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Health inequalities in different age groups: the case of type 2-diabetes: a study with health insurance and medication data

Summary

Objective: This study investigates social differentials in the prevalence of diabetes type 2 in women and men in a health insurance population. It is considered whether social gradients are present over different age strata.

Methods: Analyses were performed with records obtained from a German statutory health insurance comprising 77 294 women (31.8 %) and men (68.2 %) of at least 20 years. Occupational status was used as indicator of socio-economic position. Individuals with diabetes were identified using information about antidiabetic medication or by hospital diagnoses according to ICD9. The analyses were performed for the entire insurance population and for different age strata (< 40 yrs/40 – 55 yrs/> 55 yrs).

Results: The analyses revealed considerable social differences in diabetes risks. Considering the whole insurance population with the highest socio-economic category as reference group, the odds ratio (OR) for skilled non-manuals was OR = 2.9, for skilled manuals it was OR = 4.7, and OR = 5.6 for unskilled and semi-skilled individuals. After stratifying the insurance population into three age groups the social gradients were reproduced for each stratum, but their magnitudes increased with age.

Conclusions: In the health insurance population considered health inequalities with respect to diabetes are considerable, and they are persisting after stratification into age groups.

Keywords: **Health inequalities – Diabetes – Secondary data analysis.**

Diabetes is one of the most frequent chronic diseases. In 1995 it was presumed to affect 4 % of the adult world population (King et al. 1998); according to WHO-estimates the number will continue to grow. The disease is occurring as insulin-dependent diabetes (type-1) with its onset predominantly in childhood and adolescence, accounting for 5 % of all cases of diabetes (Amos et al. 1997). In contrast, the onset of diabetes mellitus (type 2) usually occurs in older age. Frequently it is accompanied by adiposity and may remain undetected for many years until symptoms or concomitant diseases require treatment, thus posing a public health problem.

According to studies appeared so far, type 1 is not related to social inequalities (Meadows 1995; Evans et al. 2000), for type 2 the situation is reported to be different. In spite of the large body of literature on health inequalities, the number of studies dealing with diabetes is small. In the German Federal Health Survey (Knopf et al. 1999) 1998, subjective information was combined with medical examinations and physiological measurements. Men in the lowest socio-economic group turned out to having the highest diabetes risk odds ratio (OR) of 2.2, the respective figure for women was OR = 1.8. Conclusions were impaired by the relatively small numbers of diabetics, especially after having stratified them. In an earlier study (Helmert & Shea 1994) data from three cross-sectional interview surveys were combined. Again, social gradients to the detriment of the lowest socio-economic positions were found. The gradient for the most extreme groups was OR = 1.76 for males and OR = 4.01 for females. In further analyses these findings were confirmed (Helmert et al. 1994) and the respective differences in terms of lifetime prevalence between the highest and the lowest socio-economic groups were OR = 2.7 for men and OR = 4.2 for women. Interview studies from Spain also gave evidence of health inequalities with respect to diabetes (Regidor et al. 2002).

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The available US studies were conducted with smaller samples. Based on data from the National Health Interview Survey from 1989 diabetes type 2 was reported to be associated with lower socio-economic status (Cowie & Eberhardt 1995), but in other analyses evidence on social inequalities with respect to diabetes are lacking (Brancati et al. 1996; Cowie et al. 1993). In a study with data from the Third National Health and Nutrition Survey associations between income and type 2 diabetes were reported (Robbins et al. 2003). Low income and diabetes were intertwined, thus Robinson et al. concluded that the socio-economic disadvantages in this population group might account for the result. The stability of the estimates were again impaired by relatively small numbers of diabetics. This may have caused unstable effects and thus impairments of substantial conclusions. A British study produced evidence for socio-economic differences (Bhopal et al. 2002) in the prevalence of diabetes.

Ecological studies permit to observe larger populations, but the data are not at individual level, thus the results are affected with uncertainties. Connolly et al. published findings based on diagnoses drawn from treatment data, and socio-economic position wit area-based measures (Connolly et al. 2000). The highest social gradients were found for the age group between 40 and 69 years, and social differences in terms of type 2 diabetes were occurring in women and men. They appeared up to the age of 80. In two more ecological studies (Evans et al. 2000; Meadows 1995) it was demonstrated that in areas with predominantly unskilled and semi-skilled residents the diabetes rates were highest.

For our own study a large dataset from a health insurance population was available, i. e., we used administrative information on individual characteristics combined with data on medication and inpatient treatment. This permitted to stratify the population by age and to avoid problems arising out of small case numbers as reported above. Since the data were derived from data collections that were part of routine processes, problems of memory occurring in respondents answering questionnaires (Schwarz & Sudman 1994; Tourangeau et al. 2000) do not matter. Also, decreased response rates occurring in individuals with impaired health (Cohen & Duffy 2002) do not affect substantial conclusions. As analyses with the low case numbers of type 1 diabetics appeared to be hardly possible even with a large dataset, the analyses were restricted to type 2 only. The research questions to be dealt with are:

– Does a social gradient in diabetes exist in our insurance population?
– Can social gradients be observed in different age groups?

Method

Study population

The following analyses are based on data from a German statutory health insurance, the Allgemeine Ortskrankenkasse Mettmann; the material covers the year 1995. Originally the material had been collected for accounting purposes; in different data sets sociodemographic information, data on insurance periods, unemployment, retirement and inpatient treatment are recorded.

For the analyses to be presented below basic information (age, sex, insurance periods) and data on inpatient treatment of the insured population was combined with medication data in order to identify individuals with diabetes. We also restricted our analyses to individuals of at least 20 years. According to German insurance regulations, the insured population is divided into main insured and jointly insured. The latter group is made up out of family members without employment or own income, while members of the first group are employed and pay insurance fees according to his/her income. As no information on qualification or financial properties on the jointly insured was available in the insurance records, we assigned them the status of the main insured.

The identification of insured with diabetes was performed by combining information on medications and hospital (discharge-) diagnoses. The identification based on medications is possible since the indication of antidiabetics is unequivocal and specific, there is no other use for them.

After having extracted all diabetes medications, the patients treated respectively were identified. The second way of finding them in the data were hospital diagnoses given upon discharge: Cases were classified as diabetics if they got the diagnoses ICD9: 250.1 (diabetes type 1), ICD9: 250.0 (diabetes type 2), or ICD9: 250.9 (diabetes without precise specification). The medication with oral antidiabetics is a valid indicator for diabetes type 2, but the identification of type 1 is more difficult. In the literature the age at onset of diabetes in younger age groups is described as an indicator of type 1, but the age limit differentiating between type 1 and type 2 is not entirely clear. According to the literature, there is a variation between 30 (Connolly et al. 2000; Meadows 1995) and 40 years (Amos et al. 1997). For our analyses we classified all insulin-dependent diabetics under 30 years as type 1. Given that no social gradients exist in type 1 diabetes, this should not result in biased results.

Then all cases with clearly documented type 1 were excluded. Altogether 21 were classified accordingly; 11 on the basis of their age and insulin medication, and 10 based on their hospital diagnoses.

Table 1 Age distribution of the study population with prevalence rates (in percentages) of the age strata

Age groups	Men diabetes		Women diabetes		Men and women diabetes		Total N
	No	Yes	No	Yes	No	Yes	
20–29	9011	2 (<0.01 %)	4277	1 (<0.01 %)	13288	3 (<0.01 %)	13291
30–39	14565	41 (0.3 %)	5709	14 (0.2 %)	20273	55 (0.3 %)	20328
40–49	10292	96 (0.9 %)	5214	45 (0.9 %)	15506	141 (0.9 %)	15647
50–59	11179	335 (2.9 %)	5676	115 (2.0 %)	16856	450 (2.6 %)	17306
60–69	6374	341 (5.1 %)	3158	161 (4.9 %)	9532	502 (5.0 %)	10034
70–79	455	24 (5.0 %)	148	13 (8.1 %)	603	37 (5.8 %)	640
>79	23	1 (4.2 %)	23	1 (4.2 %)	46	2 (4.2 %)	48
Total	5899	840 (1.6 %)	24205	350 (1.4 %)	76104	1190 (1.5 %)	77294

Thus, diabetics in the analyses were defined with at least one of the following characteristics:
- oral antidiabetic medication
- insulin dependent diabetes and at least 30 years old
- hospital diagnosis of diabetes other than ICD9: 250.1

Thus, there may be some undetected type-I diabetics in our study population, and we could not identify unhospitalized cases whose diabetes can be controlled by sticking to a special diet without requiring medication.

The classification for *occupational group membership* was performed according to five categories: "unskilled and semi-skilled positions", "skilled manuals", "skilled non-manuals", "intermediates" and "professionals". Due to the small number of professionals, the intermediates and professionals had to be counted together and subsequently these will serve as the reference category in the regression analysis.

When combining occupations to groups, the qualification levels as published by the German Institut für Arbeitsmarkt- und Berufsforschung (Institute of Labour Market and Occupation Research) was taken into account (Parmentier et al. 1996).

In Germany information on occupational changes is routinely transferred from the employer to the health insurance. For a considerable proportion of the insured, information about the socio-economic status was not available for several reasons (missing data, longstanding unemployment, or early retirement).

As we did not consider only employed insured, some decisions had to be made how to deal with the retired and the spouses who had been jointly insured (usually wives). For retired individuals, we assigned the highest occupational position attained during their working life. If this information was not available, they went into the group of unclassified insured. For the jointly insured, we assigned the occupational position of their spouses. This solution is not an optimal one since it disregards individual status and educational differences between spouses. However, there are findings justifying this solution (Arber & Ginn 1993; Baxter 1994), although the question whether spouses can be assigned the occupational status of the main wage earner is under debate (Goldthorpe 2000).

Statistical analyses

The following analyses are based on cross-tabulations for inspecting the data and Pearson χ^2-tests for analyzing the statistical associations between the variables considered. Finally a logistic regressions for estimating odds ratios (OR) is performed. In contrast to earlier work with health insurance material (Geyer & Peter 2000; Geyer et al. 2001), the present one does not depict a time process. Thus the present study can only deal with the prevalence of diabetes.

The data management was performed with SPSS 6.1 on PC, the tests and the regression model were computed with STATA 7.0 (Stata Corp. 2001).

Results

The dataset comprises information of 124151 subjects; 21 cases were excluded because they had been identified to having type 1 diabetes, and for 46867 individuals no information on their occupational position was available. This loss of cases is primarily due to individuals in the higher age groups. Finally 77294 observations were available. According to the structure of this insurance clientele more men (68.2 %) than women (31.8 %) were insured. The number of individuals with diabetes was 1190, corresponding to 1.5 % of our study population. The proportion of men (70.6 %) was higher than of women (29.4 %) with the mean age of the subjects with diabetes being higher than in the total insurance population (57.7 years; Sd = 8.6 years vs 44.0 years; Sd = 13.0 years (Tab. 1).

Table 1 has shown that the probability of having diabetes does not show a linear shape. Rather it increases sharply beyond the age of 50. The lower proportion of diabetics in the highest age stratum is due to the loss of cases with missing

Table 2 The occurrence of diabetes by age groups and gender

Frequencies column-%	Age groups			Pearson χ^2; df = 2	Sex		Pearson χ^2; df = 1
	>40 yrs	40–55 yrs	> 55 yrs		Men	Women	
No diabetes	33562 99.8 %	23170 98.8 %	19372 95.8 %	χ^2 = 1382.5 p < 0.0001	51899 98.4 %	24205 98.6 %	χ^3 = 3.09; p = 0.80
Diabetes type 2	58 0.2 %	281 1.2 %	851 4.2 %		840 1.6 %	350 1.4 %	
Total	33620 (43.5 %)	23451 (30.3 %)	20223 (26.2 %)		52739 (68.2 %)	24555 (31.8 %)	77294 (100 %)

Table 3 The occurrence of diabetes over occupational status groups for the whole study population and separately for three age strata

Frequencies column-%	Group	Occupational position				Pearson χ^2; df = 3
		Unskilled/ semi-skilled	Skilled manuals	Skilled non-manuals	Intermediates/ professionals	
Whole population	No diabetes	42844 98.3 %	19856 98.3 %	10701 99.1 %	2703 99.6 %	χ^2 = 64.39 p < 0.0001
	Diabetes type 2	741 1.7 %	342 1.7 %	97 0.9 %	10 0.4 %	
Age > 40 yrs	No diabetes	19009 99.8 %	8341 99.8 %	5065 99.9 %	1146 100 %	χ^2 = 5.28 p = 0.15
	Diabetes type 2	40 0.2 %	13 0.2 %	5 0.1 %	0 0 %	
Age 40 < 55 yrs	No diabetes	1864 98.6 %	5633 98.6 %	3562 99.2 %	1111 99.8 %	χ^2 = 16.73 p < 0.001
	Diabetes type 2	177 1.4 %	72 1.3 %	30 0,8 %	2 0.2 %	
Age > 55 yrs	No diabetes	10971 95.4 %	5881 95.8 %	2074 97.1 %	446 98.2 %	χ^2 = 19.28 p < 0.0001
	Diabetes type 2	524 4.6 %	257 4.2 %	62 2.9 %	8 1.8 %	
Total	43585 (56.4 %)	20198 (26.1 %)	10798 (14.0 %)	2713 (3.5 %)	77294 (100 %)	

data on occupational position. The age-dependent occurrence of the disease is again shown in Table 2 where the age groups are again condensed in order to obtain robust results. In the present data there are no differences for diabetes between women and men.

The associations between diabetes and occupational position are presented in Table 3. For all age groups the results show a social gradient to the detriment of individuals holding lower occupational positions. The result of the χ^2-test indicates a linear relationship, i.e., the risk of falling into the group with diabetes is increasing monotonously with decreasing occupational position.

After separating the study populations by age strata, the relationship between occupational positions and diabetes still holds in all age groups, although firm conclusions are hampered by the small numbers of diabetes cases in the younger age groups. Additionally in the group of intermediates/professionals problems of obtaining robust estimates are present since over all age groups only 10 diabetes cases are available. The results of the χ^2-tests for the three age strata indicate the presence of social gradients above 40 years, and they are also increasing with age.

In the final analysis all variables of interest are brought together in a logistic model in order to examine whether the results presented in tables two and three still hold in a multivariate analysis.

The regression (Tab. 4) confirms the results concerning a social gradient for the case of diabetes. The OR are increasing monotonously with decreasing occupational position, and compared to individuals holding intermediate/professional

Table 4 Results of a multivariate regression for the risk of falling into the group of individuals with diabetes for occupational status, sex, and age

Groups	Odds ratio (95% confidence intervals)
Skilled non-manuals*	2.92 (1.26–6.78)
Skilled manuals*	4.72 (2.09–10.64)
Unskilled/semi-skilled*	5.64 (2.52–10.63)
Sex (reference category: men)	0.79 (0.68–0.92)
Age (unit of measurement: years)	1.10 (1.08–1.11)

* Reference category: Intermediate occupations and professionals combined

occupations the OR in unskilled and semi-skilled is OR = 5.64. The widths of the confidence intervals are due to the small numbers of diabetes cases (N = 10) in the highest occupational positions. However, as long as the analyses are not performed for different age strata this can be tolerated. The OR for gender indicates a lower diabetes risk for women.

In order to check eventual distortions in effect sizes resulting out of individuals with undetected type 1 diabetes we repeated the regression analyses after having excluded all subjects with insulin medication. In some categories the ORs increased by +0.30, but in no case the results were substantially altered.

Taken together, the results have demonstrated that there are considerable social gradients for diabetes, and the stratification for age groups has revealed the smallest differences in the lowest age stratum.

Discussion

In the present study the social gradient of (type 2-)diabetes had been examined in a health insurance population. The findings are based on process-generated data that are independent from subjects' willingness to respond to survey questions. Social gradients emerged, and the ORs reported are higher than in earlier studies, only Helmert and Shea reported similar magnitudes for female respondents (OR = 4.01), for males they were lower than in our analyses (Helmert & Shea 1994). In another German study the risks were OR = 2.2 for men and OR = 1.8 for women (Knopf et al. 1999). In international publications the ORs for differences for the lowest as compared to the highest socio-economic category are ranging up to OR = 3.0 (Everson et al. 2002).

Several reasons may account for these differences. At first social gradients for Germany may in fact be higher than in other European countries and the US, but this disregards differences embedded in the research designs applied. In the present study we used a combination between medication information and hospital diagnoses for identifying diabetics, an approach that had not yet been chosen in the health inequality tradition. Apart from ecological studies (Connolly et al. 2000; Meadows 1995; Evans et al. 2000) all research work reported in the introduction builds on subject-based assessments by questionnaires. Both approaches have advantages and disadvantages resulting in differing ORs for diabetes: With medication data nearly all diabetics who were receiving treatment by medication should have been covered. For this group the reported social gradients should not be biased. What we did not have identified are diabetics whose disease can be managed by an appropriate diet. Thus, in the insurance population the health of individuals identified as diabetics should be estimated as worse than in the entire population. This latter group is however in the reach of surveys relying on self-reports. For survey studies there is evidence that individuals with impaired health may refrain from participating thus leading to better overall health measures in samples, (Cohen & Duffy 2002; Etter & Perneger 1997) consequently less pronounced social gradients should emerge. Two recent studies have demonstrated (Schillinger et al. 2002; Mühlhauser et al. 1998) that in disadvantaged individuals the course of the disease is worse or there are more complications than in less disadvantaged ones, resulting in lower probabilities to be represented in surveys. In contrast, diabetics who manage their disease well will then have higher probabilities to be interviewed. Taken together, the comparably large social gradients in our study should be due to the absence of diabetics managing their disease by adhering to an appropriate diet and to the difficulties to cover the severe diabetes cases in surveys. A final reason for the high social gradients may result out of the relatively small numbers of individuals with diabetes in the highest occupational category, resulting in the obtained ORs and in the wide confidence intervals.

The reported social differences are giving information on the potential for reductions with respect to diabetes onsets over socio-economic groups. Although health inequalities are unlikely to be redressed completely (Woodward & Kawachi 2000), they can be reduced. A recent study has demonstrated that interventions directed towards changes in health-related lifestyles may reduce the risk of diabetes onset (Tuomilehto et al. 2001).

Relationships between the size of the social gradient and age have also been found for myocardial infarction and stroke (Helmert et al. 1993), and our own findings on diabetes are in line.

Besides the methodological points discussed in connection with the size of the reported ORs some more need to be

made. Since our material was obtained from a statutory health insurance, they do not depict the upper 10 % of the income distribution. This is germane to the German health insurance system where this group is privately insured, i.e., they are outside the regulations of statutory health insurances. Keeping in mind that their diabetes risks should be lower than those of the highest occupational group in the present insurance population, our results should underestimate the social gradients in the total population. In order to reduce this inaccuracy, data from private insurances should supplement our material, but this had not yet been done. On the other end of the distribution subjects from the lowest position of the socio-economic scale are not represented, i.e., the majority of people on social welfare or the homeless. Although these groups are relatively small in number, omitting them should add to an underestimation of ORs.

The second main result refers to the age-related social gradients that persisted over the whole lifespan. This confirms an earlier work (Connolly et al. 2000) where social gradients were present up to the age of 80. We had expected more pronounced social gradients in the younger age groups because in the lower occupational positions the vulnerabilities leading to the onset of diabetes should become effective earlier. Additionally in higher age a levelling should take place. The question for reasons will have to be dealt with further, but it cannot be answered with our cross-sectional data.

Our analyses have also demonstrated that even in a large dataset problems with obtaining robust results may emerge. In the present study this was the case in the younger age groups. More than one third of our insurance population could not be classified with respect to their socio-economic position. Most of them are retired and/or over 65 years, or health coverage in the present insurance started only after retirement. In contrast, the younger unclassified are a rather heterogeneous group, consisting of single women without permanent employment. Thus, the insured excluded from the study population can be described as a mixture of elderly and disadvantaged individuals.

Limitations of our conclusions are arising out of the fact that the socio-economic structure of our insured is not the same as the German population. Rather, skilled manuals and unskilled/semi-skilled positions are over-represented, while for individuals holding intermediate positions and professionals it is the other way round (Geyer & Peter 1999), and the upper 10 % of the income distribution are lacking.

Finally, there is some reason to assume that our subgroup with insulin dependent diabetes still includes type 1 diabetics. As the proportion of this group among all diabetics can be estimated to about 5 %, their total number in our population should be low, especially as the younger patients had already been excluded prior to the analyses. However, their exact number cannot be quantified. Since for diabetes type 1 socio-economic gradients have not been reported, keeping them in our data should not bias the results.

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Zusammenfassung

Gesundheitliche Ungleichheiten über Altersgruppen: der Fall Typ 2-Diabetes: eine Studie mit Krankenversicherungs- und Medikamentendaten

Fragestellung: Es werden gesundheitliche Ungleichheiten im Hinblick auf die Prävalenz von Diabetes Mellitus bei Frauen und Männern einer Krankenversicherungspopulation untersucht. Es wird zusätzlich betrachtet, ob diese sozialen Gradienten über die gesamte Altersverteilung auftritt.

Methode: Die Analysen wurden mit Daten einer gesetzlichen Krankenkasse durchgeführt. Sie umfassten 77294 Männer (68.2 %) und Frauen (31.8 %) im Alter von mindestens 20 Jahren. Zur Klassifikation wurde die berufliche Statusposition verwendet. Versicherte mit Diabetes wurden anhand ihrer Medikation bzw. anhand von Krankenhausdiagnosen identifiziert. Die Analysen wurden für die gesamte Studienpopulation sowie für verschiedene Altersschichten (<40 Jahre/40–55 Jahre/>55 Jahre) durchgeführt.

Ergebnisse: Die Analyse erbrachte deutliche soziale Gradienten für Diabetes Mellitus. Das Odds Ratio (OR) jeweils im Vergleich zu Individuen mit der höchsten Berufsposition betrug für Ausgebildete in Verwaltung und Dienstleistung 2,9; OR = 4,7 für Facharbeiterpositionen und OR = 5,6 für Un- und Angelernte. Nach Stratifizierung in drei Altersgruppen wurden die sozialen Gradienten über die gesamte Altersspanne reproduziert, ihre Grösse nahm jedoch mit dem Alter zu.

Schlussfolgerung: In unserer Krankenkassenpopulation traten beträchtliche gesundheitliche Ungleichheiten auf. Sie bleiben auch nach Stratifizierung in Altersgruppen erhalten.

Résumé

Inégalités sociales de santé dans différentes tranches d'âge: le cas du diabète type 2: une étude avec des données d'une caisse maladie allemande

Objectifs: Les inégalités sociales de santé sont étudiées pour femmes et hommes à travers différents tranches d'âge.

Méthodes: L'étude est menée avec les données d'une caisse maladie allemande. La base des données englobe 77 294 individus dont 68,2 % hommes et 31,8 % femmes du moins de 20 ans. La population était classifiée en quatre catégories de position professionnelle. Médication et diagnostics hospitaliers étaient disponibles pour les patients diabétiques. Analyses effectuées pour toute l'échantillon et séparément par tranches d'âge (<40/40–55/>55 ans).

Résultats: Il existe de fortes différences sociales. Comparé avec la catégorie de position professionnelle la plus haute (cadres et positions intermédiaires), l'odds ratio (OR) est OR = 2,9 pour les employés, OR = 4,7 pour les professions manuelles qualifiées et OR = 5,6 pour les professions semi-qualifiées/non-qualifiées. Les inégalités de santé se manifestent dans tous les groupes d'âge et augmentent avec l'âge.

Conclusion: Dans la population de cette caisse maladie il y a des inégalités sociales profondes, observables dans trois tranches d'âge.

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