Diabetes adherence - does gender matter?

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REVIEW ARTICLE

Diabetes adherence—does gender matter?

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Abstract
Aim This paper aims to unobtrusively identify gender patterns in diabetics' adherence to their medication regimen.
Subjects and methods Non-adherence is a major problem in health care as it affects both the patient's individual health as well as public health. Seen worldwide, the problem of non-adherence is even more important due to the increasing numbers of the elderly population and of chronic diseases such as diabetes, asthma, HIV, etc. It is estimated that in Germany alone, non-adherence is responsible for costs of €10 billion per year. Finding useful health behaviour patterns could be especially important for the increasing number of patients with chronic diseases such as diabetes, where costs are high and consequences such as retino-, nephro- and neuropathy severe for 180 million diabetics worldwide. This paper analyses the records of two German pharmacies, P1 and P2, regarding gender patterns in adherence to oral antidiabetics as this analysis method has a high specificity. Out of 4,474 (P1) respectively 2,650 (P2) datasets, those were selected that showed the use of medication with oral drugs for diabetes based on ATC code level A10B. The selected medication datasets were fully analysed, also the respective adherence rate for drugs used for hypertension, ATC code level C.
Results Average adherence rates for oral antidiabetic agents varied, with 25.4% (P1 women) and 34.6% (P1 men), and 27.8% (P2 women) and 26.1% (P2 men). In contrast, average adherence rates with drugs for the cardiovascular system were high, with 73.4% (P1 women) and 74.2% (P1 men), and 57.0% (P2 women) and 70.2% (P2 men).
Conclusion Adherence rates for oral antidiabetic agents showed no gender patterns. This finding is supported by varying adherence rates for medication for hypertension. In both cases, the chi-square test showed no significant correlation between gender and adherence classification, and also Cramer's V only showed a small effect of gender on adherence behaviour.

Keywords Diabetes · Adherence · Gender · Pharmacy records

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Backgound

It is well known that non-adherence comprises a large part of the costs in health systems. In Germany alone, non-adherence is estimated to cause €10 billion in costs per year (ABDA, Bundesvereinigung Deutsche Apothekerverbände, 7 June 2007). What seems to be missing is a practical and economical instrument to contain the costs created by this kind of patient behaviour and to limit disease progression and co-morbidities.

Finding useful health behaviour patterns could be of special importance for the increasing number of patients with chronic diseases, such as diabetes, where costs are high and consequences like retino-, nephro- and neuropathy severe for 180 million diabetics worldwide [World Health Organization (WHO), September 2006]. Because the difficulty imposed by diabetes is less when patients are not dealing with severe complications, diabetics seem to be more susceptible to non-adherence than patients suffering from other chronic diseases. Furthermore, often existing co-

morbidities like hypertension demand additional adherent behaviours.

In Germany, 5–6 million people have been diagnosed with diabetes; additionally, 1.5 million people with diabetes are undiagnosed (Lange and Ziese 2007). Ninety percent of all diabetes patients suffer from type 2, whereas only 5% have type 1. Based on the data of a 6-year diabetes intervention study, Benecke researched gender-related aspects in the rehabilitation of diabetes (Benecke 2005). Although it is known that gender influences diabetes prevalence, there are not sufficient detailed research results about the prevalence and incidence regarding gender (Benecke 2005). Federal resources revert to figures determined in 1998 that showed the following distribution: Men who are 70 years old are more concerned with diabetes than women of a similar age, but as women age, the situation changes to the disadvantage of women (Lange and Ziese 2007). An overall higher, gender-independent prevalence of diabetes in people with poor socioeconomic status is apparent (Häussler 2006). This is not due to the status, but to the higher prevalence of diabetes risk factors such as overweight/obesity and physical inactivity as well as poor psychological health (Robert Koch Institute, July 2006).

Diabetes in Germany is responsible for €5.16 billion in direct costs (Lange and Ziese 2007): hospitalisation accounts for 50%, medication 27%, ambulatory treatment 13% and 10% for other (Icks 2005). Expenses for complications and co-morbidities have to be added to the above-mentioned direct costs. In 2002, co-morbidities were estimated to contribute €9.44 billion to overall diabetes costs (Häussler 2006). With the increasing number of diabetics, these costs should be contained. One possible way is to enhance adherence.

Adherence in terms of health care means the extent to which patients follow a therapy regimen advised by a health-care provider (Sabaté 2005; Reymond et al. 2003; Heuer et al. 1999), including taking medication as well as, e.g., exercising, dieting and/or changing one's lifestyle. As taking drugs seems to be the less complex part when adhering to an advised therapy, this could be the entry point for the development of measures to increase overall adherence rates. When speaking about medication adherence, this includes taking, dosing and timing of the medication (Heuer et al. 1999).

Regarding the measurement of adherence, diverse methods are used. The most feasible ways are direct methods, such as monitoring, measurement of drugs or metabolites in biological body fluids and measurement of biological markers as well as indirect methods, such as "clinical" estimates from medical practitioners or pharmacists, therapeutic parameters (e.g., HbA1c), patient diaries, interviews, drug consumption in relation to prescription, prescription refill or electronic monitoring (Heuer et al. 1999). Whereas direct methods have a high sensitivity (Farmer 1999), indirect methods are characterised by high specificity (Andrade et al. 2006). Each method has strengths and weaknesses. Direct measures are very complex and costly, and only applicable in hospitals and nursing homes or in clinical trials. Indirect measurements are characterised by high specificity (Andrade et al. 2006) but retain the basic problem, which is that only the unpacking of tablets (rather than the taking of the drug) can be controlled (Vrijens et al. 2005), even with electronic monitoring.

Reasons for such self-destructive behaviour are multifaceted and the subject of health sociology (Gerlinger 2006; Wolf and Wendt 2006) and health psychology (Renneberg and Hammelstein 2006; Schwarzer 2004) studies. Salient are the influences of complex personal conflicts and problems such as alcohol abuse (Ahmed et al. 2006), forgetfulness (Vedhara et al. 2004) and patients' self-perception (Aalto and Uutela 1997; Horne 1999; Lai and Cheng 2004). Disease-related factors such as the complexity of therapy (Claxton et al. 2001; Dezii et al. 2002), cost of care (Sabaté 2005), psychological strain and acceptance of the disease pattern in society also play major roles (Heuer et al. 1999).

Sabaté aggregated existent knowledge and relevant adherence studies for the World Health Organisation (WHO) and defined five dimensions of adherence (Sabaté 2005): health-care team/health system factors, therapy-related, condition-related, social/economic and patient-related factors. Sabaté identified four clusters that influence diabetes adherence the most: treatment and disease characteristics, intra-personal and inter-personal factors as well as environmental factors. Several researchers (Krueger et al. 2005; Fincham 2007; Hearnshaw and Lindenmeyer 2005; Vermeire et al. 2001), including Cramer (2004), have provided a summary of the status of adherence research. But all these summaries simply show that there are no generalities to be found, with adherence rates ranging from 15–75% (Sabaté 2005) or 36–93% (Cramer 2004). Most study designs are cross-sectional, which does not serve the purpose as individual adherence behaviour is situational and variable over the course of time (Vermeire et al. 2001).

When analysing existing adherence research, it can be seen that most studies have been conducted in clinical settings. This limits the informative value significantly as the conditions are artificial and do not reflect the real patient situation (Revicki and Frank 1999). Randomised controlled trials (RCT) are the gold standard when health technologies are evaluated (Ross et al. 1999) as they should guarantee a certain study standard and comparability. While RCTs focus on analysing the efficacy of pharmaceuticals and health technologies under ideal circumstances with high internal validity, effectiveness studies try to reflect

real-world circumstances. Salient are differences regarding basic characteristics such as the duration of the study as well as the restriction and homogeneity of patient groups. Thus, RCTs should run prior to effectiveness studies (Revicki and Frank 1999).

In clinical studies patients are selected based on the aim of the study, steadily observed or interviewed with standardised questionnaires, and do not have to pay for the study medication. There are no variations from the previously defined study protocol and generally no follow-up care. Most interesting is the run-in phase in which possible participants are rejected who could put the success of the study at risk, e.g., by being non-adherent (Farmer 1999). Additionally, there are many barriers to patients' participation (Ross et al. 1999; Robiner et al. 2009), which lead to study results not representing the comparison group in the population. As a consequence, findings based on clinical studies cannot necessarily be adapted to real-world situations.

These discrepancies are well known and are a result of the described variations in study design, which cause among other things variations in the impact of the Hawthorne effect (Hughes and Walley 2003). However, differences in adherence behaviour have been identified as the factor with the most influence on outcome discrepancies (Revicki and Frank 1999; Hughes and Walley 2003), as the number of non-adherent patients under real-world circumstances is higher than in clinical studies (Farmer 1999; Davidson 2006).

The comparability of analyses based on pharmacy records is questionable as there is no consistent selection of the relevant data. The present paper follows a different approach as only those patients with drugs used for diabetes were selected. Besides, the analysed datasets represent the real-world behaviour of the selected patients. Further selection is not useful as this limits the informative power of the findings. A high level of specificity should be the aim of an analysis of pharmacy records.

In addition, a validation of a method for adherence measurement seems problematic only because of the lack of validated reference values. As no method can provide an absolute adherence rate—direct methods are influenced by the Hawthorne effect, clinical studies are artificial, and indirect methods only measure the unpacking of medication—the methods should support the aim of a study. This means that besides a high specificity of pharmacy records, the medication supply is a reason for this proceeding. As physicians are only allowed to give a limited number of medication samples, patients can only be adherent when having enough medication to follow the advised regimen.

The next point of discussion is the use of DDD to calculate adherence rates. However, as this paper evaluates gender differences and as DDDs are identified based on prescription behaviour in Germany, this debate leads to no useful results and is not of importance here.

Referring to gender patterns, most studies do not even pay attention to gender or gender-related analyses. Those noticing gender aspects often report neutrality respectively, showing a weak influence of gender on adherence behaviour (Shah et al. 2009; Fitzgerald et al. 1995; Navuluri 2000; Vermeire et al. 2001). Already in 1981, Dunn and Turtle came to the conclusion that there is no diabetic person. Salient are only the differing health beliefs of women who are more confident with physicians and medications in general (Navuluri 2000; Vermeire et al. 2001). This could be the reason for the more frequent consultation of physicians (Benecke 2005), which results in more prescribed medication, with women receiving on average 16% more medication than men (Schwabe and Paffrath 2008). Overall, there seems to be too little research on gender-related adherence to gain significant insights.

Study design and method

As there is no gold standard for adherence measurement (Vermeire et al. 2001), the choice of an appropriate method is essentially based on the aim of the specific study (Farmer 1999). As the majority of studies concerning adherence research use direct methods for the measurement of adherence rates, they are not necessarily representative. Findings have to be analysed in terms of informative power under real-world circumstances. Studies applying indirect methods mostly focus on disease-related medication and thereby only pay attention to single aspects.

The present paper analyses pharmacy records as this method seems to fit best for researching extensive data with high specificity (Andrade et al. 2006) and without involving patients. Obtaining a representative sample of the population seems possible since German patients generally use one doctor (Schoen et al. November 2005) and one pharmacy (ABDA, Bundesvereinigung Deutsche Apothekerverbände, 21 January 2008).

The database for this analysis was extracted from two different pharmacies in Germany, both belonging to the same pharmacist. This condition guaranteed consistent data collection and thereby a consistent database. One pharmacy (P1) is located in a small countryside town with 6,100 inhabitants and has one competitor; the other one (P2) is located in a small town with 16,000 inhabitants and has seven competitors.

Medication data were collected from all individual pharmacy customers. Medication data not related to individuals were excluded from this study. P1 has 4,474 datasets of customers who received medication between 1 January 2006 and December 31 2007. Of these, 391 patients

(8.74%) received diabetes medication. Those patients who received only insulin (83 patients) as well as patients who died in 2006 or 2007 were excluded. P2 has 2,650 datasets of customers who received medication between 1 January 2006 and 31 December 2007. Of these, 240 patients (9.06%) received diabetes medication. Similarly, patients receiving only insulin (81 patients) or who died in 2006 or 2007 (8 patients) were excluded.

The percentage of diabetic patients (8.74% and 9.06%, respectively) is higher than the 7.28% of diagnosed diabetes patients in the population of Germany. An explanation could be that the customer distribution in pharmacies does not necessarily reflect the population's distribution of disease patterns as persons with diseases are overrepresented in this segment.

To extract all relevant patients out of the complete data, the Anatomical Therapeutic Chemical/Defined Daily Dose Classification (ATC/DDD Code) was used. The level of A10 drugs used for diabetes is split into A10A insulin and analogues, A10B blood glucose-lowering drugs, excluding insulin and other A10X drugs used in diabetes. Levels A10A and A10X were excluded due to special dosing respectively lack of prescription. Based on these ATC levels, the specific days of coverage for each selected ATC code were calculated.

In Germany, the official ATC classification is authored and if necessary adapted by the GKV-Arzneimittelindex im Wissenschaftlichen Institut der AOK (WIdO) and published by the Deutsches Institut für Medizinische Dokumentation und Information (DIMDI). The analysis for this paper was based on the official code from 2007 to obtain the specific daily defined dose (DDD) as well as days of coverage. This method can cause inaccuracies as advised medication regimens do not necessarily match the DDD. But as DDDs are calculated based on prescription behaviour, the DDD should represent average consumption (Cosentino et al. 2000).

The collected data included the following: consecutive number, sex, date of birth, year of birth, health insurance, number and sum of co-payments for prescriptions and self-medication, sum of medications and medication dates, number of prescribed ATC codes, number and coverage of ATC level A02A antacids, A04 antiemetics and antinauseants, A11 vitamins, A12 mineral supplements, A13 tonics, G03b H-androgens, estrogens, progestogens, androgens and female sex hormones in combination, progestogens and estrogens in combination, gonadotropins and other ovulation stimulants, antiandrogens, N02 analgesics, N05 psycholeptics, N06 psychoanaleptics, S01 ophthalmologicals, S03 ophthalmological and ontological preparations, and receipt of narcotic substances. For specific analysis of A10-level and C-level medication (cardiovascular system), the number, coverage, numbers of different ATC levels and adherence rates were calculated.

To calculate adherence rates, individual medication data were sorted according to ATC level and date. The specific coverages were added to the specific medication dates of A10- and C-level drugs. The date of the subsequent prescription conversion was subtracted from the previous result to calculate the variance in days. The resulting blocks were condensed into sums per patient for the observation period.

Adherence rates were calculated as follows: variance in days/total coverage of drugs with variances. According to the literature, results were clustered in three groups: 0–19.9% adherent, 20–79.9% partially adherent and 80–100% non-adherent (Heuer et al. 1999; Reymond et al. 2003; Fincham 2007). For clarity in reporting, result values exceeding 100% were replaced with 100% and values below 0% with 0%.

Results

Table 1 shows an overview of the database. P1 and P2 showed a relatively equal distribution of gender with 48.8% respectively 47.1% female patients receiving A10B medication (antidiabetics excluding insulin) (Tables 2, 3 and 4). The average age of 69.5 years in patients in P1 was 4.3 years higher than in P2. The average age of women in P1 was slightly lower than that of men, whereas the average age in P2 was quite similar.

Though the database included only datasets of patients who received A10B medication, not all of those could be analysed according to adherence rate. If there was not a subsequent prescription for the respective A10B level, it was not possible to calculate a variance between coverage and the next prescription conversion.

Regarding the supply of drugs used in diabetes excluding insulin, it is striking that patients in the rural P1 received 29% more DDDs than those in the more urban P2. The average was calculated for the 2-year observation period, which resulted in 178.6 (P1) respectively 138.4 (P2) DDDs for 1 year. In total, in 2006 the prescribed number of DDDs in Germany was 448 for women and 385 for men (Schwabe and Paffrath 2008). The supply for men in P1 was 14.4% higher than the supply for women, whereas in P2 it was almost equal (+ 0.4%).

The low adherence rates in both cases with 30.0% (P1) respectively 26.9% (P2) are not surprising. But the higher adherence rate of men in P1 (34.6%) compared to that of women (25.4%) is noticeable. However, chi-square showed no significant correlation between gender and adherence classification, with 3.817 for P1 and 1.130 for P2. Also Cramer's V only showed a small effect of gender on adherence behaviour, with 0.127 for P1 and 0.100 for P2.

Table 1 Overview of the database

	P1	P2
No. of datasets	4.475	2.650
No. of datasets with A10 antidiabetic medication	391	240
Share of A10 antidiabetics of total datasets	8.74%	9.06%
Calculation base: no. of datasets with A10B medication	297	157
Women/men/unknown	50.5%/48.8%0.7%	52.2%/47.1%/0.6%
No. of corresponding datasets	145/150/2	74/82/1
Average age in years	69.5	65.2
No. of corresponding datasets	258	120
Average age women/men in years at the end of observation period	71.2/67.9	65.0/65.4
No. of corresponding datasets	129/129	57/63

The situation for medication used for the cardiovascular system is different. As not all diabetics also received C-level medication, those without information were excluded.

Compared to the supply of antidiabetic agents, the higher number of average prescribed DDDs for the cardiovascular system is striking. Whereas there were gender differences concerning antidiabetic agents at P1, the C-level medication level for men was 16.8% higher than for women at P2. However, chi-square test showed no significant correlation between gender and adherence classification, with 0.042 for P1 and 1.651 for P2. Also, Cramer's V only showed a small effect of gender on adherence behaviour, with 0.014 for P1 and 0.143 for P2.

Also the adherence differences were reversed. Whereas the overall compliance was quite high, with 73.8% (P1) respectively 64.1% (P2), there was a difference between adherence of women and men at P2 and almost none at P1.

Discussion

Before discussing the above findings, the validity of an analysis based on pharmacy records has to be considered. The literature provides extensive overviews, which come to varying conclusions (Andrade et al. 2006; Guénette et al. 2005; Fairley et al. 2005; Rickles and Svarstad 2007; Steiner and Prochazka 1997).

The most important question to focus on is the existence of gender patterns. First of all, it seems striking that there is neither a gender pattern regarding diabetes prevalence (Benecke 2005) nor support from the literature for such a conclusion regarding adherence. But an overall higher, gender-independent prevalence of diabetes in people of poor socioeconomic status exists (Häussler 2006). The prevalence of non-insulin-dependent diabetes in the lower classes, with 5.6% respectively 8.5% for men and women,

Table 2 Analysis of A10B medication

A10B medication (antidiabetics excluding insulin)	P1	P2
Average no. of A10B DDD per patient for observation period	357.2	276.8
Women/men	334.5/382.8	277.6/278.8
No. of corresponding datasets	145/150	74/82
Average coverage with A10B medication for observation period	48.9%	37.9%
Women/men	45.8%/52.4%	38.0%/38.2%
No. of datasets with information regarding A10B adherence rate	235	112
Women/men	112/123	50/62
Average adherence rate of patients with A10B medication	30.0%	26.9%
Standard deviation of A10B adherence	34.6%	35.6%
Average A10B adherence women/men	25.4%/34.6%	27.8%/26.1%
No. of corresponding datasets	112/123	50/65
Standard deviation of A10B adherence rate women/men	33.7%/35.0%	37.9%/34.0%
Chi-square*	3.817	1.130
Cramer's V*	0.127	0.100

* with adherence rates clustered in 3 groups: 0–19.9% non-adherent, 20.0–79.9% partially adherent, 80–100% adherent

Table 3 Analysis of C (cardiovascular) medication

C medication (cardiovascular system)	P1	P2
Average no. of C DDDs per patient for observation period	1,622.4	1,288.8
Women/men	1,624.6/1,620.2	1,189.9/1,390.7
No. of corresponding datasets	134/133	60/69
Average coverage with C medication	222.3%	176.6%
Women/men	222.5%/221.8	163.0%/190.5%
No. of datasets with information regarding C adherence rate	243	101
Women/men	122/121	49/51
Average adherence rate of patients with C medication	73.8%	64.1%
Standard deviation of C adherence rate	34.4%	41.4%
Average C adherence women/men	73.4%/74.2%	57.0%/70.2%
No. of corresponding datasets	122 / 121	49/51
Standard deviation of C adherence rate women/men	34.4%/34.5%	41.8%/39.9%
Chi-square*	0.042	1.651
Cramer's V*	0.014	0143

* with adherence rates clustered in 3 groups: 0–19.9% non-adherent, 20.0–79.9% partially adherent, 80–100% adherent

is significantly higher than in the middle class (3.5% respectively 3.4%) and the upper class (2.5% respectively 1.6%) (Häussler 2006).

It has been well researched that poor socioeconomic status (SES) is linked with higher morbidity and mortality (Jungbauer-Gans 2006), but the reason behind this effect is not yet clear. It is apparent that the distribution of risk factors, e. g., overweight, shows a disproportionate burden for the poor (Max Rubner Institute 2008), as health conditions follow the SES (Jungbauer-Gans and Gross 2006). However, this is not due to the status, but to the higher prevalence of diabetes risk factors, such as overweight/obesity and physical inactivity as well as worse psychological health (Robert Koch Institute 2006). This could explain why there is no gender pattern, though women more often have a low socioeconomic position (Babitsch 2006). Even in childhood, this position already is a strong indicator for diabetes for women, and women are less often able to change this position (Maty et al. 2008).

Regarding adherence rates resulting from the present analysis, there is also no identifiable gender-related behaviour. Neither the number of diabetics in P1 (women 50.5%, men 48.8%) and P2 (women 52.2%, men 47.1%) nor adherence rates showed a clear pattern.

While in rural P1 the fill-adherence of women with A10B medication was considerably lower (25.4%) than that of men (34.6%), the fill-adherence for cardiovascular medication was almost equal, with 73.4% for women and 74.2% for men. A completely different situation was shown in the more urban P2, with a fill-adherence for A10B medication only slightly higher for women than for men (27.8% women, 26.1% men), whereas the fill-adherence for cardiovascular medication was clearly higher for men than for women (57.0% women, 70.2% men).

This led to the first conclusion: that there is no gender pattern detectable because it does not exist. However, as medication adherence is influenced by many factors, it could also be that there is a gender pattern that is overlain by psychological influences on health. Further research has to analyse this possibility.

Conclusion

There is a gap in the current diabetic literature on adherence and gender. Many clinical studies give no insight into gender patterns and cannot be analysed in retrospect for gender information, which contributes to the lack of data.

Table 4 Comparison of adherence rates

Average A10B adherence women/men	25.4%/34.6%	27.8%/26.1%
No. of corresponding datasets	112/123	50/65
Chi-square	3.817	1.130
Cramer's V with adherence rates clustered in 3 groups: 0–19.9% non-adherent, 20.0–79.9% partially adherent, 80–100% adherent	0.127	0.100
Average C-adherence women/men	73.4%/74.2%	57.0%/70.2%
No. of corresponding datasets	122/121	49/51
Chi-square*	0.042	1.651
Cramer's V*	0.014	0.143

* with adherence rates clustered in 3 groups: 0–19.9% non-adherent, 20.0–79.9% partially adherent, 80–100% adherent

The main conclusion that can be drawn based on the analysed data is the lack of gender patterns when it comes to adherence. A patient's decision for or against adherence seems to be influenced by so many individual factors that it implies profound multidimensionality. To contain this set of problems will challenge all actors in health care.

As adherence may vary from situation to situation, other actors in the health system besides only physicians should be addressed, because they can give up-to-date information that represents the real circumstances of the patient's situation and can serve as indicators for when to intervene.

Conflict of interest The authors declare that they have no conflict of interest.

References

Aalto A, Uutela A (1997) Glycemic control, self-care behaviors, and psychosocial factors among insulin-treated diabetics: A test of an extended health belief model. Int J Behav Med 4(3):191–214

ABDA-Bundesvereinigung Deutsche Apothekerverbände: Non-Compliance kostet 10 Milliarden Euro—Apotheker verbessern Therapietreue. Press release 2007-06-07 Meran/Berlin

ABDA-Bundesvereinigung Deutsche Apothekerverbände: Patienten bevorzugen wohnortnahe Apotheke—Rezeptbelieferung überwiegend am gleichen Tag. Press release 2008-01-21 Berlin

Ahmed AT, Karter AJ, Liu J (2006) Alcohol consumption is inversely associated with adherence to diabetes self-care behaviours. Diabet Med 23:795–802

Andrade SE, Kahler KH, Frech F, Chan KA (2006) Methods for evaluation of medication adherence and persistence using automated databases. Pharmacoepidemiol Drug Saf 15(8):565–574

Babitsch B (2006) Die Kategorie Geschlecht: Implikationen für den Zusammenhang zwischen sozialer Ungleichheit und Gesundheit. In: Richter M, Hurrelmann K (eds) Gesundheitliche Ungleichheit. Grundlagen, Probleme, Perspektiven, 1st edn. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 271–287

Benecke A (2005) Geschlechtsspezifische Aspekte in der Rehabilitation bei Diabetes mellitus. Pabst, Lengerich

Claxton AJ, Cramer J, Pierce C (2001) A systematic review of the assocations between dose regimens and medication compliance. Clin Ther 23(8):1296–1310

Cosentino M, Leoni O, Banfi F, Lecchini S, Frigo G (2000) An approach for the estimation of drug prescribing using the defined daily dose methodology and drug dispensation data. Eur J Clin Pharmacol 56:513–517

Cramer JA (2004) A systematic review of adherence with medications for diabetes. Diabetes Care 27(5):1218–1224

Davidson MH (2006) Differences between clinical trial efficacy and real-world effectiveness. Am J Manag Care 12(15):405–411

Dezii CM, Kawabata H, Tran M (2002) Effect of once-daily and twice-daily dosing on adherence with prescribed glipizide oral therapy for type 2 diabetes. South Med J 95(1):68–71

Dunn SM, Turtle JR (1981) The myth of the diabetic personality. Diabetes Care 4(6):640–646

Fairley CK, Permana A, Read T (2005) Long-term utility of measuring adherence by self-report compared with pharmacy record in a routine clinic setting. HIV Med 6:366–369

Farmer KC (1999) Methods for measuring and monitoring medication regimen adherence in clinical trials and clinical practise. Clin Ther 21(6):1074–1090

Fincham JE (2007) Patient compliance with medications. Issues and opportunities. Pharmaceutical Products Press, Binghamton New York

Fitzgerald JT, Anderson RM, Davis WK (1995) Gender differences in diabetes attitudes and adherence. Diabetes Educ 21:523–529

Gerlinger T (2006) Historische Entwicklung und theoretische Perspektiven der Gesundheitssoziologie. In: Wendt C, Wolf C (eds) Soziologie der Gesundheit. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 34–56

Guénette L, Moisan J, Préville M, Boyer R (2005) Measures of adherence based self-report exhibited poor agreement with those based on pharmacy records. J Clin Epidemiol 58:924–933

Häussler B (2006) Weißbuch diabetes in Deutschland: Bestandsaufnahme und Zukunftsperspektiven der Versorgung einer Volkskrankheit. Thieme, Stuttgart

Hearnshaw H, Lindenmeyer A (2005) What do we mean by adherence to treatment and advice for living with diabetes? A review of literature on definitions and measurements. Diabet Med 23:720–728

Heuer H, Heuer SH, Lennecke K (1999) Compliance in der Arzneitherapie: Von der Non-Compliance zu pharmazeutischer und medizinischer Kooperation. Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart

Horne R (1999) Patients' beliefs about treatment: the hidden determinant of treatment outcome? J Psychosom Res 47:491–495

Hughes DA, Walley T (2003) Predicting "real world" effectiveness by integrating adherence with pharmacodynamic modeling. Clin Pharmacol Ther 74(1):1–8

Icks A (2005) Diabetes mellitus. Gesundheitsberichterstattung des Bundes, 24, Robert Koch-Institute, Berlin

Jungbauer-Gans M (2006) Soziale und kulturelle Einflüsse auf Krankheit und Gesundheit. In: Wendt C, Wolf C (eds) Soziologie der Gesundheit. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 86–108

Jungbauer-Gans M, Gross C (2006) Gesundheitliche Ungleichheit. Grundlagen, Probleme, Perspektiven. In: Richter M, Hurrelmann K (eds) Gesundheitliche Ungleichheit. Grundlagen, Probleme, Perspektiven, 1st edn. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 73–89

Krueger KP, Berger BA, Felkey B (2005) Medication adherence and persistence: A comprehensive review. Adv Ther 22(4):313–356

Lai JCL, Cheng S (2004) Health beliefs, optimism, and health-related decisions: A study with Hong Kong Chinese. Int. J Psychol 39 (3):179–189

Lange C, Ziese T (2007) Gesundheit in Deutschland. 2. edn. Robert-Koch-Institute (ed) Gesundheitsberichterstattung des Bundes, Berlin

Maty SC, Lynch JW, Raghunathan TE, Kaplan GA (2008) Childhood socioeconomic position, gender, adult body mass index, and incidence of type 2 diabetes mellitus over 34 years in the Alameda County Study. Am J Public Health 98(8):1486–1494

Max Rubner-Institut, Karlsruhe (ed) (2008) Nationale Verzehrsstudie II, Ergebnisbericht, Teil 1 Die bundesweite Befragung zur Ernährung von Jugendlichen und Erwachsenen

Navuluri RB (2000) Gender differences in the factors related to physical activity among adults with diabetes. Nurs Health Sci 2:191–199

Renneberg B, Hammelstein P (2006) Gesundheitspsychologie. Heidelberg, Springer Medizin

Revicki DA, Frank L (1999) Pharmacoeconomic evaluation in the real world—effectiveness versus efficacy studies. Pharmacoeconomics 15(5):423–434

Reymond J, Lennecke K, Marty S (2003) Compliance. In: Jaehde U, Radziwill R, Mühlebach S, Schunack W (eds) Lehrbuch der

Klinischen Pharmazie, 2nd edn. Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart, pp 241–253
Rickles NM, Svarstad BL (2007) Relationship between multiple self-reported nonadherence measures and pharmacy records. Res Social Adm Pharm 3(4):363–377
Robert-Koch-Institute (ed) (2006) Health in Germany. Federal Health Reporting, Berlin
Robiner WN, Yozwiak JA, Bearman DL, Strand TD, Strasburg KR (2009) Barriers to clinical research participation in a diabetes randomized clinical trial. Soc Sci Med 68(6):1069–1074
Ross S, Grant A, Counsell C, Gillespie W, Russell I, Prescott R (1999) Barriers to participation in randomised controlled trials: a systematic review. J Clin Epidemiol 52(12):1143–1156
Sabaté E (2005) Adherence to long-term therapies: evidence for action. World Health Organization (WHO), Geneva
Schoen C, Osborn R, Huynh PT, Doty MM, Fenley JA (November 2005) The Commonwealth Fund 2005 International Health Policy Survey of Sicker Adults in Six Countries. (Commonwealth Fund pub. no. 871) The Commonwealth Fund, New York
Schwabe U, Paffrath D (2008) Arzneiverordnungs-Report 2007-Aktuelle Daten, Kosten. Trends und Kommentare, Springer Medizin, Berlin, Heidelberg
Schwarzer R (2004) Psychologie des Gesundheitsverhaltens—Einführung in die Gesundheitspsychologie, 3rd edn. Hogrefe, Göttingen
Shah NR, Hirsch AG, Zacke C, Taylor S, Wood GC, Stewart WF (2009) Factors associated with first-fill adherence rates for diabetic medications: A cohort study. J Gen Intern Med 24 (2):233–237
Steiner JF, Prochazka AV (1997) The assessment of refill compliance using pharmacy records: Methods, validity, and applications. J Clin Epidemiol 50(1):105–116
Vedhara K, Wadsworth E, Norman P, Searle A, Mitchell J, Macrae N et al (2004) Habitual prospective memory in elderly patients with type 2 diabetes: implications for medication adherence. Psychol Health Med 9(1):17–27
Vermeire E, Hearnshaw H, Van Royen P, Denekens J (2001) Patient adherence to treatment: three decades of research. A comprehensive overview. J Clin Pharm Ther 26(5):331–342
Vrijens B, Tousset E, Rode R, Bertz R, Mayer S, Urquhart J (2005) Successful projection of the time course of drug concentration in plasma during a 1-year period from electronically compiled dosing-time data used as input to individually parameterized pharmacokinetic models. J Clin Pharmacol 45(4):461–467
Wolf C, Wendt C (2006) Perspektiven der Gesundheitssoziologie. In: Wendt C, Wolf C (eds) Soziologie der Gesundheit. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 9–33
World Health Organization (WHO) (ed) (September 2006) Fact Sheet Diabetes. (Fact Sheet WHO, 312). World Health Organization (WHO), Geneva