

Adherence

Adherence to and beliefs in lipid-lowering medical treatments: A structural equation modeling approach including the necessity-concern framework

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ABSTRACT

Objective: This study attempts to identify a structure among patient-related factors that could predict treatment adherence in statin patients, especially with regards to the necessity-concern framework.

Methods: 414 Swedish patients using statins completed a questionnaire about their health, treatment, locus of control, perception of necessity-concern and adherence. The data were handled using a structural equation modeling approach.

Results: Patients that reported high perceptions of necessity to treatment seemed to adhere well, and side effects appear to affect adherence negatively. Disease burden, cardiovascular disease experience and high locus of control seem to have mediating effects on adherence.

Conclusion: This study provides support for the hypothesis that health- and treatment-related factors, as well as locus of control factors, are indirectly associated with treatment adherence via their association with mediating factor necessity.

Practice implications: This study highlights the importance of considering patients' beliefs about medications, disease burden, experience of cardiovascular events and locus of control as these factors are associated with adherence behavior to statin treatment. This study also emphasizes more generally the importance of an approach targeting necessity and concern when communicating with and treating patients with lipid-lowering medication.

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1. Introduction

Cardiovascular disease (CVD) is the leading cause of death in the industrialized world [1,2]. Dyslipidemia is an important risk factor for CVD, estimated to cause 18% of cerebrovascular disease and 56% of ischemic heart disease [3]. Cholesterol lowering has been the primary goal of therapies aimed at CVD risk reduction, and several randomized studies have demonstrated the benefits of statins (hydroxymethylglutaryl-CoA reductase inhibitors) in the reduction of cardiovascular-related events within high-risk patient groups [4]. Currently, statin drug treatment is one of the most important treatment strategies when managing patients with, or at high risk of, CVD.

Adherence is defined as the extent to which a person's behavior, such as taking medication, following a diet or executing lifestyle

changes, corresponds with the recommendations from a health care provider [5]. Poor adherence has been shown to be an important factor for treatment failure when looking at both high cholesterol levels [6] and morbidity [7–9], and, as a result, non-adherence to treatment is considered to be a cardiovascular risk factor [10]. Adherence to long-term pharmacological therapy for chronic illnesses in developed countries averages 50% [5], and for lipid-lowering pharmacological therapies the long-term adherence is poor and declining considerably over time.

In 2003, the World Health Organization (WHO) described adherence as a phenomenon determined by five dimensions: patient-related factors, social and economic factors, health care team and system-related factors, condition-related factors and therapy-related factors [5]. To describe adherence and for the analysis of non-adherence among patients with CVD, hypertension and other long-term therapies, a large number of hypotheses and factors have been proposed [11].

Several models that aim to explain health behavior are based on patients weighing positive and negative perceptions for a treatment or health advice, where the balance directs the behavior. The models that been used in adherence studies are the Health

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Belief Model [12,13], the Transtheoretical Model [14], the Protection Motivation Theory [15,16] and the Self-Regulatory Model (SRM) [17,18]. The SRM proposes that health-related behaviors are cognitive responses influenced by a patient's perception of treatment and emotional response to treatment. These responses can be derived from both manifest symptoms and concern about a health threat, or experience or concern about side effects from a treatment.

Influenced by the earlier models, the necessity-concern framework (NCF) was developed to specifically investigate drug treatment adherence [19]. According to the NCF, a patient's decision regarding adherence is the result of a trade-off between the patient's perceived need for a prescribed treatment (necessity) and their worries about the potential adverse effects as a result (concern). In this study, we chose to assess patients' beliefs using the NCF as it has been used in a broad range of different quantitative studies exploring drug treatment adherence [20–23], especially for cardiovascular diseases [24–27].

Some factors seem to be more related than others. Factors with a high probability of affecting adherence include gender [28], demographics [29,30], patient understanding and perception of medication [5], sickness- and treatment-related factors [31–34], and health locus of control [35]. The health locus of control model is defined by three different dimensions: an individual's sense of control over their health is directly related to their own beliefs and actions (internal); to chance externality (chance); or to the influence of other important persons (powerful others) [36]. There is support for the idea that a person's locus of control is associated with health behavior, mainly in combination with other predictive factors [37]. Qualitative studies suggest that individuals with a strong locus in powerful others might be more adherent to the recommendations of health care professionals [38].

To date, how these (and other) factors are related to adherence and non-adherence for patients with CVD has not been fully explored, and there is little information available regarding how strong the influence of these factors is on adherence in adjusted models. This study attempts to identify a structure among factors regarding demographic, health and treatment factors, locus of control, NCF and adherence in patients using statins. The aim is to present a model that describes the relationships between the central variables and a measurement structure that possibly predicts adherence within patient groups at high risk of CVD.

2. Methods

For this study, a cross-sectional study design was applied. A total of 600 postal questionnaires were distributed in May 2009 to the 28 operating pharmacies within the county of Uppsala in central Sweden. The number of questionnaires distributed to each pharmacy was proportional to the number of previous statin prescription sales. The employees of each pharmacy were instructed to invite every patient who visited the pharmacy for the preparation of their statin prescription. There were no inclusion criteria other than the statin prescription requisite, and no exclusion criteria. Patients agreeing to participate, after receiving oral and written information about the study by the pharmacist, were handed a questionnaire to take home and complete, and then return by post. The number of patients declining to participate was registered for control of non-participants. The first page of the questionnaire contained precise information on the purpose of the study. Completed questionnaires were returned anonymously in a prepaid envelope. All questionnaires returned within three months were included in the study. A total of 697 statin users were asked to participate: 109 declined to participate and 588 questionnaires were handed out (one pharmacy failed to distribute their questionnaires).

Questionnaires were returned by 414 individuals, making the response rate of the distributed questionnaires 70.4% (414/588) and the overall response rate 59.4% (414/697).

2.1. Measures in questionnaires

The questionnaire contained a total of 76 questions. The main data types and measures that were included were:

Demographic data: This was collected using questions that assessed the respondent's gender, age, occupation and educational level, including compulsory school, secondary school (or equivalent) and university.

Health-, disease- and treatment-related factors: Data were collected using a list of 14 common health problems (used as a cumulative measure of disease burden and number of health problems), cardiovascular disease experience (myocardial infarction and/or angina), perceived satisfaction with treatment explanations made by a physician, and time on statin treatment; these questions have been used earlier [39]. Experiences or worries of side effects and difficulties swallowing solid doses can affect adherence negatively [34], and data were assessed by the question: Do you experience any of this unpleasantness when taking your statins? (a) Yes, I feel that I have trouble swallowing tablets, (b) Yes, I feel that I encounter unpleasant side effects from them, (c) No, I do not feel any unpleasant reactions related to my treatment. The variable was scored as a count variable.

Health locus of control: These data were measured using the Multidimensional Health Locus of Control (MHLC) 18-item test [36]. MHLC is a measurement instrument that includes three six-point Likert scales: Internal (MHLC-I), Chance externality (MHLC-C) and Powerful others (MHLC-PO). The different scales, or levels, were analyzed separately. In this study, the MHLC scales were treated as index only in the correlation matrix.

Beliefs about medicines: Results were measured using NCF based on the Beliefs about Medicines Questionnaire-Specific (BMQ-S) [19]. BMQ-S is a validated 10-item test instrument which assesses beliefs about perceived medication necessity and perceived medication concerns on five-point Likert scales. BMQ is a two-scale construction and is also available to use as an index. In this study, the index was only used in the correlation matrix. The BMQ questionnaire has been translated into Swedish, with a back translation approved by the original author of the questionnaire, and has been previously used in Sweden [40–43].

Medication adherence: These data were self-reported using the Morisky scale of adherence (MSA) in a four-item form [44]. The MSA is a count variable and the first question is: "Do you ever forget to take your medicine?". The Morisky scale was originally designed to evaluate medication adherence in hypertensive patients, but has subsequently been found to be reliable in a variety of adherence studies [45,46]. In previous statin studies, the MSA used was binary, with only two categories [47]. Patients who answered "no" to all questions were categorized as highly adherent, while patients who answered "yes" to at least one question were categorized as having low adherence. This categorization system is consistent with what was used when developing the original scale, as well as how it has been used in several adherence studies [47,48].

2.2. Method of data analysis

The Statistical Package for the Social Sciences version 19 (Chicago, IL, USA) was used for descriptive statistics, factor analysis, to measure the variance inflation factor (VIF), and Chi-square and Mann-Whitney *U* tests. WarpPLS vs. 2.0 was used for structural equation modeling (SEM) analysis with the partial least squares (PLS) estimation technique [49]. SEM is a combination of

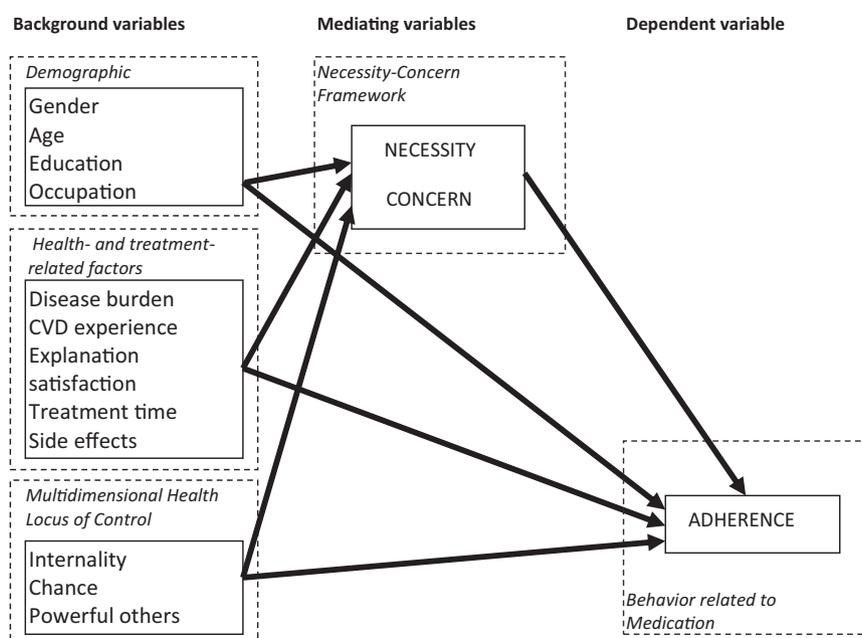


Fig. 1. Research framework.

This BATLoC model outlines the theoretical direct and indirect relationships between the background variables: demographics, health- and treatment-related factors, MHLc and the mediating variables in NCF and the dependent variable adherence.

confirmatory factors and path analysis, which allows the inclusion of latent variables (LV) that are not directly measured [50]. SEM works with both continuous and discrete observed variables as indicators (LVs). SEM is a second-generation statistical method that, in contrast to regression, allows for the simultaneous assessment of multiple independent and dependent constructs, including multi-step paths [51] and mediating effects [52]. LVs differ from the observed sum scores (index) of the indicators as they can account for measurement errors in the items, and items are allowed differential weights in estimating the latent construct [53]. In essence, LVs can be formative or reflective. The difference is

in the direction of theoretical causality between measures and constructs. Reflective measures are theoretically caused by the latent construct, whereas formative measures theoretically cause the latent construct [54].

SEM was conducted using the PLS estimation technique with Wold's algorithm [55–57]. PLS is a modeling approach with a flexible technique, which can handle data with missing values, strongly correlated variables and small samples. SEM-PLS is a well-suited method for exploratory research and theory development [58], which was the purpose of this study. SEM-PLS has also been used for adherence studies [59,60]. SEM works with two models:

Table 1

Characteristics of the study group ($n=414$).

		High adherent	Low adherent	Total	<i>P</i>
Sex	Male (%)	27.6	23.2	50.8	0.898 ^a
	Female (%)	27.0	22.2	49.2	
Age, mean (s.d.)		64.6 (10.0)	63.3 (9.1)	64.2 (9.5)	0.197 ^b
Education	Compulsory school (%)	21.9	18.0	39.9	0.636 ^a
	Secondary school (%)	16.7	12.3	29.1	
	University (%)	16.0	15.0	31.0	
Occupation	Full- or part-time work (%)	21.5	19.6	58.9	0.391 ^a
	Not in workforce (%)	33.4	25.5	41.1	
Disease burden	Low (%)	15.9	17.0	32.9	0.234 ^a
	Medium (2–4) (%)	27.3	19.7	47.1	
	High (%)	11.1	8.9	20.0	
Cardiovascular disease	No experience (%)	37.9	34.6	72.6	0.184 ^a
	Experience (%)	16.4	11.0	27.4	
Satisfaction with treatment explanation	None or poor (%)	4.2	4.4	8.6	0.506 ^a
	Fair (%)	9.8	9.6	19.4	
Treatment time	Good or very good (%)	40.5	31.4	72.0	0.850 ^a
	Less than 2 years (%)	20.4	17.9	38.3	
	Between 2 and 5 years (%)	14.7	12.5	27.3	
Side effects	More than 5 years (%)	19.4	15.0	34.4	0.021 ^a
	No (%)	50.4	37.7	88.0	
MHLc, indexform	Yes (%)	4.7	7.2	12.0	0.513 ^b
	Internal (MD)	23	23	23	
	Chance (MD)	17	16	17	
BMQ, indexform	Powerful others (MD)	20	19	19	0.050 ^b
	Necessity (MD)	17	15	17	
	Concerns (MD)	11	11	16	

^a Chi-squared test.

^b Mann–Whitney *U* test.

Table 2
Correlation analysis among indicators (observed variables).

	Min	Max	Std.dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1. Gender	1	2	.50																
2. Age	22	89	9.52	.06															
3. Education level	1	3	.84	-.09	-.27**														
4. Occupation	0	1	.49	0	-.73**	.25**													
5. Disease burden	1	3	.72	.05	.06	-.02	-.13*												
6. CVD experience	0	1	.45	-.16**	.18**	-.12*	-.11*	.18**											
7. Treatment explanation satisfaction	1	5	.97	-.06	-.04	.13**	.09	-.04	-.01										
8. Treatment time	1	3	.85	-.09	.24**	-.08	-.22**	.19**	.24**	-.01									
9. Sideeffects	0	1	.32	.02	-.06	.11*	.10*	0.02	-.02	-.02	.00								
10. MHLC Internal	6	36	5.37	-.17**	-.05	-.02	.03	-.13*	-.10*	.09	-.06	-.04							
11. MHLC Chance	6	33	4.59	.03	.12*	-.27**	-.15**	.12*	.01	-.06	.11*	-.02	.18**						
12. MHLC Powerful other	7	36	5.26	-.22**	.24**	-.11*	-.17**	.02	0.10	.14**	.11*	.02	.22**	.21**					
13. Necessity	5	25	3.82	-.01	.11*	-.13**	-.12*	.26**	.20**	.07	.25**	.00	.02	.10*	.27**				
14. Concern	5	23	4.30	0	-.09	-.04	.08	0.08	-.07	-.20**	.01	.18**	.02	.10*	.08	.23**			
15. Adherence	0	1	.50	.01	.06	-.02	-.04	0.05	.07	.07	.02	-.12*	-.03	-.01	.10	.22**	.08		

Max. min. standard deviations and correlations indicators. This matrix has been calculated with Spearman’s significant test. Indices were used for multidimensional health locus of control, perception of necessity and concern and adherence. All indicators in the model were coded so that (hypnotized) higher scores on the independent variable also indicate higher scores on the outcome variable, if there was a positive association.

* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.

(I) a measurement model (also called the “outer model”), which determines the relationships between observed manifesting variables and their association with latent variables; and (II) a structural model (also called the “inner model”), relating latent variables to other latent variables. PLS estimates loading and path parameters between latent variables and maximizes the variance explained for the dependent variables. The WarpPLS program can handle linear as well as S- and U-shaped relationships between variables. The paths in the model were tested for significance using the bootstrapping procedure, with 200 cases of resampling

incorporated in WarpPLS. Significant mediating effects were calculated using the Sobel test [61].

Model fit indicators are important in SEM since they offer comparable measurements. Model fit indicators apply to the degree of correspondence between the observed data and the model-implied data. The degree of correspondence is determined by a function of the sum of the squared deviations between the observed sample covariance matrix and the model-implied covariance matrix. In WarpPLS, the output model fit is assessed by three indices: average path coefficient (APC), average R-squared (ARS) and

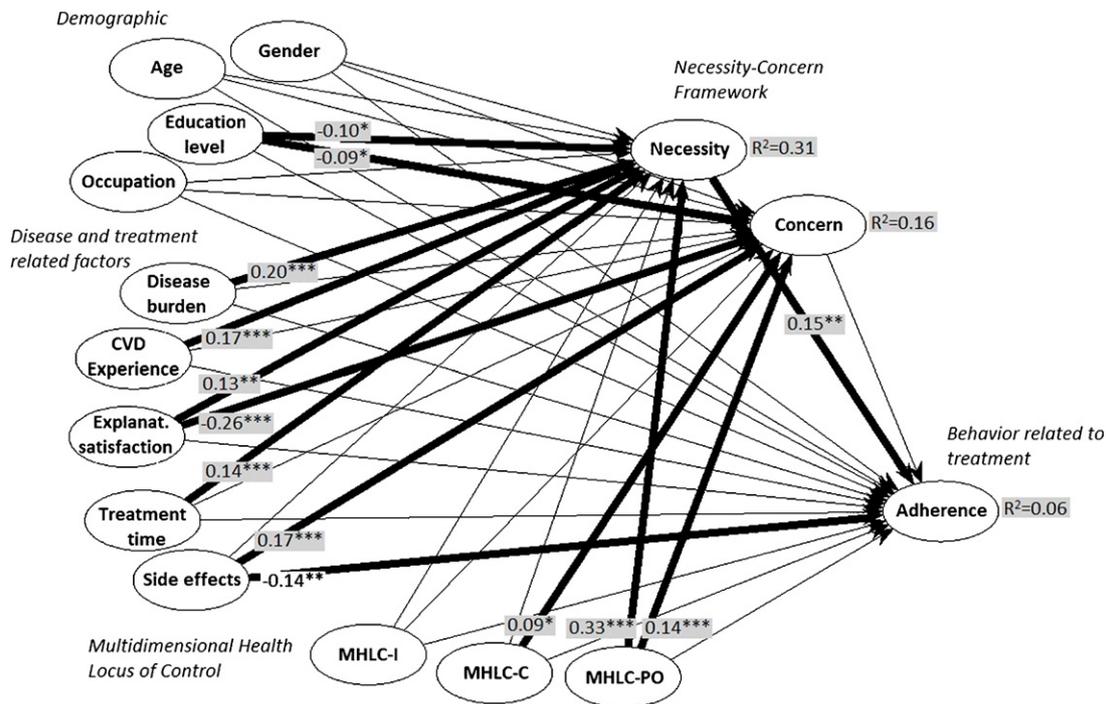


Fig. 2. SEM analysis of data outlined after the framework.

(*) Patch is significant at the 0.05 level.
(**) Patch is significant at the 0.01 level.
(***) Patch is significant at the 0.001 level.

SEM analysis generated through a partial least squares estimation technique, with path coefficients of the structural pathway model (i.e. inner model). The model outlines the hypothesized relationships among the latent variables in the BATLoC model. To test whether direct effects had an impact on adherence, the demographic factors, MHLC and health- and disease-related factors were tested directly against adherence in the model. Significant associations between latent variables are presented in bold.

average variance inflation factor (AVIF). The main reason why WarpPLS includes APC and ARS is to enable an acceptable comparison between different models, which is why these measures are of lower importance in studies like this, where each path is independently important. However, figures for APC and ARS should both be under 2 and should both be statistically significant ($p < 0.05$), while the value for AVIF is recommended to be below 5.

2.3. Research framework and model construction

A research model of balanced adherence influenced by treatment and locus of control factors (BATLoC) was constructed to examine the relationships between the variables (Fig. 1). The model contains one dependent (adherence), two mediating (perception of necessity and perception of concern), and twelve independent LVs. The twelve background LVs were divided into three groups: demographic variables (gender, age, education level and occupation); health- and treatment-related variables (disease burden, cardiovascular disease experience, treatment explanation satisfaction, treatment time and side effects); and health locus of control variables (on three levels: internal, chance and powerful others).

3. Results

The average age of the study population was 64.2 years (S.D. ± 9.5), and the group consisted of slightly more men (51.1%) than women (48.9%). Compulsory school was the most commonly completed education level (40.0%). Approximately 40.6% of the group were in full-time or part-time work, while the remaining 59.4% were unemployed or retired from the work market. The distribution of demographics and key variables in the study population is shown in Table 1.

3.1. Adherence and cardiovascular diseases

In the whole group, 54.5% of patients were classified to have high adherence, and 45.5% were classified to have low adherence to their statin treatment. About one-fifth of the group reported a high disease burden (suffering from five or more diseases) and half of the group had between two and four diseases. Overall, 72.8% of the patients did not report any CVD experience, and therefore received their treatment as primary prevention, 27.2% of the group reported at least one CVD experience, so received their treatment as secondary prevention. The majority of the group did not report any side effects, but 11.9% did experience some side effects.

Table 3
Path coefficients and *P*-values of direct effects on NCF and adherence.

Background variables	Mediating variables				Dependent variable	
	Necessity		Concern		Adherence	
	Path coefficients	<i>P</i> -Value	Path coefficients	<i>P</i> -Value	Path coefficients	<i>P</i> -Value
Gender	0.04	0.199	−0.06	0.124	0.02	0.310
Age	0.02	0.188	−0.06	0.356	0.04	0.269
Education level	−0.10	0.033	−0.09	0.017	0.02	0.358
Occupation	−0.03	0.486	0.01	0.303	0.01	0.407
Disease burden	0.20	<0.001	0.06	0.328	0.02	0.378
CVD experience	0.17	<0.001	−0.06	0.108	0.02	0.242
Explanation satisfaction	0.13	0.008	−0.26	<0.001	0.06	0.127
Treatment time	0.14	<0.001	−0.08	0.272	−0.05	0.225
Side effects	0.04	0.102	0.17	<0.001	−0.14	0.006
MHLC internal	−0.00	0.363	0.03	0.325	−0.05	0.179
MHLC chance	−0.02	0.416	0.09	0.025	−0.05	0.191
MHLC powerful other	0.33	<0.001	0.14	0.001	0.05	0.191
Necessity					0.15	0.010
Concern					0.08	0.067

3.2. Multidimensional health locus of control and beliefs about medicines

The Mann–Whitney *U* test in Table 1 showed no significant difference on internal or chance between patients with low and high adherence, only small differences were seen on the MHLC index scales.

3.3. Correlation matrix

Several of the associations outlined in the research framework (Fig. 1) were also significant in the correlation matrix (Table 2). The highest correlation to the adherence variables was seen with the perception of necessity of treatment. The indicator variables were tested for multicollinearity, and no variable had over 2.5 in VIF, which indicates that the risk for multicollinearity can be considered to be low. These imply acceptability of using a structural equation model.

3.4. Full model and PLS-SEM analysis

A PLS estimation procedure was used to examine the hypothesized relationships (Fig. 2) between constructs depicted in the theoretical framework (Fig. 1). The SEM analysis showed a significant relationship between adherence and necessity of treatment ($\beta = 0.15$, $p = 0.010$), but not with concern (Table 3). The explanatory variables were also tested directly against adherence, and it was found that side effects ($\beta = -0.14$, $p = 0.006$) had a significant effect on adherence.

The analysis showed that education level ($\beta = -0.10$, $p = 0.033$), disease burden ($\beta = 0.20$, $p < 0.001$), CVD experience ($\beta = 0.17$, $p < 0.001$), satisfaction with treatment explanations made by a physician ($\beta = 0.13$, $p = 0.008$), treatment time ($\beta = 0.14$, $p < 0.001$) and powerful others in locus of control ($\beta = 0.33$, $p < 0.001$) each had an effect on perception of the necessity of treatment. In addition, education level ($\beta = -0.09$, $p = 0.017$), satisfaction with treatment explanations made by a physician ($\beta = -0.26$, $p < 0.001$), side effects ($\beta = 0.17$, $p < 0.001$), MHLC-C ($\beta = 0.09$, $p = 0.025$) and MHLC-PO ($\beta = 0.14$, $p = 0.001$) all had an effect on concern. In total, these variables could explain almost 31% of the variance seen in perception of necessity ($R^2 = 0.31$) and 16% of the variance seen in perception of concern ($R^2 = 0.16$) and 6% of the variance seen in adherence ($R^2 = 0.06$).

Three background LVs had significant mediating effects on adherence (through necessity of treatment): disease burden ($\beta = 0.03$, $p = 0.034$), CVD experience ($\beta = 0.03$, $p = 0.034$) and powerful others ($\beta = 0.05$, $p = 0.019$).

3.5. Test of path model

The whole model demonstrated an acceptable fit to the data for $APC = 0.081$ ($p < 0.001$), $ARS = 0.176$ ($p < 0.001$) and $AVIF = 1.269$.

4. Discussion and conclusion

This study aimed to create and examine a model that could contribute to the understanding and predictability of adherence within patient groups at risk of CVD. A new model and structure was outlined that tested the associations of demographics, health and treatment, locus of control on NCF and adherence. Most factors included were already known to have an impact on adherence. A primary aim was to create a model that could handle the whole framework simultaneously.

4.1. Discussion

In this study of statin users, high belief in treatment necessity has a positive association with adherence, while concerns about treatment seem to have little association with adherent behavior. This indicates that patients seem to attach more importance to factors other than a negative association with drugs when it comes to actual treatment behaviors.

Among the background variables, disease burden, CVD experience, treatment time and powerful others in locus of control seem to have positive relationships with belief in treatment necessity. Three of the background variables also had a significant mediating effect on adherence through the perception of necessity: disease burden, CVD experience and locus of control through powerful others. This means that these factors have a positive impact on adherence behavior through mediating necessity of treatment. These findings are interesting in several ways, especially as factors that increase sickness severity seem to increase the perceived necessity of treatment, and therefore contribute to a higher adherence. This is logical, since a patient at higher risk of a disease also has more to gain from a risk-lowering treatment. However, in earlier studies this association did not become evident at a patient level [39].

Higher education and satisfaction with treatment explanations made by a physician were negatively associated with concerns that the patients held about their medications. Side effects and high belief in chance and powerful others seem to increase the concerns that the patients reported about their medical treatment. Side effects and fear of potential side effects are well known to be important factors for non-adherence [62].

A high satisfaction with the treatment explanation was associated with a higher perception of necessity of treatment and lower concerns about treatment. This is consistent with earlier studies which have shown that the communication of related issues between patients and physicians has an impact on adherence [30]. Physicians and health care personnel in general might also be viewed as powerful others by patients, which is also measured as a locus of control variable. Powerful others were positively associated with necessity of and concerns about treatment, with necessity showing the strongest association. These results are consistent with the study performed by Gillibrand and Flynn, who found an association between powerful others and the ability to cope with long-term treatments [38].

The results show that disease burden had a positive association with necessity of treatment, and a mediating effect on adherence. An explanation could be that a person with many diseases has more contact with health care providers, and is provided with more information and encouragement in order to manage their health care problems.

The factors in this model explained 6% of adherence in this study. That may seem low, but it is in the same range that other studies have shown for patients in this medical group [63]. NCF has a higher potential, and Horne and Weinman indicated that patient beliefs about medications contributed to about one-fifth of the total variance in the adherence behavior of patients with chronic physical illness [32]. However, this indicates that adherence is associated with other variables to a large extent. Another type of adherence measure could possibly have obtained a different result, but adherence is generally a complex behavior to measure [64].

Four of the factors had more than one significant path. Experiences of side effects appeared to both lower adherence and increase concern, and this outcome seems logical. Experience of side effects was also the only background variable that had a direct impact on adherence, which is a behavior that has been seen in other patient groups as well [65]. In addition, satisfaction with the explanation of treatments also had a logical relationship with the perception of necessity and concern, as it explained necessity and lowered concerns. Educational level is negatively associated with both necessity and concern to almost the same degree, which should exclude the effect of this variable in a clinical situation. Indeed it did not appear to have any direct effect on adherence. Belief in powerful others showed an inconsistent association with necessity and concern, as it increased both, but not to the same extent. An explanation for this could be that a person who has great impressions of their surroundings might get accurate information regarding both risks and benefits, which increases necessity and concern.

4.2. Limitations

This study was of a cross-sectional type, which restricts the possibility of causal conclusions. The data on adherence to medication and NCF were self-reported, and therefore some of the respondents may have underestimated or overestimated their rate of adherence.

The research model was explorative, and in future studies the model may be complemented by other factors of interest, e.g. health beliefs [66,67], self-efficacy [68–72] and socioeconomic status [73], or tested in other theoretical approaches to investigate factors of interest.

This was a sample with limited diversity based on self-selection. No data on non-respondents were collected. To limit the impact of possible selection bias the model was adjusted for demographic variables such as age and gender. As such, utility and effectiveness among diverse populations should be evaluated in future research. In addition, this patient group was selected whilst fetching their prescribed medications. Therefore, the results only apply to secondary adherence behavior and should not be generalized to patients that are not primary adherent, which includes those patients who did not even purchase their prescription drugs [74].

4.3. Conclusions

In conclusion, this study identified both the perception of necessity of treatment and side effects as directly significant factors associated with adherence among patients using lipid-lowering medical treatments. This study also provided preliminary support for the notion that health- and treatment-related factors, as well as locus of control factors, are indirectly associated with medical adherence through their associations with mediating perception of necessity of treatment.

Even though much of the adherence behavior is under the patients' control [64], this result shows that perception of the necessity of treatment is associated with several modifiable

factors, and that a high perception of the necessity of treatment is associated with higher adherence among statin users. This supports the idea that present health care professionals have not seized the potential of increasing adherence in this patient group to its full extent.

4.4. Practice implications

The study implies that it might be possible to increase adherence by managing some of the modifiable factors that are associated with CVD patients' beliefs about medications. Importantly, patients' satisfaction with treatment explanation seems to have a positive association with treatment necessity and at the same time a negative association with treatment concerns.

The study highlights the importance for health care professionals of considering beliefs about medications, disease burden, experience of cardiovascular events and locus of control factors that characterize the patient when it comes to increasing adherence. The results of this study imply that an approach targeting necessity and concern might be able to increase adherence to statin therapy.

Conflict of interest

None of the authors have a conflict of interest to declare.

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Ethical approval

Ethical approval was sought at the regional Ethical Committee of Clinical Investigation in Uppsala but was not deemed necessary since the study group responded anonymously, leaving no possibility of individual identification.

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