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Medication beliefs predict medication adherence in older adults with multiple illnesses

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Abstract

Objective: To examine factors preventing medication nonadherence in community-dwelling older adults with multiple illnesses (multimorbidity). Nonadherence threatens successful treatment of multimorbidity. Adherence problems can be intentional (e.g., deliberately choosing not to take medicines or to change medication dosage) or unintentional (e.g., forgetting to take medication) and might depend on a range of factors. This study focused in particular on the role of changes in beliefs about medication to explain changes in adherence. **Methods:** Longitudinal study with N=309 individuals aged 65–85 years with two or more diseases at three measurement points over six months. Medication adherence and beliefs about medicines were assessed by questionnaire. Hierarchical weighted least squares regression analyses were used to predict individual intentional and unintentional nonadherence. **Results:** Changes in intentional nonadherence were predicted by changes in specific necessity beliefs (B=−.19, P<.01), after controlling for sociodemographic factors, health status and number of prescribed medicines. Changes in unintentional nonadherence were predicted by changes in general overuse beliefs (B=.26, P<.01), controlling for the same covariates. **Conclusion:** Beliefs about medication affect both intentional and unintentional adherence to medication in multimorbid older adults. This points to the importance of addressing medication beliefs in patient education to improve adherence.

Keywords: Medication adherence; Medication beliefs; Beliefs about medicines questionnaire; Multimorbidity; Patient education

Introduction

Getting older is often accompanied with an increasing number of health problems [1]. In fact, it has been estimated that between 61 % (men) and 65 % (women) of all people over 60 years of age suffer from two or more co-occurring diseases [2], which impairs individual functioning [3] and quality of life [4]. Apart from general lifestyle recommendations such as changes in physical activity and nutrition, the cornerstone of most treatment approaches towards multimorbidity are more or less complex medication regimens [5]. Adherence to such regimens is a major prerequisite for their effectiveness: Reviews have shown that poor medication adherence is associated with poor health outcomes [6] and increased mortality [7]. Despite this, adherence rates tend to be below recommendations. A review estimates that about 25% of the adult population with prescribed medication are not adherent [6]. This problem applies to older adults as well [8]. Poor adherence is a major problem for both individuals and the health care systems, which calls for further examination of the factors determining adherence behavior.

An important distinction in this context is the discrimination between unintentional nonadherence and intentional nonadherence [9,10]. Unintentional nonadherence implies that persons do not take medicines as prescribed due to factors beyond their control. In multimorbid older people, one of these factors might be plain forgetting: With a growing number of conditions, the number of medicines and

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the complexity of medication regimens tend to increase, which can contribute to nonadherence [8]. For example, studies have shown that the likelihood of nonadherence increases with an increasing number of prescribed medications, with one or two medications being less problematic than four or five [11]. Another important factor is disease severity, which increases along with an increasing number of conditions and has proven to negatively affect adherence behavior [12]. These problems can be further amplified or complemented by problems with functional health, as sometimes administration regimens and medicine packing are difficult to operate [13].

Intentional nonadherence, on the other hand, is the consequence of a deliberate decision not to take medications as prescribed [9]. There are cases in which choosing not to adhere to a prescribed regimen might be an individually adaptive reaction, in particular, when faced with actual or expected potentially problematic interactions from multiple medication [8] or to prevent unpleasant or dangerous side-effects [14]. In addition to this, a number of studies have shown that many older adults with multiple medication feel insecure and not fully informed about effects and side-effects of their medication, which directly affects adherence behavior [15]. This implies that intentional nonadherence depends on informational and motivational factors affecting individual behavior.

In this respect, psychosocial theories can offer insights into the variables affecting adherence behavior. The most prominent approach in the context of medication adherence draws on beliefs about medicines and is based on the Common Sense Model of Self-Regulation (CSM [16]). This theory assumes that adherence behavior is an attempt to cope with illnesses which results from parallel cognitive and emotional appraisals of one's illnesses. According to the theory, individual adherence is more likely if adherence makes sense within the individual concept of illnesses, considering previous experience with illnesses and medication, potential outcomes of medication adherence and personal beliefs about illnesses [16]. For example, if someone considers his or her illness (or multiple illnesses) to be severe, but also to be controllable by medication, adherence can be perceived as an adaptive response to the threat posed by the illness or illnesses. On the other hand, if a medication does not fit into the individual representations of illnesses, e.g., by not being perceived as effective, adherence to this medication is not adaptive in terms of reducing the illness threat and accordingly becomes less likely. In order to account for the influence of medication beliefs on adherence within the CSM framework, an extended CSM model that integrates additional medication beliefs into the cognitive pathway of the CSM has been introduced [17,18]. This model suggests that medication adherence or nonadherence is directly related to specific beliefs about medication. Specific necessity beliefs are beliefs about beneficial effects of the medication used by a person, whereas specific concerns beliefs are related to worries about detrimental effects or dependence on the own medication. In addition, two general beliefs are suggested: General harm beliefs describe a general feeling of mistrust towards medication, while general overuse beliefs describe the concern that doctors prescribe too many medicines.

These beliefs about medicines have been applied to medication adherence in patients suffering from a number of different illnesses such as cardiovascular diseases [19], inflammatory bowel disease [20], or diabetes [21]. A consistent result within these studies was that specific necessity and specific concerns were better predictors of intentional nonadherence than the general factors. The goal of our study is to examine the usefulness of such medication beliefs in predicting changes in adherence behavior in older adults with multiple illnesses. Such individuals experience a multitude of symptoms [1–3] and are likely to have to adhere to multiple medications [5], which makes the assessment of specific medication and illness beliefs difficult. We will therefore assess participants' beliefs about their medication as a whole instead of restricting the research focus on specific medication for specific illnesses. As the reality of most older people consists of multiple illnesses [1–4], focusing on predicting individual reactions to single illnesses is accompanied with the risk of ignoring important information on the complex health status of the individual, even if this might come at the cost of underestimating effects of specific illnesses and illness-specific medication beliefs.

In addition, to date most studies on the association between medication beliefs and nonadherence employ cross-sectional research designs. Longitudinal data are scarce: only two studies examined effects of medication beliefs on adherence over time [22,23]. These studies have not examined the effects of changes in medication beliefs on changes in behavior, instead they used between-individual differences in cognitions to predict later cross-sectional between-individual differences in behavior. However, like most psychosocial theories of behavior change, the CSM assumes that changes in cognitions produce changes in individual coping attempts [24]. Applied to medical adherence, this means, for example, that people who become increasingly convinced that their medication can help with their illness status, will also become more adherent. Previous studies have mostly related cross-sectional individual differences in beliefs to cross-sectional or time-lagged differences in behavior, which provides weak evidence for the psychosocial mechanisms underlying behavior change. Only if behavior change is examined, reciprocal relations between cognitions and behavior can be disentangled and determinants of behavior change be identified.

This study, therefore, aims at providing evidence for the change-change associations inherent in the CSM. In particular, we assume that changes in specific necessity and specific concerns beliefs will affect subsequent intentional nonadherence, as previous studies have shown that specific beliefs are better predictors of intentional adherence than general medication beliefs [19–21]. With regard to

unintentional nonadherence, we assume that general beliefs and sociodemographic factors might be more important than specific medication beliefs [10].

In order to account for the differential processes involved in intentional and unintentional nonadherence, we conducted all analyses separately for intentional and unintentional nonadherence.

Method

Participants and procedure

Participants of this study were recruited from the third assessment wave of the German Ageing Survey [25], a population-based representative survey of the German population aged 40 and over. Participants were considered eligible for this study if they (a) were 65 years or older, (b) suffered from at least two conditions mentioned either in the Charlson Comorbidity Index [26] or the Functional Comorbidity Index [27] and (c) had given consent to be contacted for further studies. This left a total eligible n=443 participants of which n=309 (69.7 %) gave informed consent for this study and made an appointment for the first point of measurement (Time 1, March 2009). Participants were visited at their homes by trained interviewers and completed a 30-minute personal interview and additionally filled in a questionnaire with a prepaid return envelope. The second point of measurement (Time 2, June/July 2009) was a questionnaire only, which was filled in and sent back by n=252 (81.56% of the initial sample). The third point of measurement (Time 3, September/October 2009) contained interview and questionnaire, which were completed by n=271 (87.7% of the initial sample). Participants not returning the questionnaire within two weeks after every measurement point received one postal reminder. We expected this time frame with two intervals of three months each sufficient to detect changes in medication beliefs and changes in adherence. In the target group of elderly individuals with multiple illnesses both acute events and substantial changes in health status are more probable in such relatively short time periods than in healthier populations (e.g., [28]). Such changes in turn affect how individuals think about their illnesses and accordingly their medication [17,29]. In addition, the limited amount of evidence from previous studies makes it difficult to determine optimal measurement intervals.

Measures

A computer-assisted full medication inventory [30] was conducted during the interview at Time 1: interviewers asked participants to bring all of their medicines and recorded them using the medication code (if available) or the drug brand name and dosage.

Beliefs about medicines were assessed in the questionnaires at Time 1 and Time 2 using the Beliefs about Medicines Questionnaire (BMQ [17]). Due to space constraints in the questionnaire, a 9-item short version was used which has been developed in a pilot study with N=104 older adults. We selected the items loading highest in a varimax-rotated principal component analysis on the factors of general harm [two items, e.g., "Most medicines are addictive"; λ_1=.76, λ_2=.73 (in pilot study); inter-item correlation r_{ii}=.44, P<.01), general overuse [three items, e.g., "Doctors use too many medicines"; λ_1=.88, λ_2=.85, λ_3=.75 (in pilot study); Cronbach's alpha=.77], specific necessity [two items, e.g., "My health, at present, depends on my medicines"; both λs=.87 (in pilot study); r_{ii}=.79, P<.01], and specific concerns (two items, e.g., "My medicines disrupt my life"; λ_1=.82, λ_2=.78 (in pilot study); r_{ii}=.56, P<.01). This procedure ensured that the short version items are representative for the BMQ subscales. All items were answered on a 5-point scale from 1 "totally disagree" to 4 "totally agree."

Nonadherence to medication was assessed at Time 1 and Time 3 using two items from the Reported Adherence to Medication Scale (RAM [17]) to assess both intentional nonadherence ("Some people […] say that they miss out a dose of their medication or adjust it to suit their own needs. How often do you do this") and unintentional nonadherence ("Some people forget to take their medicine. How often does this happen to you?"). Results from the pilot study showed that these two items had the least skewed distributions from the four original RAM items. Items were answered on a five-point scale ranging from 1 "(almost) never" to 5 "very often," so that higher values indicate higher degrees of nonadherence.

Illnesses were assessed by asking participants to indicate the illnesses they suffered from on a list of 23 conditions informed by the Charlson Comorbidity Index [26] and the Functional Comorbidity Index [27].

Control variables included age, sex, number of illnesses and educational status approximated with the International Standard Classification of Education [31] on three levels.

Analytical procedure

All descriptive analyses were conducted using SPSS 15. Hierarchical weighted least squares (WLS) regression analyses predicting adherence at Time 3 from adherence at Time 1 (Step1), control variables (Step 2) and changes in BMQ variables between Time 1 and Time 3 (Step 3) were conducted using MPlus 5 in order to model missing values under full information maximum likelihood estimation with the weighted least squares estimator. The modeling of missing data procedure allows estimating the relations between changes in beliefs and adherence without biases, which are more likely if longitudinal dropout is not completely at random (see below). Change scores of BMQ variables were obtained by subtracting Time 1 from Time 2 measures.

Table 1
Means, standard deviations, range, and intercorrelations

	M	S.D.	Range	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. No. of illnesses	5.55	2.98	0–19															
2. Age	73.27	5.10	65–85	.19**														
3. Education	2.23	.66	1–3	−.16*	−.07													
4. No. of medicines	4.26	2.96	1–17	.47**	.10	. −.09												
5. Specific necessity T 1	3.73	1.24	1–5	.35**	.06	−.07	.51**											
6. Specific concern T 1	2.11	1.09	1–5	.32**	.03	−.17**	.29**	.36**										
7. General harm T 1	2.43	.99	1–5	.15**	.06	−.15**	−.10	−.13*	.26**									
8. General overuse T 1	3.00	1.01	1–5	.17**	.03	−.06	−.12*	−.15*	.25**	.51**								
9. Intentional nonadherence T 1	1.33	.70	1–5	.08	.06	.04	−.11*	−.11	.13*	.08	.16**							
10. Unintentional nonadherence T 1	1.32	.58	1–5	.07	.00	.05	.01	−.01	.10	.01	.09	.26**						
11. Specific necessity T 2	3.62	1.25	1–5	.28**	.13*	−.09	.47**	.74**	.33**	−.19**	−.20**	.14*	.03					
12. Specific concerns T 2	2.21	1.11	1–5	.40**	−.06	−.22**	.31**	.40**	.49**	.12	.11	.04	−.08	.49**				
13. General harm T 2	2.41	.94	1–5	.06	−.08	−.15*	−.11	−.15*	.08	.53**	.36**	−.03	−.13	−.15*	.25**			
14. General overuse T 2	3.22	.91	1–5	.08	−.07	−.12	−.13*	−.14*	.15*	.42**	.64**	−.11	−.17*	−.19**	.14*	.55**		
15. Intentional nonadherence T 3	1.32	.68	1–5	.07	−.06	.05	−.10	−.02	.13*	.07	.15*	.38**	.09	−.14*	.07	.14*	.14*	
16. Unintentional Nonadherence T 3	1.4	.67	1–5	.08	−.05	−.03	.03	−.02	.12	.08	.20**	.04	.37**	.01	.18*	.15*	.18*	.19*

*$P<.05$; **$P<.01$.

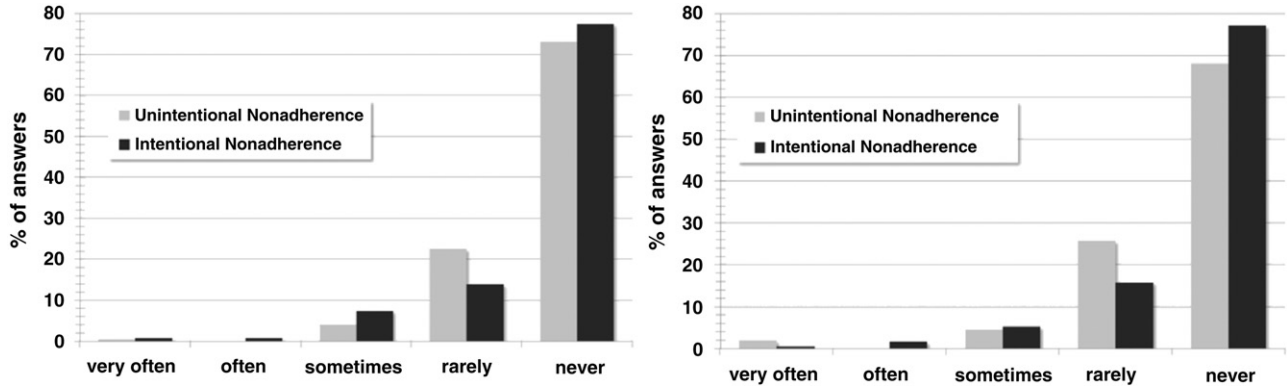

Fig. 1. Distributions of intentional and unintentional nonadherence at Time 1 (left) and Time 3 (right). Graphs represent percentage of answers to the items "Some people […] say that they miss out a dose of their medication or adjust it to suit their own needs. How often do you do this" (intentional nonadherence) and "Some people forget to take their medicine. How often does this happen to you?" (unintentional nonadherence).

Dropout analyses

Participants dropping out between Time 1 and Time 2 or between Time 1 and Time 3 were examined for significant differences in the study variables at Time 1. Dropouts indicated significantly higher specific necessity beliefs at Time 1 and significantly lower general overuse beliefs (all $p<.05$). No significant differences on any of the study variables at Time 1 were found between those who dropped out between Time 1 and Time 3.

Results

Descriptive statistics can be found in Table 1. On average, participants were 73.27 years old (S.D.=5.1), and 41.7% were women. Most participants reported perfect adherence to medication, with only 25% of the participants reporting some intentional nonadherence at Time 1 and Time 3 and about one third of the participants reported some unintentional nonadherence (see Fig. 1). This means that both Time 1 and Time 3 RAM indicators were severely skewed. No significant gender differences were found in both intentional nonadherence and unintentional nonadherence at both Time 1 and Time 3 (all $p>.05$). All change scores of medication beliefs displayed significant variance ($P<.01$), which indicates that there was substantial individual change between Time 1 and Time 3.

On average, participants took 4.26 medicines and suffered from 5.61 illnesses.

Predicting adherence to medication

Intentional and unintentional nonadherence at Time 3 were predicted in two hierarchical WLS regression analyses from nonadherence at Time 1 in the first step, control variables in the second and difference scores in the BMQ variables (Time 2−Time 1) in the third step.

In the prediction of intentional nonadherence at Time 3, nonadherence at Time 1 was a significant predictor in the first step (cf. Table 2). In the second step, nonadherence was further predicted by the number of illnesses, with more illnesses predicting more intentional nonadherence, and by the number of medicines, with more medicines predicting better adherence. In the third step, BMQ variables were entered. Only changes in specific necessity between Time 1 and Time 2 predicted intentional nonadherence at Time 3 over and above baseline nonadherence and control variables. Individuals who increasingly perceived their medication as

Table 2
Hierarchical WLS regression analyses predicting intentional nonadherence time 3

Step	Predictor	B Step 1	S.E. (B Step 1)	B Step 2	S.E. (B Step 2)	B Step 3	S.E. (B Step3)	ΔR^2
1	Intentional nonadherence Time 1	.61**	.09	.58**	.10	.58**	.09	.17**
2	Sex (0=female, 1=male)			−.01	.21	−.13	.20	.01
	Age			−.02	.02	−.02	.02	
	Education			.05	.16	.02	.15	
	No. of Illnesses			.06	.04	.05	.04	
	No. of medicines			−.04	.04	−.03	.04	
3	Change specific necessity					−.19**	.06	.03*
	Change specific concerns					−.01	.06	
	Change general harm					−.08	.06	
	Change general overuse					.10	.08	

*$P<.05$; **$P<.01$.
Table displays unstandardized regression coefficients. The item assessing intentional nonadherence was "Some people […] say that they miss out a dose of their medication or adjust it to suit their own needs. How often do you do this?"

Table 3
Hierarchical WLS regression analyses predicting unintentional nonadherence

Step	Predictor	B Step 1	S.E. (B Step 1)	B Step 2	S.E. (B Step 2)	B Step 3	S.E. (B Step3)	ΔR^2
1	Unintentional nonadherence Time 1	.71**	.09	.70**	.09	.70**	.09	.15**
2	Sex (0=female, 1=male)			−.25	.21	−.16	.20	.02
	Age			−.02	.02	−.01	.02	
	Education			−.05	.15	−.04	.14	
	No. of illnesses			.06	.04	.05	.03	
	No. of medicines			−.02	.03	−.03	.03	
3	Change specific necessity					.04	.06	.03*
	Change specific concerns					−.03	.07	
	Change general harm					.07	.08	
	Change general overuse					.26**	.10	

*P<.05; **P<.01.
Table displays unstandardized regression coefficients. The item assessing unintentional nonadherence was "Some people forget to take their medicine. How often does this happen to you?"

necessary were more adherent at Time 3. None of the general beliefs about medicines predicted intentional nonadherence.

When predicting Time 3 unintentional nonadherence, again baseline behavior was a significant predictor in the first step (cf. Table 3). None of the control variables entered in Step 2 was significant, but increases in perceptions of general overuse between Time 1 and Time 2 entered in Step 3 significantly predicted more unintentional nonadherence at Time 3 over and above baseline behavior.

Discussion

This study examined whether beliefs about medicines predict intentional and unintentional medication nonadherence in older individuals with multiple illnesses, a group at particular risk for further health deteriorations [1] and with high need of adherence to medication [5]. Following the common-sense approach of self-regulation of health and illness [24], we examined whether changes in cognitive representations about medicines as assessed in the BMQ [17] could predict changes in individual adherence behavior. We found that in particular changes in beliefs about specific subjective necessity predicted changes in intentional nonadherence (self-regulated changes in medication adherence). Changes in general beliefs about overuse of medication predicted changes in unintentional nonadherence (medication slips).

Our study found that individual intentional adherence behavior, (e.g., choosing to adhere to medication or not), depends on cognitive representations (e.g., the effects of medication). This replicates earlier findings from studies using the BMQ and the common-sense approach to medication adherence [20,21,23]. Our finding that particular beliefs about the specific necessity of the medication are protective factors against nonadherence and that specific concerns about medication seem to play a minor role, however, stresses that individual perceptions about the effectiveness of medication are crucial for understanding adherence. This is further underscored by the finding that these beliefs are particularly important in older individuals with multiple illnesses, even though this group is very likely to be dependent on adhering to complex medication regimens with many different drugs [8,15] — our participants took about four medicines on average with a range from 1 to 19 different medicines. The relative importance of cognitions about specific necessity suggests that individuals improve their adherence behavior if they are convinced that medication serves their needs and enables them to control the course of their illness. This is in accordance with previous research based on the common-sense model of health and illness, which has shown that individual representations about the course and in particular controllability of illnesses are most predictive of successful individual adaptation to illnesses [32]. Our results suggest that if older people with multiple illnesses are convinced that their medication serves their specific needs, they will more likely stay adherent. However, there is research showing that multimorbid older individuals often feel not sufficiently informed about the effects and necessity of their medication [15]. With our results showing that changes in beliefs about necessity predict improving adherence, this further points to the importance of thoroughly and understandably explaining the needs and effects of medication. Although this might sound like a commonplace, studies show that there are in fact huge discrepancies between what doctors think their patients should do in terms of medication adherence and what patients actually do [33]. In some cases, however, intentional nonadherence might be an adaptive choice of behavior, since polypharmacy in older multimorbid individuals in itself might pose a health risk, due to potentially dangerous interactions resulting from multiple medications [8].

Our study also found that changes in unintentional nonadherence are predicted by changes in general overuse perceptions. This means that if patients are increasingly convinced that doctors prescribe too many medications and that doctors did not have enough time for patients, they are more likely to forget taking their medication. This points in two important directions: on the one hand, perceptions of overuse intensified between Time 1 and Time 2, which suggests that participants increasingly felt that doctors relied

too much on medication to treat their illnesses. This could be due to deficits in the doctor-patient communication in terms of explaining the necessity of medication, which seems to affect medication adherence [8,15]. On the other hand, the finding that general overuse beliefs affect unintentional nonadherence suggests that the participants were more likely to forget adherence, if they had more negative attitudes towards medication in general. This finding can be interpreted in terms of the congeniality hypothesis which poses that people are more likely to remember things they have a positive attitude towards [34]. Studies in the health domain have accordingly shown that health-related information is better remembered by individuals with a positive attitude towards health [35,36]. In other words, it is more likely to forget to take medication if one has negative attitudes towards medication. The finding that only general overuse beliefs and not general harm beliefs predicted nonadherence might be due to the fact that general harm beliefs did—at least on the mean level—not change between Time 1 and Time 2.

The finding that specific concerns did not predict nonadherence was not necessarily expected, as concerns in previous research were able to predict nonadherence (e.g., [22]). Our sample on the other hand consisted of older adults with multiple illnesses, a group in which concerns about medication effects, albeit present, might be less important for nonadherence than specific necessity beliefs [21].

Our study also found no effects of sociodemographic factors such as sex, age, or education on adherence. This corroborates previous findings that doubt the existence of a clear-cut nonadherent patient prototype [9] but, rather, suggest that individual factors are responsible for both intentional and unintentional adherence behavior.

Our results further support the idea that intentional and unintentional nonadherence are distinct phenomena [10], as they were predicted by differential factors. In terms of prevention, this suggests targeting intentional and unintentional nonadherence differentially. Accordingly, interventions to prevent intentional nonadherence should target factors affecting individual motivation to change behavior, while interventions targeting unintentional nonadherence should target processes relevant for remembering and carrying through behavior. Current theories of health behavior acknowledge these differential processes [37], and systematic reviews suggest that interventions taking into account such differences might be more effective than one-size-fits-all interventions [38].

There are some limitations to our study. The fact that our sample comprised individuals with varying combinations of multiple illnesses required that we include a broader assessment of medication beliefs not referring to specific illnesses. In particular, the interpretation and attribution of unspecific symptoms such as dizziness, tiredness or nausea to specific illnesses might vary considerably between older adults with multiple illnesses. In addition, assessing specific medication beliefs for specific illnesses in older people with multiple illnesses would have invariably led to recruitment problems, as sampling strategies involving specific illness combinations would have required much larger sample sizes in a population at high risk for further health deteriorations.

However, this approach implies severe limitation for the interpretation of our results, as the unspecific assessment does not allow modeling the relations between specific illness beliefs, beliefs about medicines for such specific illnesses and the resulting adherence (or nonadherence) to this specific medication as outlined in the CSM. Research has shown that medication and treatment beliefs can differ substantially between different illnesses [39] and treatment approaches [40]. Applied to the context of multiple illnesses, this means that persons suffering from multiple conditions and, accordingly, need for different medicines could hold differential beliefs for each of their medicines and might differentially adhere (or not adhere) to either or all medicines. In particular with regard to concerns and harm beliefs, fundamental differences between medications can be expected (e.g., between a gel against arthritis and chemotherapeutic agents). Thus, our approach might systematically underestimate the effects of such specific beliefs. Our broad approach, on the other hand, allows accounting for individual variations in attributions and beliefs and taps in the reality of potentially complex multimorbidity patterns.

Furthermore, both intentional and unintentional adherence were self-reported, which might limit the validity of our measure given that adherence is highly socially desirable. However, comparative analyses showed that self-reported measures of adherence can be considered valid [41]. In addition, we relied on the RAM scale to assess both intentional and unintentional nonadherence, although the scale was not specifically designed for this purpose. A number of studies, however [10,42], have shown that the RAM scale can in fact be used to distinguish intentional and unintentional nonadherence. Due to space limitations in the questionnaires, we were unable to use all items of the Beliefs about Medicines Questionnaire [16], which might compromise the reliability and validity of our results. However, the finding that our short assessments of medication beliefs predicted adherence points to the usability of the short version. We were not able to conduct more than one full medication inventory, which prevented us from analyzing changes in medication as predictors of adherence.

We conducted separate regression analyses for unintentional and intentional nonadherence, as previous findings suggest differentiating between these two behaviors [9,10]. This approach however prevented us from testing whether the coefficients for variables predicting intentional nonadherence were significantly different from those predicting unintentional nonadherence, but suggested that these phenomena are related to different individual factors. Finally, our sample was limited to community-dwelling older adults who voluntarily participated in an unpaid survey, which suggests that our sample might overrepresent relatively healthy individuals with multiple illnesses, as older adults with multimorbidity in

bad health are more likely to be hospitalized or living in care facilities. However, the sample of our study was drawn from the representative sample of the German Ageing Survey [25], which includes a wider range of socioeconomic backgrounds than usual convenience samples.

Despite these limitations, however, we think that our study has a range of important implications. It was the first study to examine whether changes in medication beliefs can predict changes in medication adherence in a population of multimorbid older adults, a population at particular high risk for health deteriorations and mortality [1–3]. Our finding that changes in specific necessity beliefs predict changes in nonadherence suggests to put more emphasis on patient education in primary care of multimorbid older adults, since there seems to be a deficit in patient information [15], potentially due to miscommunication but also health care fragmentation and a lack of harmonized treatment recommendations for multimorbid elderly patients [43]. Such educational measures might put emphasis on providing patients with the information necessary to detect changes in medication effectiveness, since, in particular, this perception affected adherence in our study. The finding that changes in perceptions of general overuse predict forgetting to take medication further underlines the role of patient education—if doctors succeed in explaining the use and necessity of multiple medication, such beliefs might decrease and—according to our study results—exert beneficial effects on adherence.

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