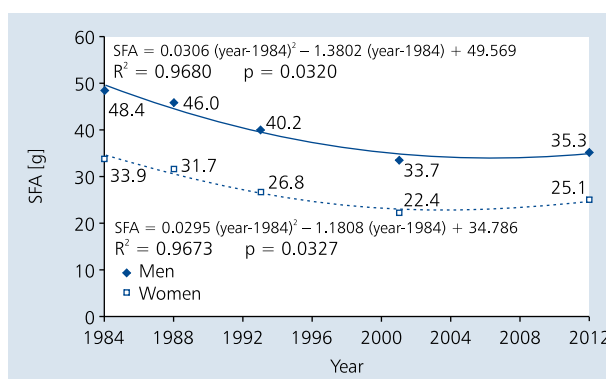

Figure 6. Trends for saturated fatty acid (SFA) intake in the adult Warsaw population over 28 years

added animal fat, i.e. used for spreading onto bread and cooking. In 2012, total energy intake and total fat intake was reduced by more than 20% compared to 1984 in both genders, and cholesterol intake was reduced by 40%. Consumption of added animal fat reduced by 60% in men and 42% in women. These nutritional changes showed exponential trends which are shown in Figures 2–5.

Table 1. Pearson correlation coefficients for the associations between 10-year mortality risk and nutritional factors that showed a significant temporal trend

Nutritional factors	Men		Women	
	r	P	r	P
Total energy	0.89925	0.0378	0.87372	0.0500
Total fat	0.98396	0.0024	0.95488	0.0114
Animal fat	0.90114	0.0368	0.84802	0.0695
Cholesterol	0.92990	0.0220	0.90122	0.0367
Saturated fatty acids	0.88152	0.0481	0.85786	0.0629

Regarding SFA, different changes were observed in 1984–2001 and 2001–2012. In the former period, a reduction in SFA intake by about 30% was noted, while this trend reversed in the latter period, with an increase in SFA intake by about 5% in men and 12% in women compared to 2001. For this nutrient, a second degree binomial regression model was better than an exponential model. The trend and its mathematical model are shown in Figure 6. The trends for the remaining analysed nutritional parameters over 28 years were not significant.

These nutritional trends in the adult Warsaw population correlated with the SCORE risk. Significant correlations were noted for total energy, total fat, and dietary cholesterol intake in both genders, and in men also for animal fat and SFA intake. The latter two correlations in women were of borderline significance (Table 1).

DISCUSSION

Our data are the only in Poland that were collected over such a long period of time (1984–2012) based on cross-sectional population samples evaluated using a standardised methodology. This study was performed in a period of intense social and economic change in Poland. In a previous project performed in the same Warsaw population [14], we showed that beneficial nutritional changes in 1984–2001 contributed to a reduction in CV mortality. Significant changes in that period included an increase in plant fat intake, reduced energy intake, and a reduction in the intake of animal fat and cholesterol, leading to a reduced atherogenicity of the average diet.

During the last decade (2001–2012), continued positive trends were seen but only in regard to some nutritional factors, i.e. total energy, total fat, dietary cholesterol, and added animal fat intake. At the same time, these beneficial trends were reduced or even reversed for some other nutrients. This was seen for SFA, intake of which decreased until 2001 but then showed a gradual increase. This is a highly disturbing trend as SFA contribute to hypercholesterolaemia and increase CV risk, particularly if their increased intake is accompanied by a reduction in PUFA intake [1]. Unfortunately, a decrease in PUFA intake (in absolute terms in both genders and as a percentage of the total energy intake in women) was also seen in the Warsaw population after 2001. It seems that this was caused by a shift in fat selection for spreading onto bread, frying, and cooking. In the last decade, a significant decrease in the intake of added plant fat (including margarines and oils) was seen, from 28.6 g per day in 2001 to 24.2 g per day in 2012 in men, and from 21.3 g to 12.9 g, respectively, in women. At the same time consumption of butter, meat, and cold cuts increased in the Warsaw population. Due to these adverse nutritional changes, the atherogenicity of the average diet increased.

Of note, a similar phenomenon was also observed in Lithuania, a country which underwent a similar political transformation as Poland did. Between 1994 and 2010 [15], a reduction in butter intake and an increase in plant oil intake was seen in Lithuania, similarly to Poland. Of note, however, a reduction in butter intake occurred in the 1990s, with a clear increase in its intake after 2000, again similarly to our country.

Our findings are confirmed by national Polish data which indicate a reduction in added animal fat intake, similarly to Warsaw. Both the household budget approach used by the Central Statistical Office of Poland (*Główny Urząd Statystyczny*) [16] and the food balance approach [17] showed a reduction in added animal fat consumption starting from the early 1990s. It should be noted, however, that these approaches are not very precise and they do not measure actual individual consumption.

Regarding worldwide situation, a systematic review of studies performed in 266 countries [18] showed that the global intake of SFA, cholesterol, and trans fats did not change in 1990–2010, while the intake of omega-6 and omega-3 fatty acids increased, both from seafood and plant sources.

An interesting study that included 18,000 of Americans aged over 55 years was reported in the United States [19]. This study showed an increase in the mean energy and carbohydrate intake and a reduction in total fat intake in 1977–2010, while the contribution of SFA to total calories remained at the same level. Somewhat discordant findings were reported in a 17-year Framingham Heart Study Offspring Cohort [20], covering years 1991–2008. In this study, total fat and protein intake increased, as did the contribution of SFA to total calories in both genders. In the Nutrition and Health Survey in Taiwan (NAHSIT) [21], conducted in 1993–1996 and 2005–2008, an increase in

low-fat meat intake was shown, leading to high protein, SFA, and cholesterol intake. It may be thus concluded that dietary trends observed in our population seem to be more beneficial compared to those observed in other countries.

Our study also showed that dietary trends observed in the Warsaw population contributed to a reduction in the SCORE risk. However, the latter effect should be interpreted in the context of changes regarding other important factors. In addition to positive dietary trends, major CV risk factors may also be controlled by drug therapy, in particular as the proportion of respondents taking drugs to reduce CV risk factors increased significantly over the 28 years of follow-up. Thus, we also performed additional analyses limited to those subjects who did not use lipid-lowering, antidiabetic, and antihypertensive medications. Although, as expected, the SCORE risk in this group was lower than in the overall Warsaw population, the observed association between nutritional factors and the SCORE risk was similar, with significant correlations between the SCORE risk and cholesterol and SFA intake in both genders, and significant or borderline significant correlations for total fat and added animal fat intake.

It should be also noted that among subjects without severe risk factors (those not taking medications), some increase in the SCORE risk occurred during the last decade, which may suggest a negative effect of an increased SFA intake since 2001. It is also well known that in population studies, lifestyle changes (including changes in nutrition) affect health indicators only after some delay which may range from several years to several decades. As the present study was finished only 2 years ago, the adverse trends regarding fat intake structure that were initiated in the last decade may be expected to exert a greater effect on the SCORE risk only after some time.

Of note, SCORE risk reduction is associated with a reduction in CV mortality observed in Poland since 1991, which has been attributed to a reduction in major risk factors in more than 50%, and to improved treatment effectiveness in only one third [22]. It should be stressed, however, that the rate of this mortality reduction decreased in the last decade [23, 24] which may be explained, at least partially, by the reported adverse changes in the structure of fat intake.

CONCLUSIONS

A significant reduction in the SCORE risk was seen in the Warsaw population in 1984–2012, which was associated with positive dietary changes. However, an unexpected decrease and reversal of the favourable trends in the structure of SFA consumption occurred in the last decade.

Conflict of interest: *none declared*

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Związek między 28-letnimi trendami wybranych czynników żywieniowych a 10-letnim globalnym ryzykiem zgonu z powodu chorób sercowo--naczyniowych w dorosłej populacji Warszawy

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Streszczenie

Wstęp: Dieta odgrywa istotną rolę w etiologii chorób sercowo-naczyniowych (CVD). Popularnym i prostym narzędziem służącym do oceny ryzyka zgonu sercowo-naczyniowego jest wskaźnik SCORE.

Cel: Celem pracy było prześledzenie w dorosłej populacji Warszawy trendów dotyczących spożycia żywności w latach 1984–2012 oraz ocena ich związku z 10-letnim globalnym ryzykiem zgonu z powodu CVD.

Metody: Sposób żywienia i poziom czynników ryzyka CVD zbadano w niezależnych reprezentatywnych próbkach populacji Warszawy w kolejnych edycjach programu Pol-MONICA (1984, 1988, 1993 i 2001 r.) oraz projektu WAW-KARD (2012 r.). Łącznie we wszystkich badaniach przekrojowych uczestniczyło 3404 mężczyzn i 3446 kobiet w wieku 35–64 lat. Wartość wskaźnika ryzyka zgonu sercowo-naczyniowego wyliczono przy użyciu funkcji SCORE dla regionów Europy o wysokim ryzyku. Na podstawie zebranych danych estymowano przebieg wybranych mierników oceny sposobu żywienia i SCORE w latach 1984–2012.

Wyniki: W analizowanym okresie 28 lat zaobserwowano znaczny spadek wartości wskaźnika SCORE (o 20% u mężczyzn i o 35% u kobiet), któremu towarzyszyły istotne zmiany w strukturze spożycia. Zanotowano istotnie malejące trendy (model wykładniczy) dla: energii, tłuszczu ogółem, cholesterolu pokarmowego i tłuszczów zwierzęcych dodanych. Spożycie nasyconych kwasów tłuszczowych spadało do 2001 r., a następnie korzystna tendencja została zahamowana i odwrócona (model regresyjny wielomian 2. stopnia). Wymienione zmiany w strukturze spożycia były skorelowane z wartościami wskaźnika SCORE. Istotny związek wystąpił dla energii, tłuszczów ogółem i cholesterolu pokarmowego u obu płci oraz tłuszczów zwierzęcych i nasyconych kwasów tłuszczowych w grupie mężczyzn (współczynnik korelacji w granicach 0,85–0,98).

Wnioski: W populacji Warszawy w latach 1984–2012 doszło do znacznego obniżenia wartości wskaźnika SCORE, wiązało się z pozytywnymi zmianami w sposobie żywienia. Jednak w ostatnim 10-leciu wystąpiło nieoczekiwane zahamowanie i odwrócenie korzystnych tendencji w strukturze spożycia tłuszczów.

Słowa kluczowe: dieta, trendy żywienia, ryzyko zgonu z powodu chorób sercowo-naczyniowych, SCORE

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