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WHO MONICA Project: Risk Factors

WHO MONICA PROJECT*

WHO MONICA Project/Keil U (Ruhr-Universität Bochum, Abteilung für Sozialmedizin und Epidemiologie, D-4630 Bochum and GSF–Medis–Institut, D-8042 Neuherberg, Federal Republic of Germany) and Kuulasmaa K. WHO MONICA Project: Risk Factors. *International Journal of Epidemiology* 1989, **18 (Suppl.1)**: S46–S55.

The WHO MONICA Project was designed to measure trends and determinants in cardiovascular disease mortality and coronary heart disease and cerebrovascular disease morbidity, and to assess the extent to which these trends are related to changes in known risk factors in 39 collaborative centres in 26 countries. Results of the baseline population surveys are presented. Use of standardized methods allows cross-sectional comparisons to be made of data from the 39 collaborating centres.

The proportion of smokers varied between 34–62% among men and 3–52% among women.

The median systolic blood pressure (SBP) values varied from 121 mmHg to 145 mmHg in men and from 117 mmHg to 143 mmHg in women. Median diastolic blood pressure (DBP) values varied from 74 mmHg to 91 mmHg in men and from 72 mmHg to 89 mmHg in women. The prevalence of actual hypertension, defined as SBP and/or DBP >159/94 mmHg, or on antihypertensive medication, varied between 8.4% and 45.3% in men and between 12.6% and 40.5% in women.

Median serum total cholesterol values varied from 4.1 mmol/l to 6.4 mmol/l in men and from 4.2 mmol/l to 6.4 mmol/l in women.

The results show that there is a large variability in the risk-factor patterns among the MONICA populations. They also indicate that populations with low levels of risk factors are in the minority.

The WHO MONICA Project was designed to measure trends and determinants in cardiovascular disease mortality and coronary heart disease (CHD) and cerebrovascular disease morbidity, and to assess the extent to which these trends are related to changes in known risk factors, daily living habits, health care, and major socioeconomic features measured at the same time in defined communities in different countries.[1,2] Use of standardized methods also allows cross-sectional comparisons to be made of data from 39 collaborating centres in 26 countries. This paper focuses on variation in the major risk factors for CHD in men and women, aged 35–64 years, in the different MONICA Collaborating Centres (MCCs).

Data from population studies suggest that the levels of major risk factors are not stable and that changes in CHD mortality may be related to changes in risk factors. However, the evidence is based on a few isolated observations in selected populations and does not allow firm conclusions but rather stresses the need for further investigations.[3]

METHODS

Risk factors in the WHO MONICA Project are monitored through three independent cross-sectional population surveys.[1,2]

Study Populations and Survey Methods

The populations included in the present report are listed in Table 1, together with information about the sample size, participation rate, and survey period. The populations studied are not necessarily representative of the countries in which they are located, but in some MCCs the reporting units were selected to be typical. The surveys were intended to include representative probability samples of at least 200 people in each sex and ten-year age group, for the age range 35–64 years. About one-half of the centres used simple random sampling in all reporting units. In the rest of the MCCs, multistage sampling was used. The duration of the population surveys varied from four months to nearly four years, and participation rates varied from 54% to 89% for those centres that reported them (Table 1).

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TABLE 1 *Sample size, participation rate and survey period in MONICA populations. Men and women combined, age groups 35–64.*

Population	MCC	Sample size	Participation rate %	Survey period
Perth	10	1535	85	May 83–Oct 83
Newcastle	11	3658	67	May 83–Nov 83
Ghent	12	1437	72	Feb 85–Jun 87
Charleroi	12	1391	59	Mar 85–Aug 86
Luxembourg Province	14	3614	54	Jun 83–Jan 85
Beijing	17	1420	89	Aug 84–Nov 85
Czechoslovakia	18	2285	85	Mar 85–Nov 85
Glostrup	19	3563	79	Nov 82–Feb 84
North Karelia	20	3085	80	Jan 82–Apr 82
Kuopio Province	20	2397	85	Jan 82–Apr 82
Turku/Loimaa	20	3019	85	Jan 82–Apr 82
Berlin-Lichtenberg	23	. . .	. .	Apr 84–May 85
Halle County	23	. . .	. .	Nov 83–Jul 84
Karl-Marx-Stadt County	23	. . .	. .	82–Nov 85
DDR MONICA	23	. . .	. .	82–Nov 84
Bremen	24	1826	71	May 84–Nov 84
Rhein-Neckar Region	25	2865	86	Sep 83–Jul 87
Augsburg: (urban)	26	1866	75	Oct 84–May 85
Augsburg: (rural)	26	2118	80	Oct 84–May 85
Budapest	27	1472	80	Jul 82–Jun 83
Pecs	27	. . .	. .	Jul 82–Jun 83
Iceland	28	1793	76	Jun 83–Nov 83
Friuli	32	1795	81	Jan 86–Sep 86
Auckland	33	1950	81	Jan 82–Jul 82
Belfast	34	2649	70	Oct 83–Sep 84
Tarnobrzeg Voivodeship	35	3373	81	May 83–Nov 84
Warsaw	36	3600	74	Dec 83–Jan 85
Glasgow	37	1536	64	Feb 86–Oct 86
Catalonia	39	1046	75	Apr 86–May 87
Göteborg	40	1461	75	Feb 85–Nov 86
Stanford	43	1402	69	May 79–Apr 80
Kaunas	45	2086	69	Jan 83–Mar 85
Moscow:				
(intervention)	46	3598	67	Feb 84–Oct 86
(control)	46	1825	78	Feb 84–Feb 86
Novosibirsk:				
(intervention)	47	1720	73	May 85–Nov 85
(control)	47	3045	69	Nov 85–Mar 86
Novi Sad	49	1448	82	Aug 84–Dec 84
Vaud/Fribourg	50	1966	62	Oct 84–Jun 85
Ticino	50	1948	79	Nov 85–May 86
Malta	52	2249	67	Jan 84–Jun 84
Bas-Rhin	54	—	66	Jan 85–Dec 86
Haute-Garonne	55	2264	58	May 85–Dec 86
Brianza Area	57	1773	71	Apr 86–Dec 86
Northern Sweden	60	1501	84	Jan 86–Apr 86

Measurement and Categorization of Risk Factors

Smoking

Data on smoking were obtained with a standard questionnaire following standard instructions.[4] In the present analysis responders were classified as follows:

- Regular cigarette smokers reported smoking cigarettes every day.
- Other current smokers were not regular cigarette smokers but smoked at least 1 g of pipe tobacco per week or at least one cigar per week.
- Ex-smokers reported smoking cigarettes regularly in the past but not currently.
- Non-smokers were not current smokers and had never smoked cigarettes regularly.

The number of cigarettes smoked per day was used as a measure of exposure to cigarette smoke for current smokers.

Blood pressure

Blood pressure (BP) was measured on the right arm with the subject in the sitting position after at least five minutes at rest. Random zero sphygmomanometers were used in ten MCCs: otherwise, regular mercury sphygmomanometers were used. Two consecutive BP measurements were performed, and systolic (SBP) and diastolic blood pressures (DBP) were recorded to the nearest 2 mmHg. DBP was determined at the beginning of Korotkoff phase V. The mean value of the two readings was used in the present analysis.

Participants were asked whether they had ever been told by medical personnel that their BP was high and whether they had taken drugs for high BP within two weeks prior to the examination.

On the basis of the above information and BP measurements at the survey, participants were classified into one of the following categories:

- Controlled hypertensives = SBP <160 mmHg and DBP <95 mmHg, on treatment for hypertension
- Treated, uncontrolled hypertensives = SBP >159 mmHg and/or DBP >94 mmHg, on treatment for hypertension.
- Untreated hypertensives = SBP >159 mmHg and/or DBP >94 mmHg, not on treatment for hypertension.
- Normotensives = SBP <160 mmHg and DBP <95 mmHg, not on treatment for hypertension.

Total cholesterol

A venous blood sample was drawn with the subject in the sitting position, and with limited use of a tourniquet. It was recommended that total cholesterol be determined by the enzymatic method on the day of blood collection. The enzymatic method was used by 25 MCCs. Other MCCs used the direct Liebermann-Burchard or the extraction methods.

TABLE 2 *Smoking: Age-standardized proportions (%) of regular cigarette smokers, other current smokers and ex-smokers and median number of cigarettes smoked per day per cigarette smoker in MONICA populations. Men, age group 35–64.*

Population	MCC	Number of observations	Regular cigarette smokers %	Median no. of cigarettes smoked per day	Other current smokers %	Ex-smokers %
Northern Sweden	60	640	23.7	15	10.7	28.4
Iceland	28	657	26.3	20	24.9	21.5
Auckland	33	1018	28.7	20	5.6	30.2
North Karelia	20	1127	29.4	20	7.6	33.6
Augsburg (rural)	26	846	29.6	20	8.2	23.8
Turku/Loimaa	20	1194	30.2	20	8.7	34.5
Rhein-Neckar Region	25	1174	31.0	20	7.2	31.9
Vaud/Fribourg	50	627	32.2	20	6.3	27.5
Göteborg	40	525	32.3	20	8.5	31.6
Berlin-Lichtenberg	23	528	32.3	15	4.2	34.2
Perth	10	631	32.8	20	3.2	31.3
Newcastle	11	1218	32.9	20	2.1	28.9
Kuopio Province	20	969	33.0	20	10.4	28.8
Belfast	34	927	34.0	20	11.7	27.3
Bas-Rhin	54	666	34.3	20	6.9	34.8
Friuli	32	719	34.9	15	2.7	35.9
Augsburg (urban)	26	712	36.2	20	3.7	28.4
Haute-Garonne	55	678	36.5	20	6.6	31.4
Karl-Marx-Stadt County	23	804	36.8	15	2.9	31.8
Halle County	23	983	38.0	15	5.9	31.6
Kaunas	45	728	38.1	15	3.6	22.2
DDR MONICA (other surveys)	23	978	38.2	15	1.3	31.3
Ticino	50	781	38.2	20	5.5	24.1
Stanford	43	426	40.0	25	3.1	31.4
Luxembourg Province	14	990	42.6	–	8.4	28.3
Ghent	12	539	42.7	20	9.1	25.4
Brianza Area	57	618	43.5	15	3.5	27.8
Czechoslovakia	18	948	44.2	20	4.2	24.3
Glostrup	19	1456	44.6	15	16.5	16.5
Bremen	24	633	44.8	20	1.9	33.5
Moscow (intervention)	46	1163	46.2	20	3.1	19.3
Catalonia	39	397	47.3	17	10.4	22.1
Moscow (control)	46	770	48.3	20	1.3	25.9
Pecs	27	607	48.5	20	0.7	22.1
Malta	52	695	48.8	20	4.8	14.3
Novi Sad	49	592	48.9	20	1.6	24.0
Charleroi	12	384	50.2	20	5.4	27.4
Budapest	27	566	51.9	20	1.0	20.1
Glasgow	37	502	52.4	20	9.7	16.3
Novosibirsk (intervention)	47	601	53.4	20	0.9	22.9
Tarnobrzeg Voivodship	35	1250	57.9	20	1.2	18.3
Beijing	17	619	58.2	11	2.8	4.4
Warsaw	36	1309	58.5	20	1.4	22.0
Novosibirsk (control)	47	1060	58.8	20	0.5	22.3

Height and weight

Height and body weight were measured with participants standing without shoes and heavy outer garments. Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2) as a measure of relative weight.

Quality Assurance Procedures

It is essential for each MONICA Centre to use identical survey procedures at three points in a ten-year period so that changes in risk factors can be detected that are unconfounded by data collection or measurement procedures. The standards for data collection

TABLE 3 *Smoking: Age-standardized proportions (%) of regular cigarette smokers, other current smokers and ex-smokers and median number of cigarettes smoked per day per cigarette smoker in MONICA populations. Women, age group 35–64.*

Population	MCC	Number of observations	Regular cigarette smokers %	Median no. of cigarettes smoked per day	Other current smokers %	Ex-smokers %
Novosibirsk: (intervention)	47	646	2.7	10	0.2	2.7
(control)	47	1054	3.4	5	0.4	1.6
Kaunas	45	735	3.8	7	1.2	2.5
Catalonia	39	389	5.5	10	1.6	3.2
North Karelia	20	1211	8.2	10	5.8	6.5
Moscow Province (intervention)	46	1234	8.7	8	2.3	3.6
Kuopio	20	978	9.6	13	4.7	6.9
Malta	52	756	10.2	7	6.0	1.1
Tarnobrzeg Voivodship	35	1472	11.1	10	0.8	2.4
Augsburg (rural)	26	857	12.0	8	3.4	9.2
Moscow (control)	46	645	12.2	10	1.7	5.4
Halle County	23	1059	13.9	6	4.3	6.9
Karl-Marx-Stadt County	23	897	14.5	6	1.3	7.0
Bas-Rhin	54	714	14.5	10	3.0	7.1
Haute-Garonne	55	645	17.4	10	1.5	11.0
DDR MONICA (other surveys)	23	1012	17.5	8	0.0	7.6
Turku/Loimaa	20	1269	17.5	15	5.0	9.3
Beijing	17	641	17.5	5	1.5	1.2
Luxembourg Province	14	958	17.8	–	0.1	10.1
Augsburg (urban)	26	679	18.4	10	3.1	9.7
Brianza Area	57	639	18.4	10	2.2	4.2
Vaud/Fribourg	50	568	20.6	15	7.7	10.2
Rhein-Neckar Region	25	1272	21.4	12	3.5	14.4
Perth	10	661	21.9	15	0.6	16.3
Czechoslovakia	18	990	22.0	10	3.1	7.5
Berlin-Lichtenberg	23	565	22.8	10	0.9	10.6
Newcastle	11	1241	23.3	15	0.0	10.9
Charleroi	12	435	23.7	21	0.2	10.6
Ticino	50	769	24.1	15	3.9	9.0
Pecs	27	606	24.3	15	1.2	4.9
Auckland	33	567	24.9	15	2.5	24.6
Ghent	12	495	25.0	17	0.2	10.5
Friuli	32	724	26.4	10	2.1	9.5
Northern Sweden	60	611	26.5	10	4.0	16.2
Novi Sad	49	539	27.8	15	3.0	5.9
Bremen	24	656	29.3	15	0.0	17.4
Belfast	34	925	33.4	15	1.9	15.1
Warsaw	36	1337	33.7	13	1.0	10.4
Göteborg	40	564	34.5	15	4.3	21.3
Budapst	27	538	35.7	20	1.0	7.4
Stanford	43	517	36.8	20	0.4	16.2
Iceland	28	704	39.8	17	4.6	15.5
Glostrup	19	1361	43.7	13	5.9	11.8
Glasgow	37	480	50.2	20	1.8	11.8

and quality control are described in detail in the MONICA manual.[2]

Special attention was paid to training survey personnel, and detailed guidelines and training material were provided for BP observers. Data on smoking were collected by a widely used standard questionnaire.[4] The MONICA Quality Control Centre for lipid measurements in Prague, which was standardized to the Centers for Disease Control (CDC) in Atlanta, recommended intra-laboratory quality control procedures and organized continuous external quality control. Blind sets of samples were sent from Prague

TABLE 4 *Systolic blood pressure (mmHg): Age-standardized 10th, 50th, 90th percentiles in MONICA populations. Men and women, age group 35–64.*

Population	MCC	Men				Women			
		No of observations	Percentiles 10th	50th	90th	No of observations	Percentiles 10th	50th	90th
Catalonia	39	397	105	121	146	389	101	118	146
Iceland	28	657	107	123	146	703	102	118	143
Glostrup	19	1456	108	125	148	1361	104	121	147
Beijing	17	618	106	126	162	641	102	127	157
Ghent	12	426	110	126	146	348	102	117	144
Stanford	43	434	110	127	147	520	105	120	148
Rhein-Neckar Region	25	739	110	128	153	784	104	123	153
Charleroi	12	275	114	129	151	247	107	123	147
Newcastle	11	1219	112	129	156	1245	105	125	156
Haute-Garonne	55	678	113	130	150	645	105	125	150
Vaud/Fribourg	50	624	112	130	153	566	106	123	148
Tarnobrzeg Voivodship	35	1250	111	130	160	1472	110	131	170
Budapest	27	591	110	130	160	579	105	129	160
Luxembourg Province	14	985	114	131	153	949	108	127	157
Northern Sweden	60	647	112	131	151	614	107	126	154
Ticino	50	781	112	131	156	769	107	126	154
Novosibirsk (control)	47	1060	110	131	162	1054	109	131	163
Auckland	33	1019	111	131	155	568	104	123	150
Perth	10	631	112	131	159	661	105	122	150
Novi Sad	49	606	117	132	160	576	113	132	160
Belfast	34	927	112	132	163	923	108	129	162
Novosibirsk (intervention)	47	601	113	132	158	646	111	133	170
Moscow (control)	46	775	109	133	167	650	112	134	179
Augsburg (rural)	26	846	117	133	158	857	110	128	157
Moscow (intervention)	46	1165	115	134	164	1239	112	133	170
Kaunas	45	728	111	134	165	734	111	132	171
Glasgow	37	498	116	134	165	478	109	131	166
Augsburg (urban)	26	712	114	134	159	679	107	128	157
Czechoslovakia	18	943	118	135	163	990	110	133	160
Brianza Area	57	615	115	136	162	630	110	131	160
Malta	52	656	120	136	162	687	119	138	165
Pecs	27	605	116	137	166	619	110	134	170
Halle County	23	982	117	137	164	1055	116	138	172
Karl-Marx-Stadt County	23	796	121	138	164	889	115	138	164
Bremen	24	640	118	139	163	658	114	135	168
Berlin-Lichtenberg	23	526	120	139	163	565	115	135	163
Warsaw	36	1309	119	140	174	1337	114	138	176
Friuli	32	713	120	140	170	727	112	136	166
Turku/Loimaa	20	1199	120	140	168	1280	114	133	166
DDR MONICA (other surveys)	23	529	122	142	163	592	118	140	170
Bas-Rhin	54	666	122	143	170	714	113	133	166
North Karelia	20	1144	121	143	169	1238	118	141	169
Kuopio Province	20	977	124	145	171	988	119	143	176

periodically to all collaborating laboratories. Criteria of acceptability were based on the coefficient of variation (standard deviation/mean), and per cent bias was calculated separately for each set. The highest acceptable bias, based on total cholesterol concentration reference values, was 5%.

Data Management and Statistical Analysis

Survey data were collected and checked by the local MCC research team before transfer on magnetic tape to the MONICA Data Centre (MDC) in Helsinki. Detailed instructions were prepared for extracting the standard set of variables from local data files. The MDC checked every variable to assure the quality and completeness of the data. Data were included in the main data base only after necessary corrections were made.[3]

As a general rule, data were not included in the present analysis if they were not collected according to standard procedure and their quality was not assured by the external quality assessment.

TABLE 5 *Hypertension* and actual hypertension†: Age-standardized proportions (%) in MONICA populations. Men and women, age group 35–64.*

Population	MCC	Men			Women		
		No of observations	Hyper-tension %	Actual hypertension %	No of observations	Hyper-tension %	Actual hypertension %
Catalonia	39	396	6.3	8.4	389	3.6	13.0
Ghent	12	390	7.6	12.9	311	4.5	16.5
Glostrup	19	1380	11.3	15.0	1339	6.6	12.6
Luxembourg Province	14	971	10.3	15.5	937	11.3	19.5
Vaud/Fribourg	50	602	13.7	18.1	551	9.2	14.0
Ticino	50	745	15.3	18.9	759	11.6	17.0
Charleroi	12	275	12.9	19.4	247	5.4	15.7
Auckland	33	1012	15.8	20.2	566	8.7	18.2
Northern Sweden	60	635	15.2	20.4	608	12.7	18.8
Augsburg (rural)	26	846	18.9	21.6	857	14.3	19.4
Rhein-Neckar Region	25	559	12.7	22.0	608	9.1	17.3
Novi Sad	49	536	16.9	22.7	519	17.4	27.7
Stanford	43	431	15.8	23.5	518	8.6	16.7
Belfast	34	927	21.0	23.8	923	15.6	20.3
Beijing	17	618	22.9	24.6	641	16.3	21.5
Perth	10	631	19.9	25.2	661	11.5	19.1
Newcastle	11	1217	17.8	25.7	1245	13.4	25.0
Haute-Garonne	55	622	21.9	25.7	626	13.0	17.6
Bremen	24	633	23.0	26.0	650	20.0	23.3
Moscow (intervention)	46	1093	24.9	26.4	1130	21.5	28.0
Augsburg (urban)	26	712	24.7	27.7	679	15.4	19.5
Tarnobrzeg Voivodship	35	1191	23.2	27.8	1428	26.7	34.4
Novosibirsk (control)	47	1060	27.5	29.2	1054	26.8	31.5
Kaunas	45	728	26.2	30.4	734	23.4	30.7
Brianza Area	57	613	29.1	31.1	630	20.2	24.6
Glasgow	37	492	27.5	32.0	475	21.5	25.4
Czechoslovakia	18	942	25.9	32.4	988	22.2	31.3
Malta	52	656	29.1	33.1	687	29.3	36.2
Halle County	23	982	30.3	33.6	1055	29.5	35.5
Friuli	32	708	30.8	33.9	720	24.6	29.2
Turku/Loimaa	20	1162	31.3	35.5	1243	19.4	24.3
Novosibirsk (intervention)	47	601	33.7	35.7	646	34.5	40.3
Moscow (control)	46	775	34.4	36.6	649	31.5	37.7
Berlin-Lichtenberg	23	526	30.8	37.2	565	22.5	32.3
Warsaw	36	1309	35.7	37.4	1337	27.7	30.9
DDR MONICA (other surveys)	23	529	31.9	37.9	592	32.5	40.5
Karl-Marx-Stadt County	23	796	35.1	38.9	889	27.6	34.7
North Karelia	20	1115	34.8	39.5	1196	29.7	34.7
Bas-Rhin	54	660	40.0	42.3	713	26.1	32.1
Kuopio Province	20	948	42.4	45.3	964	31.1	37.6

* Systolic BP >159 mm Hg and/or diastolic BP >94 mm Hg.
† People with hypertensive BP values or on antihypertensive medication.

For centres with more than one reporting unit, data were weighted by age, sex and sample size to provide estimates for the whole population. In addition, age-standardized values were calculated with use of World Standard Population weights of 12/31, 11/31 and 8/31 for the age groups 35–44, 45–54 and 55–64 respectively.[3]

Mean, median, 10th and 90th percentile values were determined to compare the distributions of particular risk factors between the population studied. Risk factors were considered present if participants were current smokers or had BPs of 160/95 or higher, or were on treatment for hypertension, or had total cholesterols equal to or higher than 6.5 mmol/l (250 mg/dl). Prevalence rates of zero, one, any two, or all three of the risk factors were determined.[3]

TABLE 6 *Total cholesterol (mmol/l): Age-standardized 10th, 50th, 90th percentiles in MONICA populations. Men and women, age group 35–64.*

		Men				Women			
Population	MCC	No of observations	percentiles 10th	50th	90th	No of observations	percentiles 10th	50th	90th
Beijing	17	619	3.3	4.1	5.4	641	3.3	4.2	5.5
Stanford	43	432	4.2	5.3	6.9	513	4.0	5.2	6.6
Tarnobrzeg Voivodship	35	1238	4.2	5.3	6.6	1462	4.3	5.4	6.9
Bas-Rhin	54	638	4.3	5.5	7.0	666	4.1	5.4	6.8
Ticino	50	751	4.3	5.5	6.9	731	4.0	5.2	6.6
Warsaw	36	1289	4.4	5.5	6.8	1301	4.4	5.5	6.8
Brianza Area	57	616	4.2	5.6	7.1	631	4.2	5.5	7.0
Auckland	33	1005	4.5	5.7	7.0	562	4.5	5.7	7.2
Budapest	27	586	4.5	5.7	7.3	565	4.4	5.8	7.4
Newcastle	11	1201	4.5	5.7	7.3	1195	4.5	5.6	7.3
Rhein-Neckar Region	25	1158	4.4	5.7	7.2	1257	4.4	5.7	7.2
Perth	10	626	4.5	5.8	7.1	650	4.4	5.7	7.2
Haute-Garonne	55	659	4.5	5.9	7.3	606	4.4	5.7	7.4
Kaunas	45	727	4.7	5.9	7.4	735	4.8	6.0	7.5
Belfast	34	916	4.7	5.9	7.4	914	4.7	6.0	7.6
Bremen	24	627	4.8	6.0	7.7	640	4.7	6.0	7.8
Charleroi	12	266	4.7	6.1	7.7	225	4.6	5.8	7.5
Göteborg	40	499	4.7	6.1	7.6	547	4.7	6.0	7.9
Augsburg (rural)	26	808	4.8	6.1	7.8	825	4.7	5.9	7.5
Turku/Loimaa	20	1205	4.9	6.1	7.6	1280	4.7	6.0	7.8
Iceland	28	656	5.0	6.1	7.5	703	5.0	6.2	7.8
Ghent	12	415	4.7	6.1	7.7	330	4.5	5.9	7.5
Glasgow	37	464	4.9	6.2	7.7	424	4.8	6.4	8.3
Augsburg (urban)	26	664	4.9	6.2	7.8	623	4.7	6.0	7.7
Kuopio Province	20	977	4.9	6.2	7.9	988	4.7	6.2	8.0
Glostrup	19	1454	4.9	6.2	7.9	1359	4.8	6.1	7.8
Vaud/Fribourg	50	620	5.0	6.3	8.1	544	4.6	6.0	7.5
North Karelia	20	1146	5.0	6.3	7.9	1239	4.8	6.2	8.1
Czechoslovakia	18	948	5.0	6.3	7.9	990	5.0	6.3	8.0
Luxembourg Province	14	989	5.0	6.4	8.1	954	4.9	6.3	8.1

RESULTS

Smoking

Tables 2 and 3 show the age-standardized proportions of regular cigarette smokers, other current smokers, and ex-smokers, and the median number of cigarettes smoked per day per cigarette smoker among men and women in 44 populations of 33 MCCs of the MONICA project. The populations are listed by increasing proportions of regular cigarette smokers. Marked inter-population differences were found in the proportion of regular cigarette smokers, which varies from 23.7% (Northern Sweden) to 58.8% (Novosibirsk control) in men, and from 2.7% (Novosibirsk intervention) to 50.2% (Glasgow) in women. The prevalence of smoking (regular cigarette smokers plus other current smokers) varied from 34.3% (Auckland) to 62.1% (Glasgow) in men and from 2.9% (Novosibirsk intervention) to 52.0% (Glasgow) in women. The proportion of people who had never smoked varied from 18% to 37% in men and from 36% to 95% in women[3] (not shown). The median numbers of cigarettes smoked by cigarette smokers were between 11 and 25 per day in men and 5 and 21 per day in women (Tables 2 and 3).

Blood Pressure

Median SBP values varied from 121 mmHg (Catalonia) to 145 mmHg (Kuopio Province) in men and from 117 mmHg (Ghent) to 143 mmHg (Kuopio Province) in women (Table 4). Median DBP values varied from 74 mmHg (Catalonia) to 91 mmHg (Bas-Rhin) in men and from 72 mmHg (Catalonia) to 89 mmHg (Novosibirsk intervention) in women[3] (not shown).

The proportion of people who had elevated blood pressures or who were classified as actual hypertensives (BP categories 1-3) are shown in Table 5. The prevalence of actual hypertension, defined as SBP and/or DBP >159/94 mmHg, or on antihypertensive medication, varied between 8.4% (Catalonia) and 45.3% (Kuopio Province) in men and between 12.6% (Glostrup) and 40.5% (DDR MONICA) in women. (Table 5).

TABLE 7 *Risk factors: Age-standardized proportions (%) of three risk factors present in MONICA populations. Men and women, age group 35–64.*

Population	MCC	Men		Women	
		No of observations	Three risk factors (%)	No of observations	Three risk factors (%)
Beijing	17	618	0.3	641	0.1
Perth	10	626	1.6	650	1.6
Rhein-Neckar Region	25	553	1.7	599	0.7
Ghent	12	379	1.9	294	2.2
Tarnobrzeg Voivodship	35	1179	2.0	1419	0.5
Ticino	50	715	2.2	722	1.1
Stanford	43	422	2.2	503	1.0
Auckland	33	997	2.3	557	0.8
Newcastle	11	1196	2.3	1192	2.0
Bas-Rhin	54	632	2.7	665	0.4
Charleroi	12	265	2.7	225	2.3
Kaunas	45	727	2.8	734	0.5
Brianza Area	57	611	3.1	620	0.4
Vaud/Fribourg	50	596	3.3	525	0.8
Belfast	34	916	3.7	912	3.2
Glostrup	19	1378	3.9	1337	3.3
Luxembourg Province	14	968	4.0	934	1.5
Augsburg (rural)	26	806	4.1	825	1.0
Haute-Garonne	55	603	4.1	587	1.3
Warsaw	36	1289	4.5	1301	2.1
Augsburg (urban)	26	664	4.9	623	1.5
Turku/Loimaa	20	1152	5.7	1228	2.7
Bremen	24	611	6.6	623	1.9
North Karelia	20	1099	6.7	1171	1.9
Czechoslovakia	18	942	6.8	988	2.3
Glasgow	37	455	7.3	414	5.4
Kuopio Province	20	943	9.1	950	2.1

Total Cholesterol

Median serum total cholesterol values varied from 4.1 mmol/l (158 mg/dl) (Beijing) to 6.4 mmol/l (247 mg/dl) (Luxembourg Province, Belgium) in men, and from 4.2 mmol/l (Beijing) to 6.4 mmol/l (Glasgow) in women. (Table 6)

Unfortunately, only 30 of the 44 MONICA populations complied with all quality control requirements for the determination of total cholesterol.

Risk Factor Scores

Table 7 shows the proportion of men and women with three risk factors (actual hypertension, hypercholesterolaemia, and current smoking). The 27 MONICA populations for whom determinations of all three major risk factors were available were arranged in ascending order according to the proportion of male participants with all three major risk factors. The proportion of participants with all three major risk factors varied from 0.3% (Beijing) to 9.1% (Kuopio Province) in men and from 0.1% (Beijing) to 5.4% (Glasgow) in women. The proportion of participants with none of the major risk factors (defined above) varied from 42.5% (Auckland) to 14.1% (Glasgow) in men and from 62.6% (Beijing) to 21.7% (Glasgow) in women[3] (not shown here).

Body Mass Index

The range of median BMI was from 23.4 (Beijing) to 27.5 (Kaunas) in men and from 23.5 (Glostrup) to 29.3 (Kaunas) in women. (Table 8)

DISCUSSION

The findings presented here provide a unique opportunity to compare risk factor levels in a large number of populations from different parts of the world, based on common standardized survey methods for data collection and centralized data analysis. Although surveys were not all conducted at the same time, the results are not likely to be affected much by secular changes in risk factors over such short intervals.

Smoking is a common habit and generally more common among men than among women. Fewer cigarettes were smoked by female than by male smokers in all populations studied.

There were seven male and three female populations in whom the median SBP value was equal to or higher than 140 mmHg. There were four male popula-

TABLE 8 *Body Mass Index (kg/m²): Age-standardized 10th, 50th, 90th percentiles in MONICA populations. Men and women, age group 35–64.*

Population	MCC	Men				Women			
		No of observations	Percentiles 10th	50th	90th	No of observations	Percentiles 10th	50th	90th
Beijing	17	616	19.5	23.4	27.6	641	19.8	23.9	29.5
Göteborg	40	517	21.6	25.0	29.1	560	20.2	23.6	29.6
Tarnobrzeg Voivodship	35	1249	20.7	25.2	30.6	1472	21.7	27.3	34.5
Iceland	28	656	21.8	25.4	30.3	704	20.5	24.2	30.5
Glasgow	37	499	21.4	25.4	30.1	482	20.8	25.5	32.4
Auckland	33	1019	22.0	25.4	29.5	568	20.2	23.7	29.5
Glostrup	19	1456	21.7	25.4	30.3	1360	20.1	23.5	30.0
Brianza Area	57	614	21.9	25.5	30.3	632	20.1	24.3	31.5
Haute-Garonne	55	675	21.5	25.5	29.8	644	20.0	23.6	30.2
Perth	10	631	21.6	25.5	29.8	661	20.0	23.8	30.0
Belfast	34	924	21.8	25.5	30.2	924	20.6	24.8	31.4
Luxembourg Province	14	955	21.7	25.6	30.8	941	20.7	25.1	32.4
Stanford	43	433	21.7	25.6	29.9	520	19.7	23.5	31.8
Moscow (control)	46	775	21.6	25.6	30.8	650	22.7	27.8	36.0
Northern Sweden	60	647	22.0	25.6	30.4	611	20.6	24.7	31.5
Moscow (intervention)	46	1145	21.8	25.7	30.4	1218	22.1	28.0	34.3
Novosibirsk (control)	47	1060	21.8	25.7	31.1	1052	23.2	28.9	36.1
Budapest	27	592	21.3	25.8	30.8	580	20.7	25.5	32.4
Novosibirsk (intervention)	47	601	21.7	25.9	30.7	646	23.8	29.1	36.2
Berlin-Lichtenberg	23	525	21.9	25.9	30.6	562	20.8	24.7	32.0
Vaud/Fribourg	50	619	22.1	25.9	30.3	569	20.1	24.0	30.8
Newcastle	11	1219	22.2	26.0	30.8	1245	20.4	24.5	31.5
Ghent	12	425	21.8	26.1	30.4	348	20.8	25.2	32.5
Pecs	27	608	21.3	26.1	31.6	619	20.5	26.4	33.8
Rhein-Neckar Region	25	1186	22.4	26.2	30.8	1292	20.4	24.3	30.7
DDR MONICA (other surveys)	23	968	22.6	26.3	31.2	1003	21.5	25.8	33.6
Karl-Marx-Stadt County	23	803	22.3	26.3	30.9	894	21.0	24.9	32.0
Charleroi	12	276	22.5	26.3	31.5	247	20.9	26.0	33.6
Friuli	32	715	22.3	26.3	31.3	726	21.3	25.6	32.6
Bremen	24	640	22.7	26.3	30.9	661	21.4	25.5	32.7
Warsaw	36	1309	22.1	26.4	31.7	1337	21.7	26.8	34.3
Kuopio Province	20	976	22.1	26.4	31.6	990	21.7	25.9	32.7
Turku/Loimaa	20	1202	22.5	26.5	31.6	1282	21.0	25.2	31.4
Catalonia	39	397	22.0	26.5	30.3	389	22.1	26.3	33.4
Halle County	23	983	22.8	26.7	31.2	1058	21.3	26.2	34.2
North Karelia	20	1146	22.6	26.7	31.7	1239	21.6	26.2	33.6
Novi Sad	49	606	22.0	26.7	31.2	576	22.6	27.4	34.9
Augsburg (urban)	26	710	23.2	26.8	31.3	677	21.1	25.1	32.1
Ticino	50	781	22.7	26.8	31.8	769	20.2	24.2	31.2
Czechoslovakia	18	946	22.9	27.1	32.4	987	22.3	27.2	34.9
Malta	52	644	22.5	27.1	32.7	680	22.0	28.6	36.5
Bas-Rhin	54	663	22.8	27.3	32.5	713	21.1	25.6	34.2
Augsburg (rural)	26	839	23.4	27.3	31.9	852	21.5	25.8	33.2
Kaunas	45	728	23.2	27.5	32.1	735	23.4	29.3	36.5

tions in whom the median DBP value was equal to or higher than 90 mmHg. The proportion of people with high BP or who were on treatment for hypertension was 25% or higher in most of the populations studied, and the proportions with uncontrolled hypertension were high. If BP >140/90 were included, the prevalence of high BP would be even higher. The degree of hypertension control for a particular MONICA population can be calculated from Table 5. For example, the percentage of hypertensive males whose BP is controlled in Augsburg (urban) can be calculated as follows: the prevalence of actual hypertension (27.7%) minus the prevalence of high blood pressure (24.7%) = 3.0% divided by the prevalence of actual hypertension. In fact, only about 11% of male actual hypertensives are controlled (3.0/27.7 = 10.8%). The results presented here point out that BP control is not at all satisfactory in most MONICA communities. It must be noted, however, that data based on two BP measurements at one occasion cannot establish the

clinical diagnosis of hypertension.[5-7] Obviously, the degree of hypertension treatment will be underestimated when one relies on the survey methodology.

According to a WHO Expert Committee,[8] populations whose mean total cholesterol values are about 4.14 mmol/l (160 mg/dl) have little or no clinical CHD. Populations with mean total cholesterols ranging between 4.14 and 5.17 mmol/l (160 mg/dl—200 mg/dl) have intermediate or low CHD rates. Only one of the populations studied, namely Beijing, had a mean total serum cholesterol value lower than 5.17 mmol/l (200 mg/dl).[3]

Body mass index is an accepted and commonly used measure of obesity in population studies, and values of 30.0 or greater can be considered hazardous for health. In the data presented, BMIs higher than 30.0 were found in more than 10% of people in the vast majority of the MONICA populations.

In conclusion, the results from the initial survey in a long-term international study have provided a useful base for further analyses. The present results show that there is variability in patterns in risk factors among the MONICA populations. Unfortunately, they also show that populations with low levels of risk factors are in the minority.

The cross-sectional comparison of risk factors across MONICA populations is a by-product of the MONICA Project and not one of its major goals. Nevertheless, these data are unique and provide new information about risk factors that can be related to mortality and morbidity rates in international comparisons.

REFERENCES

[1] WHO MONICA Project Principal Investigators: The World Health Organization MONICA Project (Monitoring Trends and Determinants in Cardiovascular Disease): A major international collaboration. *J Clin Epidemiol* 1988; **41:** 105–14.

[2] World Health Organization. *MONICA MANUAL*, Version 1.1, December 1986, CVD/MNC, Geneva, World Health Organization, 1986.

[3] The WHO MONICA Project: Geographical variation in the major risk factors of coronary heart disease in men and women, aged 35-64 years. *World Health Stat Q* 1988; **41:** 115–40.

[4] Rose G A, Blackburn H, Gillum R F, Prineas R J. *Cardiovascular survey methods*. Geneva, World Health Organization, 1982.

[5] Final Report of the Subcommittee on Definition and Prevalence of the 1984 Joint National Committee. Hypertension prevalence and the status of awareness, treatment and control in the United States. *Hypertension* 1985; **7:** 457–68.

[6] Final Report to the Working Group on Risk and High Blood Pressure. An epidemiological approach to describing risk associated with blood pressure levels. *Hypertension* 1985; **7:** 641–51.

[7] Keil U, Stieber J, Döring A, *et al*. The cardiovascular risk factor profile in the study area Augsburg. Results from the first MONICA survey 1984/85. *Acta Med Scand* 1988; **Suppl 728:** 119–28.

[8] Report of a WHO Expert Committee: *Prevention of Coronary Heart Disease*. WHO Technical Report Series 678, Geneva, World Health Organization, 1982.