

METHODS

## Baseline recruitment and analyses of nonresponse of the Heinz Nixdorf Recall Study: Identifiability of phone numbers as the major determinant of response

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Accepted in revised form 12 April 2005

**Abstract.** The Heinz Nixdorf Recall Study is an ongoing population-based prospective cardiovascular cohort study of the Ruhr area in Germany. This paper focuses on the recruitment strategy and its response results including a comparison of participants of the baseline examination with nonparticipants. Random samples of the general population were drawn from residents' registration offices including men and women aged 45–74 years. We used a multi-mode contact approach including an invitational letter, a maximum of two reminder letters and phone calls for the recruitment of study subjects. Nonparticipants were asked to fill in a short questionnaire. We calculated proportions of response, contact, cooperation and recruitment efficacy to characterize the participation. Overall, 4487 eligible subjects participated in our study. Although the elderly

(65–75 years) had the highest contact proportion, the cooperation proportion was the lowest among both men and women. The recruitment efficacy proportion was highest among subjects aged 55–64 years. The identifiability of the phone number of study subjects was an important determinant of response. The recruitment efficacy proportion among subjects without an identified phone number was 11.4% as compared to 65.3% among subjects with an identified phone number. The majority of subjects agreed to participate after one invitational letter only (52.6%). A second reminding letter contributed only very few participants to the study. Nonparticipants were more often current smokers than participants and less often belonged to the highest social class. Living in a regular relationship with a partner was more often reported among participants than nonparticipants.

**Key words:** Cohort studies, Epidemiologic methods, Germany, Selection bias

**Abbreviations:** EBT = electron beam computed tomography

### Introduction

The requirements of prospective cohort studies with respect to the study population differ from cross-sectional studies (surveys). In cohort studies, the distribution of the exposure prevalence in the study sample does not need to mirror the distribution of the exposure prevalence in the general population in order to study the relative disease risk whereas surveys should mirror this distribution otherwise they do not provide unbiased prevalence estimates of exposures or diseases in the general population. Famous and successful examples of large cohort studies and trials with highly selected study populations include the British Doctors' Study [21], the Physicians' Health Study [2], and the Nurses' Health Study [3]. Although general

population representativeness is often not the primary goal of cohort studies, results from cohort studies are easier generalizable to the general population if the cohort is representative for the general population.

In Europe, a frequently used approach to recruit subjects for epidemiologic studies is the use of population registries. These registries should include all residents of a defined administrative area. In Germany, the mandatory lists of residency provided by local registration offices are regarded as the most complete population registries and can be used for population-based studies [4].

The Heinz Nixdorf Recall Study is an ongoing population-based prospective cohort study of the comparative predictive value of modern risk stratification techniques for coronary events (acute

myocardial infarction and/or sudden cardiac death) and was planned to cover a representative sample of the German noninstitutionalized population of the industrial Ruhr area in Northwestern Germany without a history of a coronary artery disease [5].

To establish the cohort, subjects were recruited from mandatory lists of residency of three cities within the Ruhr area. This paper focuses on the recruitment strategy and the results with respect to the response behaviour of the population.

## Material and methods

The study rationale of the Heinz Nixdorf Recall Study has been described in detail elsewhere [5]. Briefly, this study is a population-based prospective cohort study. The study base is the general German population of three large cities within the industrial Ruhr area (about 5.45 million inhabitants in 2001, 4434 km<sup>2</sup>) in Northrhine-Westphalia, Germany. The cities included were Essen, Bochum and Mülheim and cover a population of 1.15 million inhabitants. These cities were selected for several reasons: (a) there are only few data on cardiovascular risk factors and cardiovascular diseases available for the study area, (b) behavioural and occupational risk factors for cardiovascular disease appear to be more prevalent in

the study area compared to other western areas of Germany, and (c) the principal investigators and cooperating institutes are located in the study area. Table 1 presents mortality rates based on routine death certificates for the three cities.

For feasibility reasons, certain groups of people were not eligible according to study protocol. These included: (a) people who were institutionalized (nursing homes, old people's home, prisons), (b) people who had died or moved away at the date of first contact letter, (c) people with wrong or non-existent addresses, (d) people without sufficient command of the German language, (e) severely ill people who could not be interviewed due to e.g. deafness, dumbness or other severe disabilities.

Subjects with a self-reported history of coronary artery disease (myocardial infarction, revascularization of coronary arteries including balloon dilatation and coronary bypass surgery) were not eligible for the cohort study questions according to study protocol. However, the Heinz Nixdorf Recall study was also planned to provide rough estimates of cardiovascular risk factors and diseases in the general population of the Ruhr Area. Therefore, subjects reporting a history of coronary artery disease were also examined in the study centre. Formally, pregnant women were not eligible (the probability of a pregnancy among women aged 45 years or more was very low a priori) because all participants were exposed to radiation

**Table 1.** The Heinz Nixdorf Recall Study: Routine mortality statistics of the participating three cities from 2000 through 2001

	Essen		Bochum		Mülheim	
	Men	Women	Men	Women	Men	Women
Inhabitants in 2000 (aged 45–74 years)	101,016	112,698	66,288	71,632	32,346	35,735
All-cause mortality rate, 2000–2001 <sup>a</sup>						
All ages <sup>b</sup>	959	562	960	557	900	562
45–49	405	232	398	265	388	200
50–54	716	355	672	335	578	382
55–59	1104	580	1136	480	1033	483
60–64	1682	793	1687	735	1590	678
65–69	2722	1235	2651	1180	2580	1200
70–74	4515	2218	4257	2148	3849	2136
Coronary heart disease mortality rate, 2000–2001 <sup>c</sup>						
All ages <sup>b</sup>	173	95	200	96	183	92
45–49	53	9	35	7	51	0
50–54	82	18	86	8	103	36
55–59	141	42	214	9	207	0
60–64	226	91	276	93	262	63
65–69	542	174	535	190	426	153
70–74	817	387	934	309	925	336

<sup>a</sup>Rates given as cases per 100,000.

<sup>b</sup>Direct standardized mortality rate (European Standard Population).

<sup>c</sup>Based on routine mortality statistics including uncausal causes of death coded as (ICD10): I20–I25.

due to electron beam computed tomography (EBT). Finally, people who were relatives of the study personnel were not eligible.

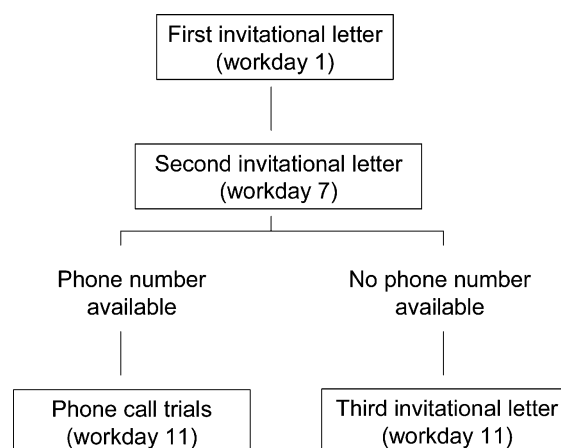
Each residents' registration office of the three cities drew a random unstratified sample (in short: registration office sample) of about 6000 men and women aged 45–75 years with German nationality from its list of residency in autumn 2000. Subjects with German nationality include people who are descendants of Germans, displaced persons of the former territory of Germany as of December 1937, or people who successfully applied for naturalization. The recruitment period started in December 2000 and ended in August 2003. Per month, about 180 randomly selected subjects from the samples provided by the registration offices were contacted by an invitational letter. This letter contained several materials including a letter of recommendation from the Prime Minister of Northrhine-Westphalia, a coloured leaflet presenting information of the study, press articles of the study, the announcement of an expense of about 20€ for participants, a toll-free phone number of the study centre and a web address of the study. In addition, until December 2002 each contacted subject received a telephone card (including a value of 3 Euro for phone calls) and thereafter a set of stamps including a value of 2.16€. People were invited to undergo a health examination in the study centre located in the city of Essen, close to the University Hospital of Essen. The examination by EBT took place in radiology institutes of Bochum and Mülheim. The average distance between the study centre in Essen and Bochum and Mülheim is 18 and 13 km, respectively.

We used a multi-mode approach to get in contact with people eligible for our study. First, people were contacted by an invitational letter. People who did not respond to the letter were reminded by a second letter 7 working days later. At workday 11, nonresponders with known phone numbers were tried to be contacted by phone by at least 10 phone call trials before subjects with identified phone numbers were classified as nonresponders without any contact. For several reasons, a small group of subjects with phone numbers also received a third letter to increase the response.

Nonparticipants without known phone numbers were reminded by a third letter at workday 12. Figure 1 gives an overview of the recruitment procedure. We did not do home visits of nonparticipants because home visits are time-consuming and expensive.

Nonparticipants were asked to fill in a short questionnaire (if possible) that contained few core items including height (cm), weight (kg), number of days ill in the recent 12 months, general health status, reason for nonparticipation, smoking status, number of cigarettes smoked, highest school degree and living in a stable relationship with a partner.

The reasons for nonparticipation were coded. Invited subjects who could only be contacted via next of kin were coded as “never reached” if the next of kin refused



**Figure 1.** Flowchart of the recruitment procedure of the Heinz Nixdorf Recall Study.

study participation for the index person. Within the context of case-control studies, Slattery et al. [6] and Stang et al. [4] suggested standard calculation methods for proportions of response, contact, cooperation, and recruitment efficacy. A working group of the German Epidemiological Society recently recommended to regularly calculate these proportions to enable a comparison of response among different studies [7]. We calculated these recommended proportions.

The contact proportion expresses the percentage of subjects that could be contacted by the investigator regardless of the subjects' eligibility. The response proportion includes all eligible subjects in the denominator, even subjects that died or moved away before a contact could be made. The cooperation proportion expresses the willingness to participate among eligible subjects that could be contacted. Certain nonparticipation categories that are included in the response proportion (subjects who died, moved away or were too ill) cannot be influenced much by the investigator. If these categories are excluded from the response proportion, the revised proportion indicates the efficacy of the recruitment strategy [4].

For all analyses presented, subjects with a history of coronary artery disease were treated as not eligible according to study protocol. Due to the inclusion and exclusion criteria of the cohort study, some of the terms that can contribute to the proportions (originally developed for case-control studies) do not occur in our study (e.g. people who moved away before first contact letter were ineligible according to our study protocol). We show the calculation methods for these proportions in Table 2. We stratified proportions of response, contact, and cooperation and the recruitment efficacy by gender, age, and identifiability of phone number.

## Results

From December 13th 2000 to August 14th 2003, about 9484 subjects were invited to participate in

**Table 2.** Methods of proportion calculation

Contact proportion (Slattery et al. 6)	$\frac{I+P+R+NE}{I+P+R+NE+NC}$
Cooperation proportion (Slattery et al. 6)	$\frac{I+P}{I+P+R}$
Response proportion (Slattery et al. 6)	$\frac{I+P}{I+P+R+NC}$
Recruitment efficacy proportion (Stang et al. 4)	$\frac{I+P}{I+P+HR+NR}$
<i>I</i>	Participated
<i>P</i>	Partially participated (i.e. early termination of participation)
<i>R<sup>a</sup></i>	Refusals including people who are too ill
NE	Not eligible including (a) people who were institutionalized (nursing homes, old people's home, prisons), (b) people who had died or moved away at the date of first contact letter, (c) people with wrong or nonexistent addresses, (d) people without sufficient command of the German language, (e) severely ill people who could not be examined due to e.g. deafness, dumbness or other severe disabilities, (f) pregnant women, and (g) people who were relatives of the study personnel
NC <sup>b</sup>	No contact, because of inability to locate a phone number or address or unable to reach subject; including people who moved away (after selection), and those who died before contact could be made
NR <sup>b</sup>	Never reached, excluding people who died or moved away after the selection
HR	Refusals, excluding people who are too ill

<sup>a</sup>People who refuse to participate because they were too ill, excluding severely disabled people (dumbness, deafness, etc.) (subjects with a history of coronary artery disease are not eligible according to study protocol).

<sup>b</sup>Note: due to inclusion and exclusion criteria, NR and NC result in identical numbers.

our study. Overall, 4487 eligible subjects without a history of coronary artery disease participated. In addition, 327 out of 477 subjects (5.3% out of 9046 living subjects with a correct address in the study region) with a history of coronary artery disease participated in the study but are excluded from the results presented here. The recruitment results and the distribution of the reasons for nonparticipation are presented in Table 3. As expected, the proportion of subjects with a history of a coronary artery disease increased by age and was greater among men than women among all age groups. The proportion of subjects who could never be reached was highest among the youngest age group. Although the elderly (65–75 years) had the highest contact proportion, the cooperation proportion was the lowest among both men and women. The recruitment efficacy proportion was highest among subjects aged 55–64 years.

The majority of subjects who refused to participate (1155 out of 2909 refusals, 39.7%) did not give any reason for their refusal. Other categories of refusal included “no interest” (18.7%), “no time” (14.7%), being too ill other than coronary artery disease (12.8%) and other reasons. It is interesting to note that 103 eligible subjects (3.5% of all refusals, 83 women and 20 men) denied to participate because they had to nurse members of their family and could not stay away from home for 4 hours or more.

We were able to identify telephone numbers for about 81.7% of all eligible subjects (6876 out of 8413) with similar percentages among men (82.1%) and women (81.5%). The proportion of identified phone numbers was slightly lower among the youngest age group (45–54 years: 79.1%) as compared to the older age groups (55–64 years: 83.7%, 65–75 years: 82.1%). The identifiability of the telephone number was an important predictor of response. The recruitment efficacy proportion among eligible subjects without an identified phone number was 11.4% as compared to eligible subjects with identified phone numbers with 65.3%. Among both groups of eligible subjects (with and without identified phone numbers), the recruitment efficacy proportion was lowest among the elderly aged 65–75 years.

Table 4 presents the proportion of participants who were recruited by varying degrees of recruitment efforts. The majority of subjects agreed to participate after one invitational letter only (52.6%). A second reminding letter contributed only very few participants to the study regardless whether these subjects were reached by phone or not.

Among the eligible nonparticipants, 1562 out of 3962 subjects (39.4%) filled in a short questionnaire that covered few core items of interest. The comparison of these nonparticipants with the participants is presented in Table 5. The self-reported general health status was more often described as “less well”

**Table 3.** Results of the recruitment and the distribution of the reasons for nonparticipation stratified by gender and age

Recruitment result	All	Men	Women	Men age group			Women age group		
				45–54	55–64	65–75	45–54	55–64	65–75
<i>Number of invited subjects (N) (= 100%)</i>	9484	4510	4974	1443	1635	1432	1502	1785	1687
Wrong address (%)	2.58	2.57	2.59	3.53	2.26	1.96	3.20	2.52	2.13
Moved (%)	0.92	0.98	0.86	1.25	0.80	0.91	0.87	1.06	0.65
Died (%)	1.12	1.35	0.90	0.35	0.98	2.79	0.53	0.56	1.60
Insufficient language skills (%)	0.15	0.13	0.16	0.28	0.12	0	0.33	0.06	0.12
History of coronary artery disease (%)	5.03	7.91	2.42	3.39	7.35	13.13	0.66	1.79	4.62
Residents of nursing homes or old people's homes (%)	0.22	0.24	0.20	0.21	0	0.56	0.13	0.06	0.41
Too ill, severely disabled (%)	0.94	1.06	0.82	0.28	1.04	1.89	0.53	0.62	1.30
Occupationally absent from home town (%)	0.33	0.55	0.12	0.97	0.24	0.49	0.13	0.22	0
<i>Noneligible subjects overall (N)<sup>a</sup></i>	1071	669	402	148	210	311	96	123	183
<i>Eligible subjects (N) (= 100%)</i>	8413	3841	4572	1295	1425	1121	1406	1662	1504
Never reached (%)	12.09	13.30	11.07	16.60	11.58	11.69	13.16	10.83	9.38
Refusal (%)	34.58	31.09	37.51	27.95	28.28	38.27	32.50	33.39	46.74
Participants (%)	53.34	55.50	51.42	55.32	60.14	50.05	54.34	55.74	43.89
<i>Participating subjects (N)</i>	4487	2136	2351	718	857	561	764	927	660
<i>Proportions of recruitment</i>									
Contact P.	89.3	88.7	89.8	85.1	89.9	90.9	87.7	89.9	91.6
Cooperation P.	60.7	64.1	57.8	66.5	68.0	56.7	62.6	62.6	48.4
Response P.	53.3	55.6	51.4	55.4	60.1	50.0	54.3	55.8	43.9
Recruitment efficacy P.	55.8	57.8	54.1	56.3	62.3	53.8	55.8	57.8	48.1

<sup>a</sup>Including one subject who was a relative of the study personnel.

or “poor” among nonparticipating men aged 55 years or more (25.5%) compared to participating men of this age group (11.8%). We found the opposite association among women aged 45–54 years: participating women more often described their health status as “less well” or “poor” (18.4%) as compared to nonparticipating women (11.4%). Nonparticipants were consistently more often current smokers than participants among both men and women and among all three age groups. Participants more often reported an upper secondary school degree, grade XIII (university entrance qualification), compared to nonparticipants. Living in a regular relationship with a partner was more often reported among participating men than nonparticipating men. This association also occurred among women, although less pronounced.

## Discussion

The overall recruitment efficacy proportion for the baseline recruitment of the Heinz Nixdorf Recall Study was 55.8%. Several factors may have had an influence on our results. First, subjects had to be able to come to the study centre which is located in one of the three cities only. However, the average travel distances from Bochum to Essen and Mülheim to Essen were about 18 and 13 km, respectively, which appears to be long for the elderly population especially when using public transportation (busses, underground and train). Due to the large number of medical tests and the complex quality requirements, we could not offer subjects the health examination at home. Although we offered to pay a taxi that brings subjects to the examination centre and back home as

**Table 4.** Proportion of participants by recruitment effort

Strategy	Recruitment effort				All	45–54 years		55–64 years		65–75 years		
	Invitational letter	1st Reminding letter	2nd Reminding letter	Phone calls		N	%	N	%	N	%	
1	X				2362	52.6	723	49.1	976	54.8	663	53.9
2	X			X	361	8.0	59	4.0	130	7.3	172	14.0
3	X	X		X	560	12.5	217	14.7	214	12.0	129	10.5
4	X	X	X	X	44	1.0	20	1.4	17	1.0	7	0.6
5	X	X			1079	24.0	416	28.2	415	23.3	248	20.1
6	X	X	X		81	1.8	39	2.6	30	1.7	12	1.0

**Table 5.** Comparison of participants and nonparticipants who filled in a short questionnaire by gender and age

	Men						Women					
	45–54		55–64		65–75		45–54		55–64		65–75	
	*P	NP	P	NP	P	NP	P	NP	P	NP	P	NP
Number of subjects	707	160	852	222	577	246	743	237	933	305	675	392
How would you describe your general health status? (%)												
• Very good	11.2	6.3	9.6	6.3	6.9	6.9	9.7	9.3	6.2	6.6	4.3	4.6
• Good	45.8	46.9	43.5	31.5	39.3	29.7	39.6	51.5	39.0	33.8	34.7	26.8
• Moderate	30.2	33.1	36.5	36.0	39.7	32.9	32.3	25.3	35.0	38.0	39.1	42.6
• Less well	11.2	5.6	7.4	14.4	10.7	14.6	13.2	8.4	15.3	12.1	19.3	13.3
• Poor	1.4	5.6	2.5	9.0	2.9	13.0	5.2	3.0	4.2	5.9	2.5	8.7
• Missing	0.3	2.5	0.5	2.7	0.4	2.9	0	2.5	0.2	3.6	0.1	4.0
Smoking status (%)												
• Former smoker	36.3	33.8	46.4	33.8	52.0	41.9	26.5	18.6	23.7	16.4	17.0	15.8
• Current smoker	36.3	48.8	23.9	31.5	16.5	23.2	34.5	39.2	20.2	23.3	8.1	9.2
• Never smoker	27.1	16.2	29.6	30.2	31.2	31.1	39.0	39.2	55.9	55.1	74.5	68.9
• Missing	0.4	1.2	0.1	4.5	0.3	3.7	0	2.9	0.2	5.2	0.3	6.1
Highest school degree (%)												
• No degree	1.3	5.0	0.9	1.8	2.6	2.9	1.3	1.7	1.3	1.3	4.4	3.3
• Lower secondary – Grade IX <sup>a</sup>	46.2	44.4	56.0	63.1	63.8	67.9	53.0	52.7	62.7	68.2	70.1	69.9
• Lower secondary – Grade X <sup>b</sup>	15.7	15.0	16.4	13.1	15.3	7.3	21.4	22.8	21.2	18.0	16.9	14.0
• Upper secondary - Grade XII <sup>c</sup>	10.1	10.6	9.6	5.0	6.2	4.9	4.3	4.6	3.1	1.0	1.6	2.8
• Upper secondary – Grade XIII <sup>d</sup>	25.9	20.6	16.3	10.4	11.4	9.8	19.4	11.4	11.0	2.6	6.7	2.3
• Other <sup>e</sup>	0.4	2.5	0.4	0.9	0	2.8	0.5	1.3	0.2	1.6	0	2.0
• Missing	0.4	1.9	0.4	5.9	0.7	4.5	0	5.5	0.4	7.2	0.3	5.6
Living in a regular relationship (%)												
• Yes	90.2	79.4	93.3	78.8	92.2	80.1	82.9	84.0	78.3	73.4	63.9	62.5
• No	9.3	18.8	6.5	16.2	7.3	16.3	17.1	12.7	21.4	20.0	36.0	32.9
• Missing	0.4	1.9	0.2	5.0	0.5	3.6	0	3.4	0.2	6.5	0.1	4.6

P: participants; NP: nonparticipants who filled in a short questionnaire.

\*One male participant aged 45–54 years dropped out during the interview and did not contribute information.

<sup>a</sup>Hauptschule.

<sup>b</sup>Realschule.

<sup>c</sup>Fachabitur.

<sup>d</sup>Abitur.

<sup>e</sup>Including degrees from non-European countries.

well as an expense of about 20€ for the travel costs, many people could not be convinced to participate.

Second, our public relations work may have been insufficient. We regularly had contributions in local newspapers (overall 34 articles), local radio (5 contributions) and television channels (4 contributions) to increase the public awareness and acceptance of the study. In addition, we twice invited all registered local physicians and gave presentations of the study rationale and the progress.

Third, although we offered appointments for the health examination on Saturdays, the average duration of the health examination without the EBT was about 4.5 hours and may have kept people away from participating in the study who were working full time or who had to take care for ill relatives. However, the comparison between the proportion of fully employed participants in our study with population-based census data of the same region showed that this proportion was very similar (data not shown).

Fourth, the baseline health examination of our study included the application of X-rays (EBT), a medical history and physical examination by a medical doctor. X-ray application is often considered to be dangerous in the general population and a considerable proportion of the population has an aversion to medical examinations.

Fifth, population-based studies in Germany generally tend to suffer from substantial nonresponse. In a recent meta-analysis [4], the pooled response proportion of population-based control groups (which are the study bases for population-based cohort studies), according to the calculation methods of Slattery et al. [6] was about 58%. The German National Health Examination Survey from 1998, which used a less conservative calculation method for the response proportion, achieved a response proportion of about 61.4% although this survey did not include X-rays or detailed examinations by physicians [8]. A recent population-based cross-sectional study on the prevalence

and severity of chronic venous disorders in Bonn and rural communities achieved a response proportion of 59% [9]. The EPIC cohort study in Germany revealed a response proportion of 22.7% (Heidelberg) and 38.3% (Potsdam) [10]. The population-based cross-sectional KORA-survey 2000, a successor of the MONICA study in the South German region of Augsburg, had a response proportion according to Slattery of 65% [11].

Potential determinants of nonparticipation have been studied by several authors and have revealed a large number of factors that may be associated with low participation although not consistently. These factors include age [12, 13], gender, occupational status [14, 15], socioeconomic status, education [12, 14, 16–18], life-style factors [13, 20], health status [21, 17], and methodological factors including the use of incentives, registered mailings and others.

The strongest determinant of response in our study was the identifiability of a phone number from official phone directories as has been shown in a previous meta-analysis [4]. The meta-analysis of population-based German case-control studies from 1985 through 1997 revealed that phone numbers were available in 90% of all eligible population controls [4]. The gradual dissemination of mobile phones starting in the 1990s, the increasing number of subjects who deny an entry into public phone directories, and the metropolitan character of the study region may have caused the lower proportion of identifiable phone numbers (82%) in our study. The strong association between identifiability of phone numbers and response implicates that much effort should be spent into the identification of phone numbers. We used public phone directories, web-based retrievals as well as phone directory assistances from German telephone companies (e.g. Telekom) to identify these numbers because the residents' registration offices do not provide phone numbers.

The age- and gender-specific response analyses in our study showed that especially elderly women were least likely to participate in our study. It is interesting to note in this context that especially elderly women refused to participate because they could not stay away from their home for 4 hours or more because they had to take care for ill relatives, most often their husbands. The comparison of participants with nonparticipants who filled in a short questionnaire revealed that especially male nonparticipants aged 55 through 75 years reported more often a poor health status than participants which may hint to a selection towards healthier men aged 55–75 years in our study. A selection in the opposite direction may have occurred among young women in our study. As has been shown in previous studies (e.g. [22, 15]), we also found that the proportion of current smokers is considerably higher among nonparticipants compared to participants. This difference was more pronounced among men than women. In addition, living in a regular relationship with a partner and a school degree at a university entrance qualification level was more often

reported among participants than nonparticipants as has been observed by others [17, 18, 23].

Although the comparison between participants and nonparticipants who filled in a short questionnaire gives some additional information regarding the comparability of these subjects, this approach has several limitations that should be kept in mind [24]. First, within the group of nonparticipants, only a subset of 39.4% of nonparticipants was willing to fill in a short questionnaire and therefore we cannot be sure whether this subsample is an unbiased sample of all nonparticipants. Second, an equal distribution of baseline characteristics among participants and nonparticipants with short questionnaires does not necessarily preclude nonresponse bias in the cohort study as has been shown in an occupational cohort study in Denmark [14].

Nonparticipation or nonresponse may introduce bias of effect measures usually referred to as selection or nonresponse bias, if the exposure and outcome of interest is associated with the willingness to participate in a study. However, there is no logical connection between low response proportions and the degree of potential nonresponse bias. Stang and Jöckel recently demonstrated that studies with low response proportions may be even less biased than studies with high response proportions if the non-differential misclassification error of a dichotomous exposure increases by recruitment wave [25]. Although more empirical research on nonresponse and its implications is needed, the research findings tend to be subtle and highly setting-specific [26].

The analyses of proportions of participants by recruitment efforts showed that a second reminding letter for nonparticipants (after an invitational and first reminding letter) hardly contributes to the overall response. The majority of study subjects participated after an invitational letter, one reminder letter and/or phone calls.

In consideration of the generally low response proportion of epidemiologic studies in Germany and the tedious health examinations including physical examinations by physicians and X-ray in our study, the overall response is surprisingly similar to response proportions of other German population-based studies. However, due to the inclusion criteria and the response of the Heinz Nixdorf Recall Study, this study consists of a population of the Ruhr Area that contains a higher proportion of subjects of a high social class and good health status compared to the general population in the Ruhr Area. However, this selection does not threaten the ultimate goal of the cohort study.

### Acknowledgments

We thank the Heinz Nixdorf Stiftung (Chairman Dr Schmidt) for the generous financial support of the study. We gratefully acknowledge the collaboration with: Prof Dr D. Grönemeyer (Bochum), Prof

Dr R. Seibel (Mülheim), Prof Dr K. Mann, Dr L. Volbracht, Dr S. Münkler, Dr A. Öffner, Dr A. Winterhalder, A. Feuersenger, H. Hirche (Essen), PD Dr R. Peter (Ulm).

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