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Obesity and other health determinants across Europe: The EURALIM Project

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Abstract

***Study objective*—EURALIM (EURope ALIMentation), a European collaborative study, aimed to determine and describe the extent to which European data on risk factor distributions from different populations could be pooled and harmonised in a common database for international comparisons.**

***Setting*—Seven independent population-based surveys from six European countries (France, Italy, Northern Ireland/United Kingdom, Spain, Switzerland, the Netherlands).**

***Methods*—Data for 18 381 women and 12 908 men aged 40–59 were pooled in a common database. Central statistical analyses on major cardiovascular risk factors were conducted with careful consideration of methodological issues, including differences in study designs, data assessment tools, and analytic techniques used.**

***Main results*—Because of the detected variability among methods used, direct comparisons of risk factor distributions and prevalences between studies were problematic. None the less, comparisons of within population contrasts by sex, age group, and other health determinants were considered to be meaningful and apt, as illustrated here for obesity. Results were targeted and disseminated to both the general public and public health professionals and framed in the context of a European information campaign.**

***Conclusions*—International and national comparisons between existing locally run studies are feasible and useful, but harmonisation methods need improvement. Development of an international risk factor surveillance programme based on decentralised data collection is warranted. In the meantime, risk factor contrasts across populations can be used as a basis for targeting needed public health intervention programmes.**

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Worldwide, considerable research is focused on the frequency of cardiovascular disease and cancer, as well as on the risk and protective factors related to these diseases. Interest is growing in continuously monitoring and comparing distributions of risk factors in diverse populations to inform public health professionals and guide needed actions. Many independent locally-based studies of good quality produce results that cannot be directly compared because of methodological variability. To date, three main approaches have been used to compare data across national and international studies, namely: (1) comparative standardised studies based on a uniform core protocol,[1–7] (2) meta-analyses,[8–11] and (3) the harmonisation of data from independent studies.

The third approach of harmonising data from independent studies has been less extensively investigated to date. It is known that variables measured using different methodologies are not easily compared. Because distributions of risk factors in the population are usually narrow, slight errors in measurement can lead to dramatic variations in the estimation of the prevalence of high risk groups and therefore severely bias the intended comparisons.

Although the use of different protocols limits comparability, the prospect of pooling locally-based surveys should not be rejected out of hand. In the long run and for international comparisons, it is unlikely that concerted, centralised projects will become the main source of population data. Many locally run programmes of good quality generate information on the distributions of risk factors in specific populations. It is comparatively cheap to pool and analyse these data rather than obtain new data through large concerted actions. Additional work is therefore needed to practically determine the extent to which these data can be harmonised and integrated into an international system of risk factor surveillance. Public health professionals need efficient and valid ways to compare data across national and international studies that lack uniform data collection procedures.

In 1995, the Directors of the Division of Clinical Epidemiology in Geneva and the Institut Scientifique et Technique de la Nutrition et de l'Alimentation in Paris launched a series of meetings with other interested European epidemiologists to discuss the development of a common international surveillance system allowing for the comparison of lifestyle and biological risk factors for different populations across Europe. The result was a proposal for EURALIM (EURope ALIMentation), "Co-ordination and Evaluation of a European information campaign on diet and nutrition", a European project to determine and describe the extent to which non-uniform data could be harmonised and pooled in a common database for international comparisons. This health promotion project was jointly supported by the

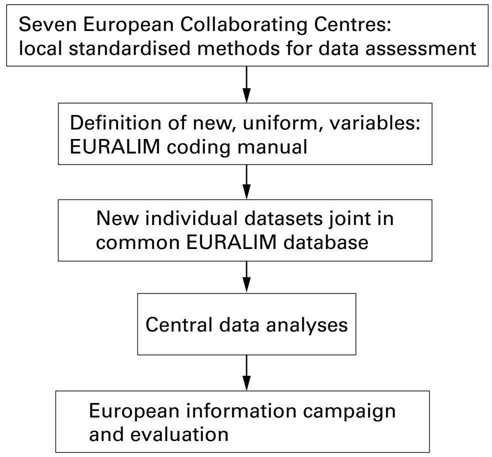

Figure 1 EURALIM study plan—harmonisation approach.

European Community and the Swiss Federal Office for Education and Science.

Here we describe the main objectives, design, and conduct of EURALIM, as well as its main methodological findings. Obesity was used as the risk factor of interest for illustrative purposes.

EURALIM pursued three main objectives that were achieved in a series of steps between March 1997 and September 1998, namely, to: (1) improve methods for comparing European data on risk factors that were collected in non-uniform manners; (2) provide the general public as well as public health professionals and politicians involved in public health issues with important contrasts found within and across included European populations; and (3) develop a technical document to assist public health professionals in the critical interpretation of risk factor data originating from various populations. This paper focuses on the methodology and first objective of EURALIM.

Methods

STUDY DESIGN

EURALIM is a collaborative European project comprised of seven local studies of high quality that provided population data on risk factors representative of the following countries, regions or cities, that is: *SU.VI.MAX*, France[12]; *Progetto ATENA*, City of Naples (Italy)[13]; *Progetto MATISS*, Province of Latina (Italy)[14]; *Belfast MONICA Project*, Greater Belfast area (Northern Ireland/UK)[15]; *Catalonia Nutrition Survey*, Province of Catalonia (Spain)[16]; *Bus Santé 2000*, Canton of Geneva (Switzerland)[17]; *Monitoring Project on Cardiovascular Disease Risk Factors*, the Netherlands.[18]

EURALIM used a harmonisation approach to compare the data from these seven locally run studies with different methods of data collection across sites. Database management and analyses were performed centrally at the data coordinating centre. Figure 1 gives an overview of the study plan.

DATABASE MANAGEMENT

Based upon a review of the assembled study protocols, questionnaires, and variable lists from the participating sites, the EURALIM group defined new, common variables covering demographic, diet, health, and lifestyle factors. A “EURALIM Coding Manual” was prepared that defined the exact content of each variable, as well as their prescribed length and order of assembly (unpublished data). All seven research partners locally prepared their own “EURALIM data sets” accordingly.

Study partners followed a common convention for data transfer developed by the advisory group (unpublished data). Manageable ASCII text files were transferred to the data coordinating centre in Geneva, Switzerland. Before file transfer, each partner ran a quality check on a defined selection of variables for verification at the data coordinating centre.

The construction of the EURALIM Database was performed using SAS software (Statistical Analyses System SAS 6.12. SAS Institute Inc, Cary NC, USA: 1996). The resulting seven SAS files underwent the same quality checks as were performed locally to help identify any remaining inconsistencies. The common EURALIM database was finalised by merging together the seven individual files and labelling all 227 variables.

The EURALIM database thus comprised data from seven population-based studies with somewhat different designs, as shown in table 1. For instance, the Italian sample from Naples consisted almost only of female volunteers. Other differences related to specific variables, for example, dietary data were assessed in only a small sub-sample of women in the Italian Province of Latina. All final analyses were performed with a database restricted to the common age group represented in all participating studies, that is, ages 40–59 years, for a total of 18 381 women and 12 908 men. Table 2 provides the population sizes by site.

DATA ANALYSES

While a multitude of preliminary analyses were conducted and examined, final analyses focused on the following major cardiovascular risk factors: increased blood cholesterol, high blood pressure, smoking, excessive body

Table 1 Characteristics and sampling methods of the participating EURALIM study populations

Population that study sample is representative of	*Year(s) of survey*	*Urban and/or rural*	*Sexes and age (y) sampled*	*Sampling method*	*Response rate by sex*
France	1995–1996	urban and rural	F, M: 35–65	random selection of a representative sample out of a large volunteer population (intervention study)	F: 86%; M: 81%
the Netherlands	1990–1992	mainly urban	F, M: 20–59	by gender, 5 year age strata	F: 62%; M: 57%
Naples (Italy)	1993–1996	urban	F: 30–69	volunteer sample (95%) & random selection (5%)	Not applicable
Province of Latina (Italy)	1993–1996	rural	F, M: 20–84	random selection, stratified by sex, age	F: 72%; M: 67%
Geneva (Switzerland)	1993–1996	urban	F, M: 29–83	random selection by gender, 10 year age strata	F: 65%; M: 65%
Belfast (United Kingdom)	1991–1992	urban	F, M: 25–65	by gender, 10 year age strata	F: 47%; M: 49%
Catalonia (Spain)	1992	mainly urban	F, M: 25–75	multistage sample, stratified by region	F: 72%; M: 66%

Table 2 Number and percentage of 40–59 year old participants by EURALIM population

Population that study sample is representative of	Women		Men		Total
	number	%	number	%	
France	6 424	35.0	4 791	37.1	11 215
the Netherlands	5 664	30.8	5 144	39.8	10 808
Naples (Italy)	3 013	16.4	0	0.0	3 013
Province of Latina (Italy)	1 254	6.8	1 084	8.4	2 338
Geneva (Switzerland)	1 083	5.9	1 040	8.1	2 123
Belfast (United Kingdom)	538	2.9	550	4.3	1 088
Catalonia (Spain)	405	2.2	299	2.3	704
Total	18 381	100.0	12 908	100.0	31 289

weight, and unhealthy diets (notably low fruit and vegetable intakes). The S-Plus statistical package (S-Plus 3.3 -1 for Sun SPARC, SunOS 5.3. MathSoft Inc Seattle, USA: 1995) was used for all analyses.

The main statistical methods used by the project were descriptive, specifically, proportions and 25th, 50th and 75th percentiles (P25, P50, P75). Gender contrasts within each population were expressed as the difference (and ratio) of the prevalence of a given risk factor for men and women. All values were presented together with their corresponding 95% confidence intervals (95% CI).

To control for a possible age effect, the data were stratified by four, five-year age groups (40–44, 45–49, 50–54 and 55–59 years). Of note, the age distributions for men and women from Catalonia and France, as well as women from Naples, were not uniform across these five year age strata and differed from those in the other studies. Ordinary proportions and percentiles were computed for each stratum. When analysing data for the entire age group of 40–59 years, differences in age distributions between the studies were removed by computing weighted proportions and percentiles (see below).

Calculation of weights

Weighted analyses were used to adjust the age distribution of each study to the standard European age distribution.[19 20] For each participating study, the observations in age group i were weighted by w_i/n_i, where n_i is the sample size of the given age group i. Age groups of all studies have respective relative weights w_i. The sum of the weights over all observations is equal to 1.

Weighted means and variances

Weighted means of continuous variables were calculated as the sums of means weighted by w_i for each age group. Weighted proportions were calculated as the sums of proportions weighted by w_i for each age group. Similarly, weighted variances were calculated as the sums of variances weighted by w_i^2. Finally, the variances of differences between two proportions were calculated as the sums of the variances of the single proportions. As the sample size was sufficiently large, a normal distribution of means and proportions was assumed and the corresponding 95% CIs were calculated as

$$\text{mean(proportion)} \pm 1.96\sqrt{\text{variance}}.$$

KEY POINTS

- EURALIM (EURope ALIMentation) is a consortium of seven independent population-based surveys from six European countries.
- EURALIM aimed to determine and describe the extent to which data on risk factor distributions from different populations could be pooled and harmonised for international comparisons.
- Because of methodological heterogeneity, direct comparisons of risk factor distributions and prevalences between studies are problematic.
- Comparisons of within population contrasts by sex, age group, or other health determinants are considered to be meaningful and apt.
- International and national comparisons using existing locally run studies are feasible and useful, but harmonisation methods need improvement.

Weighted percentiles

For each observation i=1,...,4, the weights w_i/n_i were used to compute weighted percentiles. Let V_q represent a percentile of rank of q of a variable V. V_q was selected so that the sum of weights of the observations smaller than V_q was equal to $(N - 1)$q +1, where N denotes the total sample size. If no observation corresponded exactly to this sum of weights, a linear interpolation between the closest values obtained was performed.

Individual weights w_i/n_i allowed for computing large sample 95% CIs for percentiles.[21] Ranks q_l (lower bound) and q_u (upper bound) of a percentile V_q were computed as

$$q_i \leq (N-1)q + 1 + \tfrac{1}{2} - 1.96\sqrt{Nq(1-q)}$$

and $$q_i \geq (N-1)q + 1 + \tfrac{1}{2} - 1.96\sqrt{Nq(1-q)}$$

The procedure used for determining the upper and lower limits of the ranks was the same as that used for determining the percentile V_q.

INFORMATION CAMPAIGN

Results were targeted and disseminated to both the general public and public health professionals and framed in the context of a European information campaign. Figure 2 provides an example of how the data were presented in the general public brochure entitled *Nutrition and the heart. Healthy living in Europe*,[22] to allow for comparisons of gender contrasts across populations.

The supplement for public health professionals presented and discussed the most important methodological sources of variability, additional analyses, and the rationale for interpretation of each considered risk factor.[23] Figure 3 gives an example of how age standardised gender differences were presented as the prevalence of risk factors with their associated 95% CIs. Additional analyses stratified by age group (40–49 versus 50 to 59 years), educational level, and smoking status provided additional insights into the issues associated with intra-national and international data comparisons.

The information campaign was evaluated by public health professionals in all seven collaborative centres by administering a common evaluation questionnaire (data not presented).

Results

The investigation of differences among study designs and the methodological sources of variability identified for all of the factors considered in the common EURALIM database led to the conclusion that direct comparisons of risk factor distributions and prevalences between studies was overly problematic. None

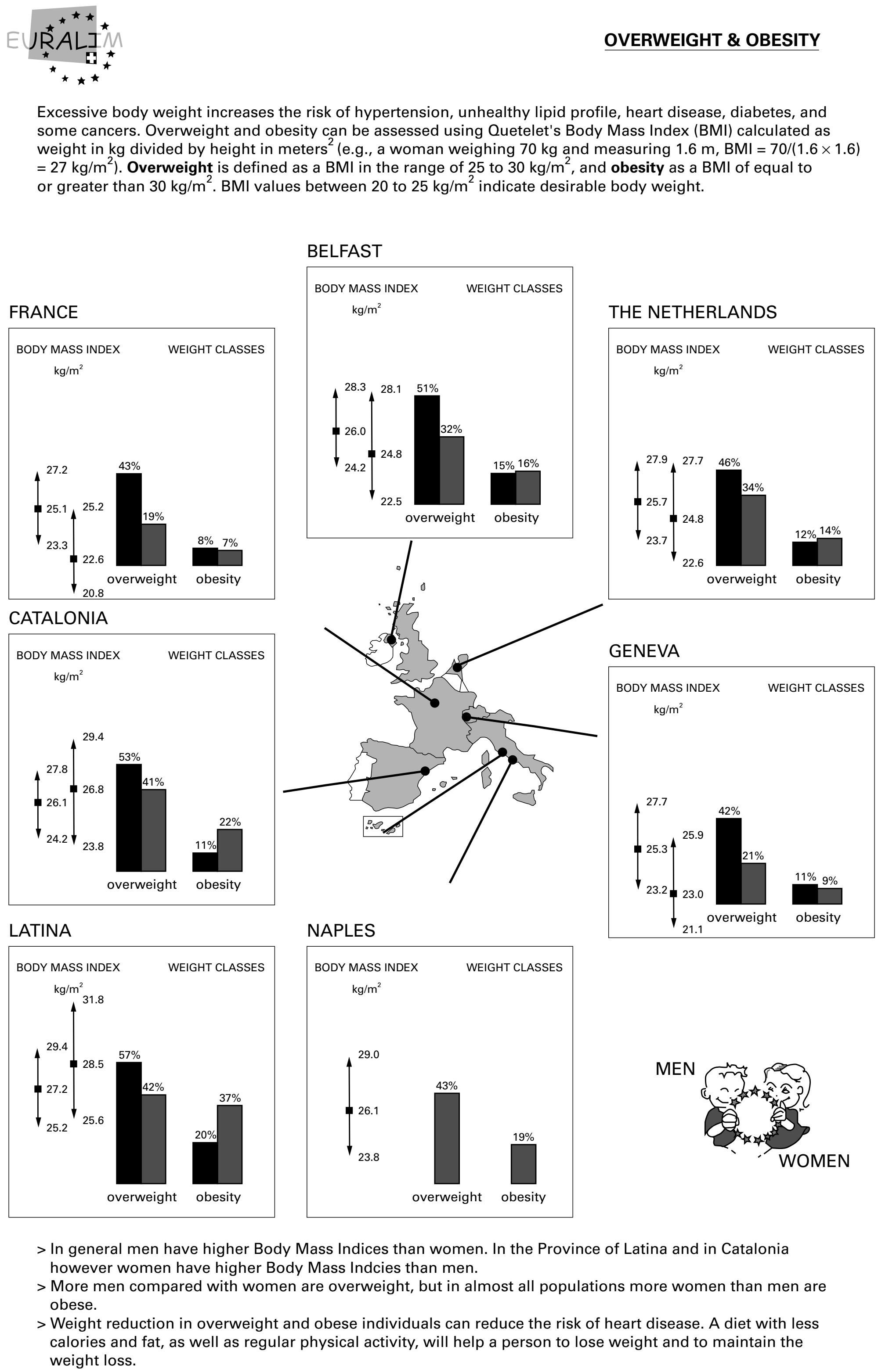

Figure 2 Brochure for the general public—Overweight and Obesity.

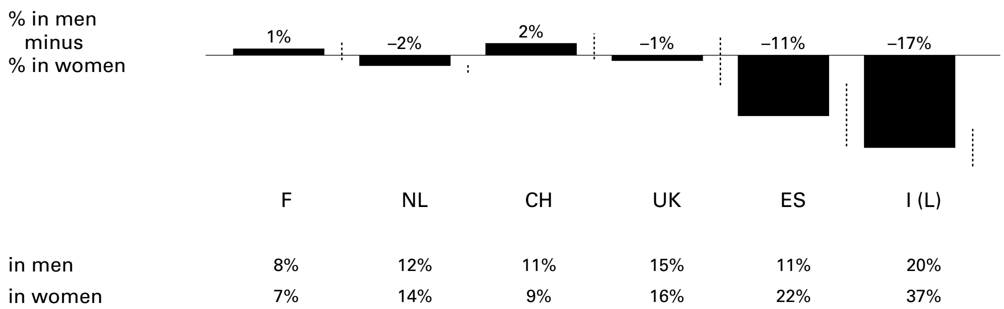

Figure 3 Supplement for public health professionals. Age standardised gender differences in the prevalence of obesity (BMI ⩾ 30 kg/m²) with their associated 95% CIs, 40–59 years.

the less, comparison of within population contrasts by sex, age group, and other measured health determinants (for example, educational level and smoking status) was possible.

In figure 2, the weighted percentiles of body mass index (BMI) as a measure of relative body weight are depicted as an example. As all data were based on measured body weight and height, it was not necessary to apply the calibration method for self reported data proposed by Kuskowska-Wolk and Rössner.[24] The major methodological differences across surveys were: the types of balances used and the manners and frequencies of their calibrations; the height measurement devices used; measurement precision; and the clothing worn. The Swiss and Dutch body weight data were made more comparable to those obtained in the other studies by subtracting 1 kg to account for the difference in assessing weight in full dress compared with undergarments only. The distributions (interquartile ranges) for men were usually shifted upward compared with the corresponding interquartile ranges for women, with the exceptions of Latina and Catalonia (note that the median values for men were 1–2 kg/m² higher than for women). BMIs for women from Naples resembled those of women from Catalonia. Women from all populations showed greater variability in measured BMIs than did men (that is, women's interquartile ranges or P25–P75 were up to 2 kg/m² larger). Additional analyses (fig 3) revealed that in all populations examined, being overweight (BMI 25–30 kg/m²) was significantly more prevalent in men than in women. There were little gender differences for obesity (BMI ⩾ 30 kg/m²) in the populations from France, the Netherlands, Geneva, and Belfast. In Catalonia and Latina, however, significantly more women than men were obese.

Table 3 Impact of a 3% measurement error for body weight on gender differences and ratios of obesity (BMI ⩾30 kg/m²)

Population that study sample is representative of	Error	Obesity: % in men	Obesity: % in women	Difference Men minus women	Ratio Men to women
France	0%	8	7	1	1.14
	3%	5	6	−1	0.83
the Netherlands	0%	12	14	−2	0.86
	3%	8	11	−3	0.73
Province of Latina	0%	20	37	−17	0.54
(Italy)	3%	14	30	−16	0.47
Geneva	0%	11	9	2	1.22
(Switzerland)	3%	8	7	1	1.14
Belfast	0%	15	16	−1	0.94
(United Kingdom)	3%	11	13	−2	0.85
Catalonia	0%	11	22	−11	0.50
(Spain)	3%	7	18	−11	0.39

Table 3 presents the gender differences and ratios of obesity in the six populations reporting data on both genders. The data presented by EURALIM (figs 2 and 3) are provided along with the corresponding data assuming a 3% underestimation error on the measurement of body weight. For illustrative purposes, it was assumed that the measurement error was similar in men and women. Results show that the nominal prevalence of obesity changes with measurement error present and that this affects the direct comparisons across groups, for instance, between women from Latina and the Netherlands. Still, the impact of measurement error on the comparisons of gender differences was minimal. Although the gender differences and ratios changed, the qualitative interpretation remains the same—that is, there is more obesity in southern European women than in southern European men, but similar levels of obesity in northern European men and northern European women.

EURALIM Day was held on 19 May 1998 in all participating centres to kick off the information campaign that ultimately reached about 1500 public health professionals across Europe. The general public brochure was in turn distributed to about 60 000 people through these 1500 contacts.

Discussion

Overall, results showed that gender differences for the considered risk factors varied substantially across populations, implying that examined factors may be amenable to modification through public health interventions.

Surveillance of risk factors requires timely data collection. The WHO recently called for the continuous monitoring of BMI to assess the trends in obesity in populations across time.[25] EURALIM used a harmonisation approach to compare the distributions of cardiovascular risk factors assessed in disparate ways among seven European research centres. Defining new uniform variables permitted joint, comparative analyses to be conducted. The constitution of a common database was a key factor in this project. None the less, only a fraction of the examined variables were essentially similar across all seven participating studies. Methods for assessing important factors such as physical activity, socioeconomic status (education, occupation), and smoking habits varied considerably across studies. For certain factors (for example, physical activity) it was not possible to define a satisfactory common variable as the methods used were so dissimilar. As educational systems differ substantially across Europe, the best possible common cut point was to set "high education" equal to "university or equivalent degree". Thus, the category "medium/low education" comprised a large, diverse spectrum of degrees. For smoking habits, the most uniform definition was able to distinguish "never", "former" and "current" smokers, but not able to provide any common information on duration or intensity. Analyses by educational level and smoking status thus require careful interpretation.

Because age is associated with most chronic disease risk factors, age standardisation is a crucial step in international surveillance projects. The problems tackled by EURALIM are probably typical of those that future harmonisation projects will encounter. For example, the overrepresentation of the youngest age group in the Catalan population was because of reliance on what turned out to be incorrect census information. The inclusion of volunteers was responsible for the unequal age distributions in the samples from France and Naples. Age standardisation helped to correct the age inconsistencies between studies. As expected, the presented population estimates were less precise for smaller samples, as reflected in the larger width of the corresponding 95% CIs for percentiles and frequency bar charts.

A key methodological finding of EURALIM is that international comparisons of within population contrasts by sex, age group, and other health determinants (for example, educational level and smoking status) are meaningful and apt. The rationale is that for any single study, the biases are similar among the groups compared and therefore tend to cancel each other out. For example, if weight is overestimated in one survey in both men and women, the gender ratio of median BMIs will be unbiased (the gender difference of median BMIs will be slightly biased, however, if the gender difference is not null). The situation is more complicated when you compare the gender prevalences of a given condition (for example, gender specific prevalences of obesity). As shown in table 3, both the ratios of prevalences and the differences of prevalences may be biased, but it is reasonable to expect that the qualitative relation (that is, whether men are more obese than women or vice versa) will not be affected if the two distributions have comparable variances.

This central finding can be of great use in future international comparisons of risk factor distributions, that is, comparing the nominal levels of prevalences may be less valid than comparing prevalence contrasts. For example, it is worth noting that obesity is more prevalent among Latina women than among Latina men, but that the reverse situation is found in France, the Netherlands and Belfast. This may indicate that environmental and therefore potentially modifiable risk factors play important parts in these differences. Similar contrasts can be computed and compared for smokers versus non-smokers, upper versus lower socioeconomic groups, etc. The disadvantage of ratios over differences is that they give no idea of the magnitude of the affected populations. Therefore, differences may be more important to public health professionals and preferred (or presented along with ratio estimates). The development of an international risk factor surveillance system based upon the continuous monitoring of locally-based standardised studies will provide repeated measurements of key risk factors. Ongoing health promotion actions that are based upon continuously collected data using within population contrasts across sites will help to better elucidate the influence of environmental and behavioural factors on health.

Standardised methods are needed to present meaningful statistics on risk factor distributions and to compare population groups. The biological variables and physiological measurements investigated in EURALIM often had asymmetric distributions, which generally hampers the interpretation of the mean as a measure of central tendency. Atypical people with outlying characteristics may also influence the usual estimates of means and variances. Therefore, three percentiles were used to summarise the distributions, namely the median or 50th percentile as a measure of central tendency, and the 25th and the 75th percentiles as measures of variability. The latter percentiles are preferred to the 5th and 95th percentiles because they can be more precisely estimated given the usual sample sizes of local surveys.[17]

To illustrate the proposed methodology for international risk factor comparisons, we presented important gender contrasts for excessive body weight across populations. Overweight is common in Europe. Up to 43% of women and 57% of men had BMIs between 25 and 30 kg/m^2. Obesity (BMI $\geqslant$ 30 kg/m^2) is also frequent in both genders, although any gender differences found were generally smaller. Overall, a north-south European gradient was perceptible in the results. Higher BMI values were observed for women from Catalonia, Spain and the two Italian study centres. On the other hand, women from France and Geneva showed the lowest BMIs and therefore had the lowest prevalences of overweight and obesity. These may be true international differences, attributable in part to varying social and cultural environments, including different kinds of occupational and leisure time activities and dietary habits. Methods of direct measurement for body weight and height varied slightly between studies. Differences in study designs may explain part of the international differences found. However, these methodological variations are probably too small to meaningfully influence the overall results. Although some of the gender differences in the body weights of men and women are biological, men and women could potentially reach the same prevalences of overweight and obesity as their female or male counterparts by adopting healthier lifestyles.[26] Health promotion programmes to lower body weight can use as targets the optimum conditions found not only within but also across populations. The general public needs to be provided with effective ways of maintaining healthy weights, or of losing excess weight, which are culturally acceptable and contextually supportable. Eating and exercise habits of female and male populations with the most desirable body weights, such as those in France and Geneva, need to be investigated for possible clues to effective interventions to mount in other populations.

The development of an international risk factor surveillance system is warranted. Further work in harmonisation procedures is needed to increase comparability among locally run studies. Gender, age group, and other health determinant contrasts may be useful in describing how chronic disease risk factors vary locally, nationally, and worldwide.[27] One suggestion for improving harmonisation methods is to perform calibration studies to assess the amount of measurement variability in each centre from commonly defined standard measures. In addition, locally run surveys may do well to incorporate a standardised "surveillance core" comprised of a short set of simple measures to allow for improved national and international comparisons over time.

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