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Relationship between illness perception, treatment, adherence behaviors and asthma control: a mediation analysis

Relación entre percepción de enfermedad, tratamiento, adherencia y control del asma: un análisis de mediación

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ABSTRACT. Introduction: the negative illness perception and the treatment is linked to the lack of treatment adherence, as well as negative results in asthma control, two of the main problems in patients with asthma. **Objective:** the aim of the study was to evaluate the mediating role of treatment perception in the relationship between illness perception, treatment adherence, and asthma control. **Material and methods:** a non-experimental cross-sectional correlational study was carried out in which 267 adults with asthma participated (74.2% women, 26% men, X_{age} 45.60 ± 14.34 years). They answered the illness perception questionnaire-revised, the belief about medicines questionnaire, the medication adherence reporting scale-asthma, and the asthma control test. A mediation analysis was performed based on the commonsense model and evaluated through absolute, general, and comparative fit indices. **Results:** the model showed that the illness perception, treatment adherence, and asthma control are mediated by the treatment perception. The model explains 43% of the variance of asthma control, showing an acceptable fit (χ^2 = 34.615, p = 0.002, χ^2/gl = 2.47, RMSEA = 0.074 [90% CI = 0.043-0.106], CFI = 0.937 and TLI = 0.874). **Conclusion:** the model locates psychological predictors of adherence and asthma control, allowing to propose interventions in the clinical context to address the problems of adherence and asthma control.

Keywords: illness perception, treatment perception, treatment adherence, asthma control.

RESUMEN. Introducción: la percepción negativa de la enfermedad y el tratamiento se vincula con la falta de adherencia al tratamiento, así como con resultados negativos en el control del asma, dos de los principales problemas en pacientes con asma. **Objetivo:** evaluar el papel mediador de la percepción del tratamiento en la relación entre percepción de la enfermedad, adherencia al tratamiento y el control del asma. **Material y métodos:** se realizó un estudio no experimental transversal correlacional en el que participaron 267 adultos con asma (74.2% mujeres, 26% hombres, X_{edad} 45.60 ± 14.34 años). Respondieron el cuestionario revisado de percepción de enfermedad, el cuestionario de creencias sobre la medicación, la escala de reporte de adherencia a la medicación-asma y el test de control del asma. Se realizó un análisis de mediación basado en el modelo de sentido común y evaluado mediante índices de ajuste absoluto, general y comparativo. **Resultados:** el modelo mostró que la percepción de la enfermedad, la adherencia al tratamiento y el control del asma están mediados por la percepción del tratamiento. El modelo explica 43% de la varianza del control del asma, mostrando un ajuste aceptable (χ^2 = 34.615, p = 0.002, χ^2/gl = 2.47, RMSEA (error cuadrático medio de aproximación) = 0.074 [IC a 90% = 0.043-0.106], CFI (índice de ajuste comparativo) = 0.937 y TLI (índice de Tucker-Lewis) = 0.874). **Conclusión:** el modelo ubica factores psicológicos predictores de adherencia y control del asma, permitiendo proponer intervenciones en el contexto clínico para abordar los problemas de adherencia y control de la enfermedad.

Palabras clave: percepción de la enfermedad, percepción del tratamiento, adherencia al tratamiento, control del asma.

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Abbreviations:

ACT = asthma control test.
CFA = confirmatory factor analysis.
BC = bootstrapping and bias-corrected model.
BMQ = beliefs about medicines questionnaire-specific.
CFI = comparative fit index.
CSM = common sense model and self-regulation of illness.
NCD = necessity–concerns differential.
COPD = chronic obstructive pulmonary disease.
IPQ-R = illness perception questionnaire-revised.
KSL = Kolmogorov Smirnov-Lilliefors statistic.
MARS-A = medication adherence reporting scale-asthma.
NCF = necessity-concerns framework.
RMSEA = root mean square error of approximation.
SEM = structural equation modeling.
TLI = Tucker-Lewis index.

INTRODUCTION

Negative illness perception and treatment is linked to lack of adherence to treatment, as well as to negative outcomes in asthma control,[1] two of the main problems in patients with asthma, since it is estimated that more than 50% are not controlled and more than 75% are non-adherent.[2,3] Negative illness perception and treatment are considered intentional causes of non-adherence, since based on them, people do not use their treatment or use it inconsistently over time, limiting the achievement of optimal results in disease control.[4] This process has been studied from the common sense model and disease self-regulation (CSM)[5] and the necessity-concerns framework (NCF).[6] These models explain the lack of control as a result of non-adherence behaviors, which would derive from negative perceptions about the disease and the treatment.

The CSM and NCF are process models that are organized in three stages: 1) the perceptual stage, whose sub-dimensions are illness perception and treatment perception; 2) response stage, which are specific behaviors derived from how the disease and treatment are perceived; and 3) outcome evaluation stage, in which adequate or inadequate disease control is observed.[5,6]

Although non-adherence and poor control are common problems in patients with asthma, the evidence should focus on determining the factors that explain them.[2,3] In this regard, research results have shown that necessity of treatment (from the NCF model) better predicts adherence behaviors (OR = 1.742, 95% CI [1.569, 1.934], $p < 0.001$)[7-9] than beliefs about the disease (from the CSM model, r = 0.04-0.13),[10,11] so that the latter has been questioned as a predictor of adherence to treatment;[12] but not of disease control and clinical outcomes (r = 0.13-0.56).[13-15] Based on both models, research studies have focused in particular on explaining adherence and non-adherence behaviors.[9-11,16-18]

Recently, predictive data on asthma adherence and control have been published, considering either the CSM model or the NCF model.[1,19] However, some authors have considered that including variables from both models could have better predictive results,[4,10,20-22] in fact, studies have been proposed in which the treatment perception would function more as a mediating variable between illness perception and adherence behaviors.[22]

Objective. To evaluate the mediating role of the positive effects of treatment perception on the relationship between illness perception, treatment adherence behaviors, and disease control in Mexican patients with asthma.

MATERIAL AND METHODS

Design. A non-experimental, cross-sectional, descriptive and correlational study was carried out with the participation of adults with asthma from the Instituto Nacional de Enfermedades Respiratorias Ismael Cosío Villegas (INER) in Mexico City.

Participants. Non-probabilistic convenience sampling was used. A total of 267 adults with asthma participated, of whom 198 (74.2%) were women and 69 (26%) men, with an average age of 45.6 ± 14.3 years. Participants would have to have a confirmed diagnosis of asthma, indication for controller treatment and no concomitant diagnosis of chronic obstructive pulmonary disease (COPD).

Instruments:

1. Sociodemographic and clinical data questionnaire: set of questions to gather information on personal, family, educational, occupational data and variables related to the disease (time of disease evolution).
2. Illness perception questionnaire-revised (IPQ-R): 14 items were used to assess the positive illness perception (timeline chronic, personal control, coherence and treatment control) of the Mexican version for patients with asthma.[23] The response form of the instrument is defined on a four-point Likert scale (one = strongly disagree, four = strongly agree).
3. Beliefs about medicines questionnaire-specific (BMQ): 10 items were used to evaluate the treatment perception (necessity and concern) of the Mexican version for patients with asthma.[24] The response form of the instrument is defined on a four-point Likert scale (one = strongly disagree, four = strongly agree). According to Horne,[6] a differential necessity-concern score (DNP) is obtained by subtracting the concern score from the need score.
4. Medication Adherence Report Scale-Asthma (MARS-A): five items were used to evaluate the frequency of intentional non-adherence behaviors to the control medication of the Mexican version for patients with asthma.[25] The responses of the instrument are defined

on a four-point Likert-type scale (one = I always do so, to four = I never do so). For the interpretation of results, higher scores on the scale imply a better level of adherence to the control treatment. In categorical terms, a score between five and 19 would correspond to non-adherent patients and a score of 20 to adherent patients.

5. Asthma control test (ACT):[26] an instrument to evaluate asthma control, consisting of five items. The responses are defined on a five-point Likert-type scale. The instrument score ranges from five to 25 points. A score of five to 19 indicates no control and asthma control is between 20-25 points.[3]

Procedure. Once the project was approved by the Research Ethics Committee of INER, with code C47-18, patients were recruited in the waiting room of the Asthma Clinic. The instruments were answered individually, each participant was informed of the objectives of the research and was given instructions for answering the instruments, emphasizing their voluntary, anonymous and confidential participation, after signing the informed consent form.

Data analysis. The data were analyzed with SPSS version 24 and AMOS 25 for Windows. Descriptive statistics were used to summarize the characteristics of the participants and the study variables and the normality distribution of the data was evaluated with the Kolmogorov Smirnov-Lilliefors (KSL) statistic.

To demonstrate the reliability and validity of the instruments used, the measurement models of each scale were estimated through confirmatory factor analysis (CFA), taking as criteria the standardized regression weighting (factor loadings) and the following fit indices: the chi-square statistic (χ^2, $p > 0.05$), the resulting χ^2/gl ratio (< 3), the root mean square error of approximation (RMSEA < 0.08, 90% CI), the comparative fit index (CFI > 0.90) and the Tucker-Lewis index (TLI > 0.90). The internal reliability of the scales was examined using Cronbach's alpha coefficient (∝).

Subsequently, a preliminary Spearman's rho correlation analysis was performed for the apropos of deriving hypotheses based on the CSM and the subsequent construction of a pathway model (SEM). In this model, we attempted to corroborate that treatment perception mediate the effects between illness perception, adherence behaviors and asthma control.

This SEM model was tested using the maximum likelihood procedure with the Bootstrapping model and 95% corrected Bias (BC) with 1,000 samples, considering the fit indices χ^2, $p > 0.05$, χ^2/gl (< 3), RMSEA < 0.08, CI 90%, CFI > 0.90 and TLI > 0.90 and the direct, indirect and total effects.[27]

RESULTS

Descriptive. Most of the study participants lived in Mexico City (n = 187, 70%) and the State of Mexico (n = 61, 21.8%).

Table 1: Sociodemographic, clinical, and psychological data of the participants.

Variable	n (%), Mdn (IQR) or rank
Gender	
Women	198 (74.2)
Men	69 (25.8)
Age [years]	45 (23)
Residence	
México City	187 (70)
State of Mexico	61 (22.8)
Other*	19 (7.2)
Education	
Basic	108 (40.5)
High School	90 (33.7)
Professional	69 (25.8)
Occupation	
Professional/Labor	142 (53.2)
Home	84 (31.5)
No labor activity	41 (15.3)
Marital status	
Living with a partner	145 (54.4)
Single	70 (27.7)
Other	48 (17.9)
Evolution [months]	108 (192)
Illness perception questionnaire-revised	
Timeline chronic	15 (4), 5-20
Personal control	12 (2), 4-16
Coherence	8 (2), 3-12
Treatment control	9 (2),3-12
Beliefs about medicines questionnaire-specific	
Necessity	15 (5), 5-20
Concern	12 (5) 5-20
Necessity-concern differential	3 (6) -10–15
Medication adherence report scale-asthma	
Adherence	19 (5) 5-20
Adherent > 19	106 (39.7)
Non-adherent	161 (60.3)
Asthma control test	
Asthma control	20 (7) 5-25
Control ≥ 20	138 (51.6)
No control ≤ 19	129 (48.4)

The sample was not normally distributed on the variables of illness perception, treatment perception, adherence behaviors, and asthma control (KSL = 0.085-2.13, $p < 0.001$).
Mdn = median. IQR= Interquartile range.
* Oaxaca, Hidalgo, Morelos, Tlaxcala, Guanajuato, Querétaro, Guerrero and Veracruz.

Table 2: Global adjustment indicators of the measurement models.

Models	χ^2	gl	χ^2/gl	p	CFI	TLI	RMSEA	RMSEA CI 90% Low-high
IPQ-R (∝ = 0.73-0.87)	518.795	317	1.6	0.000	0.929	0.921	0.046	0.038-0.052
BMQ (∝ = 0.76-0.80)	143.791	87	1.6	0.001	0.967	0.961	0.050	0.044-0.076
MARS-A (∝ = 0.81)	7.790	4	1.9	0.100	0.986	0.965	0.073	0.000-0.149
ACT (∝ = 0.85)	6.972	5	1.3	0.223	0.996	0.993	0.039	0.000-0.100

CFI = comparative fit index. TLI = Tucker-Lewis index. RMSEA = root mean square error of approximation. IPQ-R = Illness perception questionnaire-revised. BMQ = beliefs about medicines questionnaire-specific. MARS-A = medication adherence report scale-asthma. ACT = asthma control test.

Table 3: Correlation analysis between IPQ-R, BMQ, MARS-A and ACT variables.

Instruments/variables		1	2	3	4	5	6	7	8
IPQ-R	1. Timeline chronic	—	—	—	—	—	—	—	—
	2. Personal Control	0.070	—	—	—	—	—	—	—
	3. Treatment Control	-0.026	0.383**	—	—	—	—	—	—
	4. Coherence	0.148*	0.240**	0.075	—	—	—	—	—
BMQ	5. Necessity	0.169**	0.114	0.191**	-0.010	—	—	—	—
	6. Concern	-0.012	-0.127*	-0.068	-0.429**	0.226**	—	—	—
	7. DNP	0.142*	0.177**	0.214**	0.344**	0.540**	-0.634**	—	—
MARS-A	8. Adherence	0.156*	0.048	-0.017	0.232**	0.193**	-0.242**	0.351**	—
ACT	9. Asthma Control	0.047	0.345**	0.149*	0.204**	-0.127*	-0.286**	0.125*	0.215**

IPQ-R = illness perception questionnaire-revised. BMQ = beliefs about medicines questionnaire-specific. MARS-A = medication adherence report scale-asthma. ACT = asthma control test. DNP = necessity-worry differential.
* $p \leq 0.05$. ** $p \leq 0.01$.

It was identified that in the illness perception (IPQ-R) high scores were obtained in temporality (chronic), treatment control, personal control and coherence.

Regarding the treatment perception (BMQ), patients reported a high need for treatment and a moderate concern for adverse effects due to the use of the control medication; this is evidenced by the positive score on the NPD. In the self-report of adherence behaviors to control treatment (MARS-A), high scores were obtained in this variable, that is, they self-reported high levels of adherence, and in asthma control (ACT) it was identified that more than 51% were controlled, but only 10.9% (n = 29) qualified for total control of the disease. *Table 1* describes in detail the variables studied in the participants.

Measurement models. *Table 2* shows the reliability analyses and goodness-of-fit indices of the measurement models for each of the instruments used. The results show that each instrument has reliability indices ranging from acceptable to very good (∝ 0.73 to 0.85), while the data for the CFI and TLI indicators show an excellent fit based on the criteria considered (CFI > 0.90; TLI > 0.90). Only in the RMSEA result, the MARS-A scale and the ACT exceed the criterion of 0.08 for the range in the confidence interval. These findings show that the instruments used have acceptable evidence of reliability and validity.

Correlation analysis. *Table 3* shows the correlations between each of the variables evaluated for the subsequent construction of the SEM model. Although the correlation data range from weak to moderate, the most relevant would be the relationships between: 1) personal control, coherence (IPQ-R) and asthma control; 2) coherence, temporality (IPQ-R) and need for treatment (DNP); 3) need for treatment (DNP) and adherence behaviors; and 4) the weak correlations between personal control and treatment control (IPQ-R) and adherence behaviors.

Mediation model. *Figure 1* shows the simplified mediation model in which it is observed that illness perception (personal control and treatment control) has significant effects in explaining asthma control ($\beta = 0.55$, $p < 0.05$), but not in explaining adherence behaviors

(β = 0.00, p > 0.05), in the same sense, timeline chronic and coherence about the disease do not contribute in disease control (β = 0.00, p > 0.05) nor in adherence behaviors (β = 0.13, p > 0.05), at least directly.

Similar results are observed when analyzing the effects of treatment perception on asthma control (β = 0.01, p > 0.05).

Now, by including treatment perception as a mediating variable, considerable effects can be observed between illness and treatment perception (β = 0.48, p < 0.05), adherence behaviors (β = 0.25, p < 0.05) and asthma control (β = 0.28, p < 0.05).

When analyzing the statistically significant paths in the model in *Figure 1*, it can be seen that the relationship between illness perception and adherence behaviors is mediated by treatment perception (β = 121, CI = 0.006, 0.341). In contrast, illness perception generates significant effects on asthma control (β = 0.55, p < 0.05), independently of the mediating effect of treatment perception *(Table 4)*.

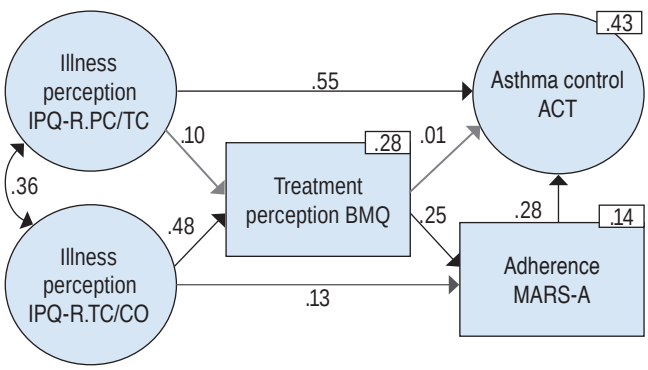

Figure 1: Simplified mediation model. Standardized path coefficients between model variables to explain asthma control are shown. Black lines represent statistically significant effects (p < 0.05) and gray lines represent non-statistically significant effects (p > 0.05). IPQ-R.PC/TC: two of the illness perception variables were grouped: personal control and treatment control. IPQ-R.TC/CO: two of the illness perception variables were grouped together: timeline chronic and coherence. BMQ: was calculated with the difference between the score obtained between necessity and concern, a variable previously defined as NCD.

The findings of the model translate into the fact that the illness perception explains 28% of the variance of the treatment perception (R2 = 0.28), together, these variables only explain 14% of the variance of adherence behaviors (R2 = 0.14) and the model, as a whole, manages to explain 43% of the variance of asthma control (R2 = 0.43). Finally, regarding the statistical fit of the model, it is identified as having acceptable indicators (χ^2 = 34.615, p = 0.002, gl = 14, χ^2/gl = 2.4, CFI = 0.937, TLI = 0.874 and RMSEA = 0.074 [CI at 90% = 0.043-0.106]).

DISCUSSION

Given that a significant proportion of patients with asthma are not adherent to their treatment (75%) and that more than 50% have difficulties in controlling their disease,[2,3] it is necessary to identify the variables that cause these problems to persist, as well as to determine the variables that need to be modified in order to address them. It is in this sense that the findings of the present study become relevant by showing an explanatory route to address the problems of adherence to treatment and asthma control, considering the effects of psychological variables such as beliefs about the disease and the treatment.

The initial results show a profile of patients with a positive illness perception (perception of asthma as a chronic disease, perceived ability to control the disease, positive attitude regarding the effects of treatment and a clear understanding of asthma) and of the treatment (greater perception of the need for treatment and less concern about its adverse effects). Similar evidence has been found from different parts of the world, including Mexico, mainly when relating these variables to the level of adherence[4,8,9,28] and asthma control.[29,30]

In relation to adherence behaviors, patients showed high scores on this variable, i.e., infrequent self-reporting of behaviors such as not using treatment, changing the number of puffs, or voluntary adjustments in the timing of treatment. However, more than 60% of the participants were categorized as non-adherent. These results are

Table 4: Total, indirect and direct effects of the multiple mediation model.

	Results				
	BMQ	MARS-A $_{(De-Te)}$	ACT $_{(De-Te)}$	MARS-A $_{(Ie\ x\ BMQ)}$	ACT $_{(Ie\ x\ BMQ)}$
Predictors	β	β	β	β (CI 95%)	β (CI 95%)
IPQ-R. PC/TC	0.101	0.000, 0.025	0.553, 0.561	0.025 (-0.165, 0.123)	0.008 (-0.021, 0.065)
IPQ-R. TC/CO	0.483	0.171, 0.292	0.000, 0.084	0.121 (0.006, 0.341)	0.084 (-0.011, 0.319)

BMQ = beliefs about medicines questionnaire-specific. MARS-A = medication adherence report scale-asthma. ACT = asthma control test. IPQ-R = illness perception questionnaire-revised. De = direct effects. Te = total effects. Ie = indirect effects. CI = confidence interval. IPQ-R. PC/TC = personal control and treatment control. IPQ-R. TC/CO = timeline chronic and coherence.

consistent with findings in African-American, Caucasian and Spanish-speaking asthma populations in the United States and patients in Mexico.[25,31-33] In that case, it should not be overlooked that sometimes socially valued behaviors such as adherence are often overestimated.[34,35]

However, it would seem contradictory to have a positive illness perception and the treatment, to report a high level of adherence and that nearly 50% of the patients did not have adequate control of the disease. In this aspect, it would be necessary to consider that the lack of asthma control is also linked to factors such as comorbidities (allergies, other respiratory diseases, obesity), exposure to triggers (pollution, smoke from various substances) and negative psychosocial aspects (depression, anxiety, economic difficulties and a negative illness perception).[2,3,30]

As mentioned above, the proposed model suggests sequential work to modify/improve illness perception, treatment perception, adherence behaviors and asthma control. Although the percentage of variance explained in adherence is low (14%), it is important to highlight that overall the model explains 43% of the variance in asthma control.

This is because addressing adherence and control problems would have a positive impact on the frequency of emergency care and hospitalization for asthma attacks, economic repercussions, emotional problems, poor quality of life and death.[2,3,36]

In contrast to the proposed model, other studies such as that of Horne and Weinman[22] developed a model to explain adherence behaviors (R2 = 0.26), but including the observed variables of timeline chronic, consequences (CSM), and necessity and concern (NCF). In turn, Chapman *et al.*[19] developed a model where only the NCF variables were considered, which showed very weak and negative effects of positive treatment perception on adherence (r = -0.08) and better for explaining asthma control (r = 0.25). Finally, Kosse *et al.*[1] proposed a correlational model shown as path analysis, where the relationships between illness perception (coherence, temporality and treatment control) and treatment (DNP), adherence behaviors and asthma control range from r = 0.13 to 0.38.

CONCLUSIONS

The proposed model suggests that multidisciplinary interventions can be developed that focus on favoring an adequate understanding of the disease and treatment, a perception of asthma as a chronic disease, increasing the perceived ability to manage the disease and the need to use the treatment, as well as minimizing the concern for the adverse effects of the control treatment. All of this is aimed at using treatment consistently over time, using it at an adequate frequency and dose, and avoiding conditional use of treatment (only when symptoms are present), in order to improve disease control.[2,3,37,38]

One of the limitations of the study is the low explanatory level of the model for adherence behaviors (R2 = 0.14), since a better performance was expected. However, this opens up new proposals for exploring other variables related to adherence, such as the experience of adverse effects, satisfaction with the medication or economic problems,[39] as well as including the perception of the need for treatment in asymptomatic periods.[40]

In relation to asthma control, the use of self-report methods is a limitation; for future studies it would be advisable to include exacerbations, pulmonary function and risk variables for poor asthma control in this evaluation.[3] Finally, another limitation could be oriented towards the characterization of the sample, where more than 74% of the participants were women. Although no process was carried out to have a proportionate sample, this type of variation is expected because the prevalence of asthma is higher in women than in men during adolescence and adulthood, contrary to what occurs in childhood.[2,3]

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