Verification of a theory of planned behavior model of medication adherence in Korean adults: Focused on moderating effects of optimistic or present bias

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Research article

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Abstract

Background: In order to prevent or recover from a disease, prescription must be correct, but it is also important for patients to adhere it. Therefore, this study verified a theory of planned behavior (TPB) model to predict the medication adherence of Korean adults and examined the role of optimistic bias or present bias in that model.

Methods: The participants were 357 Korean male and female adults whose ages ranged from 18 to 76 (M=41.53, SD=9.89). Their medication adherence was measured with the Morisky Medication Adherence Scale, the TPB factors using modified items related to medication adherence, and optimistic bias using items developed, based on the concept and previous studies.

Results: An alternative TPB model, including a direct path from attitude to behavior and a direct path from the perceived behavioral control to behavior an insignificant path from behavioral intention to behavior, was validated for Korean adults' medication adherence. This model was found to be moderated by optimistic bias or present bias.

Conclusion: The findings of this study should provide useful information for future research and for medical or health professionals who wish to improve the medication adherence of their patients.

Background

Koreans' interest in health has been heightened in the 21st century as their living standards have improved and their life expectancy increased significantly [1]. Because of their high interest in health, most people may intend to practice health behaviors to improve, maintain, or recover their health, but in fact it is reported that they do not. Even if they have a prescription from a medical care provider or health professional, they often do not actually adhere to it or practice it in action. DiMatteo [2] concluded in a meta-analysis of more than 500 studies that the proportion of people who do not adhere to prescription drugs for life-threatening serious diseases is around 25%. In addition, medication adherence rates reported in studies may be inflated [3].

In a report by the Korea Institute for Health and Social Affairs (KIHASA) [4], which studied Koreans' adherence to the treatment of chronic diseases related to life habits, the adherence ratio, i.e., the proportion of faithfully taking the medication for a year, of antihypertensive drugs was 72%, anti-diabetic medications was 73 %, and oral bisphosphonate, medication for osteoporosis was 63%, based on the self-report Morisky Medication Adherence Scale (MMAS) [5]. However, the rate at which those who participated in the study were prescribed and purchased the drug was significantly lower. For example, based on National Health Insurance data, the Medication Possession Ratio (MPR) was calculated to show that the actual period of purchase and possession of oral bisphosphonate for one year was not more than 40 percent of a year, and the ratio of people who had possessed medication for more than six months was only about 15 percent. In fact, if that is how long prescription drugs are carried, the percentage of people actually taking medication is lower than that, and if this figure reflects how long they actually have the medication, the actual medication adherence ratio is still lower. Because they have drugs or keep them at home, they cannot be considered to take them all. Park and colleagues [4] also conducted a Focus Group Interview (FGI), and confirmed that the actual rate may be much lower than the rate of self-reported medication adherence.

For recovery from disease or prevention of disease, prescriptions need to be correct. However, even though the prescription is right, treatment or prevention cannot succeed if the patient does not adhere to it [3]. No matter how good a medication is that prescribed for the treatment of a particular disease, it cannot be effective unless the patient complies with the drug use. Adherence or compliance is therefore essential to disease treatment or health promotion. Thus, in this study, I sought to verify models that can predict prescription adherence in terms of health psychology, and explore psychological variables that moderate the model.

Until now, many researchers have tried to explain health-risk behaviors or non-adherence with health behaviors through the health belief model [6], the theory of reasoned action [7], self-efficacy [8], the theory of planned behavior [9], the precaution adoption process model [10], and the transtheoretical model [11]. In this study, I basically use theory of the planned behavior (TPB) as a theoretical model to predict medication adherence. TPB has been applied to explain various health behaviors or health-risk behaviors, including underage drinking behavior [12], the health promoting behaviors of chronic pain patients [13], condom use [14], risk behaviors that can cause coronary heart disease [15], smoking behavior [16], physical activity [17], cancer screening [18], and healthy eating habits [19].

TPB [9], which includes attitudes toward health behavior, subjective norms, perceived behavioral control, and behavioral intention. This adds perceived behavioral control to the theory of reasoned action [7], which was developed because attitudes are limited in predicting behavior, in theory, behavioral intention accounts for most of the variance of behavior, and attitudes and subjective norms can affect behavior. Behavioral intention can be seen viewed as being prepared to carry out a certain behavior, and may be the closest antecedent. As the most determinant variable of behavior, it could be the channel through which attitude, subjective norms, and perceived behavioral control influence a given behavior [20].

TPB is also related to social cognitive theory [21], because perceived behavioral control is almost the same concept as self-efficacy in social cognitive theory. Many studies [22] have shown that perceived behavioral control most accounts for the variance of behavior in the TPB model, and Ajzen [9] also considered models with a direct path from perceived behavioral control to behavior (p. 182). Therefore, this study compares the goodness-of-fit of alternative models with direct routes with a model without a direct path between attitude or perceived behavioral control and medication adherence behavior.

In this study, optimist bias was adopted as a variable that might affect adherence. Optimistic bias refers to one's vague positive expectation that he or she is less likely to be at risk than others [23]. Weinstein [10] assumed that optimistic bias plays a role in adopting disease-preventing behavior and included it as a psychological variable in the precaution adoption process model for health behavior. Although it has not been studied much in Korea, some studies [24, 25] found that optimistic bias has something to do with practicing health behaviors.

Optimistic bias may be an internal and personal factor that also could be applied to other areas as well as health behaviors, one which O'Sullivan [26] believed to be a prevalent personal characteristic regardless of gender, age, and race. Furthermore, some researchers argue that animals such as rats and birds also have an optimistic bias [27]. In addition, optimistic bias was shown in both positive and negative situations, but the intensity was found to be stronger in negative situations [28]. This cognitive bias can cause great damage to individuals if it operates in a dangerous situation that could result in major injuries or fatal diseases. Some empirical studies found that an optimistic bias was highly likely to lead to actions exposing the individual to the risk of crime damage [29], the risk of failure of stock investment [30], and the risk of bungee jumping injury [31]. Most of all, since previous studies [24, 25, 32] have shown that such an optimistic bias is a meaningful factor in disease-preventing behavior, this study assumes that it could be a moderator in the TPB model for predicting medication adherence.

In addition, present bias was also adopted as a variable that could affect the model predicting medication adherence. Present bias, also called delay discounting or time preference, is a variable studied with delay gratification. Delay counting which is an economic term, refers to the relative value when a product is received after a time, versus when it was readily available [33]. In other words, if the expected benefits or outcomes are not quickly achieved or are delayed in time, the value will be discounted. This delay discounting is due to a bias that places greater importance on the present and undervalues future outcomes.

Such delay discounting is also found in practicing health risk behavior and health behavior. For example, Fields, Ramos, and Reynolds [34] found that delay discount was likely to lead to underestimating the consequences of a health risk behavior, leading to the action being carried out. A smoking study [35] found that present bias or delay discounting could moderate the relationship between impulsivity and smoking behaviors, and it was also found that if the effects of exercise appear after a long period of time, no matter how good the effect is, the incentives of its effect could be reduced [36]. Some researchers [37] point out that this present bias or delay discounting may vary depending on culture, but it was posited to be a universal personal tendency in this study, and it was assumed that present bias is also related to medication adherence and affects the TPB model to predict medication adherence.

This study designed and examined a TPB model to predict Koreans' medication adherence and analyzed whether the model was moderated by optimistic bias or present bias. First, this study verified a proposed model that does not include a direct path between attitude or perceived behavioral control and medication adherence behavior, and compared it with alternative models that include direct paths. Alternative model I includes only the direct path between perceived behavioral control and medication adherence behavior, while interpersonal model II adds the direct path between attitude and medication adherence to the model (Figure 1). Next, it was investigated whether optimistic bias or present bias moderated the model adopted in this study. This analysis is expected to provide useful information to promote Koreans' medication adherence.

Methods

Participants

The participants in the study were 357 Korean male and female adults aged 18 or older selected by convenience sampling. Their ages ranged from 18 to 76, and their average age was 41.94 (SD=9.89). Their data were collected mainly through the Internet, though some were collected directly through research assistants. As no effort was made to match the gender ratio in the process of gathering data through the Internet, the proportion of women was 67.2 percent. This difference in gender ratio is not likely to affect the study because gender differences only appeared for present bias (p<.01), and no gender differences were found in other variables.

The educational background of the participants was 218 college graduates (61.1%), 95 high school graduates (26.6%), 41 graduate graduates (11.5%), 2 middle school graduates (0.6%), and 1 (0.3%) who did not report their academic background. Most respondents (90.2%) reported their family economic status as moderate, while 35 respondents (9.8%) reported it to be low.

Moreover, 68 (19.0%) of the participants reported themselves to be smokers, and 121 (33.9%) reported that they did not drink at all, while 56 (15.7%) reported that their average alcohol consumption was one or two standard drinks, 69 (19.3%) four drinks, and 111 (31.1%) more than seven drinks.

Instruments

Factors of TPB. To measure the factors of the TPB model associated with the participants' medication adherence, questions based on Ajzen's theory [38] and studies conducted in Korea [39] were modified to suit the subject matter of this study. Items of attitude concern about whether the participants think positively or negatively about medication adherence, while items of subjective norms concern how they perceive the social norms of medication adherence, and items of perceived behavioral control concern how much control they exert over their behavior in taking medicine. In addition, items of behavior intention concern the intention to take the medication. Each factor was measured with four items, and each item was scored on a seven-point Likert scale ranging from 1 (*not at all*) to 7 (*always*). The internal consistencies (Cronbach's α) of factors of the TPB model were .85 for attitude, .84 for subjective norms, .89 for perceived behavioral control, and .95 for behavior intention in this study.

Medication adherence. The participants' behavior of medication adherence was measured using the Morisky Medication Adherence Scale (MMAS) [5]. This scale was developed to measure how well hypertension patients complied with the prescribed antihypertensive drug. In this study, participants were asked about compliance or adherence with all prescription drugs in addition to antihypertensive medication. This scale consists of four items, using a dichotomous question to assess medication compliance, but a seven-point rating scale was used in this study. The internal consistency (Cronbach's α) was .62 in this study, which was somewhat low, because the number of questions was relatively small and there are different cases in which each item fails to take the medication it asks.

Optimistic bias. The participants' optimistic bias against the results of medication noncompliance and unhealthy behavior was measured by modified items of a questionnaire developed by Suh and colleagues [24], based on Weinstein's two questions for measuring optimistic bias [40]. The items were modified to suit the subject matter of this study, "Other people may suffer serious consequences if they don't take prescribed drugs, but there won't be a big problem if I do so," and "Even if other people have health problems because they don't practice their health behaviors, I won't have such problems." This questionnaire consists of six items, and each item was scored on a seven-point Likert scale ranging from 1 (*not at all*) to 7 (*always*). The internal consistency (Cronbach's α) was .88 in this study.

Present bias. To measure present bias toward medicinal effect and healthy behavior, the researcher developed items to measure how much less valuable participants perceive the effects of medication adherence or health behavior to be due to delays. Present bias is usually measured with an experimentation giving a delay discounting task [41], but due to the nature of this study, the researcher used self-report questions about how much they recognized delayed discounts on effects of medication adherence and healthy behaviors. Examples of the items are, "I think exercising will have to late of a health effect." and "Generally, even if a prescribed drug is taken, the effect is late." The questionnaire comprise six items ranging from 1 (*not at all*) to 4 (*always*). The internal consistency (Cronbach's α) was .95 in this study.

Data Analysis

IBM SPSS Statistics for Windows and AMOS (Analysis of Moment Structure) for were used for all the statistical analyses, Pearson-Product Moment correlational analysis and t-tests to check for gender differences were performed with the SPSS, and path analysis and analysis of moderating effects were performed with AMOS. For these parametric statistical analyses, it was necessary to check the mean and standard deviation, skewness, and kurtosis of the data.

Maximum Likelihood (ML) estimate was used to estimate the model when performing path analysis with AMOS. The goodness-of-fit evaluation was performed using the relative goodness-of-fit indices TLI (Tucker-Lewis Index) and CFI (Comparative Fit Index), and the absolute goodness-of-fit indices GFI (Goodness of Fit Index) and RMSEA (Root Mean Square Error of Approximation). Finally, bootstrapping was used to decompose the causal relationships of variables and analyze the significance of the mediated effect. In addition, the TPB model with moderating effects used individual parameter verification to estimate the moderating effect from a single model of two samples. In addition, Verification of the model with moderating effects was performed by estimating the moderating effect from a single model of two samples, i.e. verification of individual parameter differences. When it was unclear whether to conclude that there was a moderating effect, analysis of the differences in two models of two samples was also used.

Results

The Relationship between Variables Involved in Medication Adherence

The results of the analysis of the relationships between the variables from the TPB, optimistic bias, present bias, and medication adherence are shown in Table 1. First, the skewedness and kurtosis were checked and the absolute value none of them was found to exceed 1, indicating that variances of each variable were close to a normal distribution.

The correlation analysis found significant positive correlations between the TPB variables involved in medication adherence. In particular, attitudes (r = .67, p < .001) and perceived behavioral control (r = .74, p <. 001) were closely related to the behavioral intention of medication adherence such that attitudes and perceived behavioral control account for 44.9% and 54.8% of the variance of behavioral intention of medication adherence, respectively.

Table 1 Correlational Matrix of Factors of TPB, Optimistic Bias, and Present Bias for Medication Adherence (*N*=357)

Variables	1	2	3	4	5	6	7
1. **1.** Attitude							
2. Subjective norm	.56***						
3. Perceive Behavioral Control	.52***	.52***					
4. Behavioral Intention	.67***	.54***	.74***				
5. Medication Adherence	.34***	.18***	.35***	.34***			
6. Optimistic Bias	-.27***	-.12*	-.24***	-.28***	-.04		.
7. Present Bias	.02	.05	-.06	.02	-.19***	.13*	
M	21.23	20.12	21.65	22.00	14.79	15.08	27.08
(SD)	(4.06)	(4.17)	(4.16)	(4.14)	(4.56)	(6.66)	(5.95)
Skewedness	-.44	.-25	-.53	-.56	.20	.65	-.21
Kurtosis	.29	-.26	.22	.53	-.26	.11	.04

* p <. 05, ** p < .01, *** p <. 001.

On the other hand, there was no significant correlation between optimistic bias and medication adherence (r = -.04, *n.s.*), though optimistic bias was negatively correlated with attitude (r = -.27, $p < .001$), subjective norms (r = -.12, $p < .05$), perceived behavioral control (r = -.24, $p < .01$), and behavioral intention of medication adherence, r = -.28, $p < .001$. The present bias for medicinal effect was significantly correlated with the medication adherence (r = -.19, $p < .001$), but it was not significantly correlated to the TPB variables involved in medication adherence.

Path Analysis of the Proposed Model and Alternative Models

This study presented a proposed model based on the TPB, and tried to determine the optimal model by comparing its goodness of fit, with those of alternative model I, which added the path of perceived behavioral control → medication adherence, and of alternative model II, which added the path of attitude → medication adherence as well as perceived behavioral control → medication adherence. Based on both accountability and simplicity, the fit index used in this study was in addition to the commonly used TLI and RMSEA, as well as GFI and CFI.

The χ^2 value of the proposed model was 34.25 (df = 3, $p < .001$), and the goodness-of-fit index was GFI = .965, TLI = .856, CFI = .957, and RMSEA = .120 (Table 2). A significant χ^2 value suggests that this model may vary depending on the number of samples. The GFI and CFI values were found to be above .90 and fell within the range of good model conditions, but the TLI (below .90) and RMSEA values (above .10) were outside the values of good model conditions.

Table 2. Comparison of the Goodness of Fit between the Proposed Model and Alternative Models

Model	χ^2	*df*	GFL	TLI	GFI	RMSEA (90% confidence interval)
Proposed Model	18.78***	3	.980	.929	.978	.122 (.173 ~ .177)
Alternative Model I	11.11**	2	.988	.937	.987	.113 (.055 ~ .182)
Alternative Model II	3.18	1	.996	.970	.997	.078 (.000 ~ .182)

** $p < .01$, *** $p < .001$.

The χ^2 value of alternative model I with the added path of perceived behavioral control → medication adherence was 11.11 (*df* = 2, $p < .01$), and the goodness-of-fit indices were GFI = .988, TLI = .937, CFI = .987, and RMSEA = .113 (Table 2). The significant χ^2 value for the proposed model suggests that it may vary depending on the number of samples. The GFI, TLI, and CFI values were shown to be above .90 and indicated a good model. But the RMSEA values (above .10) were outside the range of good model conditions, like the proposed model.

On the other hand, the χ^2 value of alternative model II with the added paths of perceived attitude → medication adherence and perceived behavioral control → medication adherence was 3.18 (*df* = 1, *n.s.*) and the goodness-of-fit indices were GFI = .996, TLI = .970, CFI = .996, and RMSEA = .078 (Table 2). First, the fact that the χ^2 value was not significant means that the model represents the total population of this sample well, so there is no statistically significant difference between the observed and estimated matrices, i.e., the covariance matrix. The GFI, TLI, and CFI values met the conditions for a good model, over .90. It was also found that RMSEA value was less than .08, also indicating a good model. This means that there is no need to compare the goodness-of-fit with χ^2 differentiation based on a nested relationship, suggesting that alternative model II should be adopted. In other words, this study validated the model with the addition of the attitudes → behavior path and perceived behavioral control → behavior path as a useful theory of planned behavior for medication adherence.

The path coefficients in alternative model II in this study are shown in Figure 2 and Table 3. Regarding each path coefficient in the adoption model involved in medication adherence, the more positive the attitude, the more likely there is to be intention of medication adherence ($\beta = .356$, $p < .001$), and the higher level of perceived behavioral control, the stronger the intention of medication adherence, $\beta = .523$, $p < .001$. In addition, if people have a positive attitude toward medication, they are more directly compliant with the prescription ($\beta = .185$, $p < .01$), and if they perceive themselves to be able to control their medication behavior, they are better at taking medication, $\beta = .195$, $p < .01$. However, the path between the intention and behavior of medication adherence was not significant.

Table 3. Estimated Parameter Values of Adopted Model (Alternative Model II) for Medication Adherence

Predictors	Non-Standardized Weight	Standardized Weight	S.E.	C.R.
Attitude → Intention	.363	.365	.041	9.06^{***}
Subjective norm → Intention	.066	.067	.039	$1.71^{\dagger}$
Perceived behavioral control → Intention	.521	.523	.038	13.73^{***}
Attitude → Adherence	.208	.185	.073	2.83^{**}
Perceived behavioral control → Adherence	.213	.195	.080	2.66^{**}
Intention → Adherence	.083	.076	.092	.91

† *p* < .10, **p* <. 05, ***p* < .01, ****p* < .001.

Alternative model II was adopted because the direct paths of attitude to medication adherence and perceived behavioral control to medication adherence behavior were significant. However, the results of the analysis of the mediated effects (Table 3) show that the indirect paths from attitude through intention, from subjective norms to through intention, and from perceived behavioral control through intention to medication adherence were not significant. This is because the relationship between behavioral intention and behavior is not significant in this model.

Table 4. Mediating Effects of the Adopted Model (Alternative Model II) for Medication Adherence

Predictors	Non-Standardized Effect	Standardized Effect
Attitude → Intention → Adherence	.363	.027
Subjective norm → Intention → Adherence	.006	.005
Perceived behavioral control → Intention → Adherence	.043	.040

Moderating Effect of Optimistic or Present Bias on Adopted Model of TPB

In this study, the goodness-of-fit of the adopted model of TPB for medication adherence was verified with either optimistic bias or present bias as a moderating variable.

The results of comparing the goodness-of-fit between the adoption model and the models with moderating effects are given in Table 5. The χ^2 value of the model with optimistic bias included as a moderating variable was 3.84 (*df* = 2, *p* = .147) and the goodness-of-fit indices were GFI = .996, TLI = .974, CFI = .997, and RMSEA = .051 (.000 ~ .128); the TLI value was slightly better than original adoption model, and the RMSEA value was less than the same .08, but much better at .051.

Table 5. Comparison of the Goodness of Fit with the Moderating Effect of Optimistic and Present Bias

Model	χ^2	*df*	GFL	TLI	GFI	RMSEA (90% confidence interval)
Adopted model	3.18	1	.996	.7000	.997	.078 (.000 ~ .182)
Model with optimistic bias	3.84	2	.996	.974	.997	.051 (.000 ~ .128)
Model with present bias	2.71	2	.997	.990	.999	.032 (.000~.115)

To clarify this point, the researcher analyzed of the differences in two models with two samples to find the moderating effects of optimistic bias on medication adherence, finding a significant difference between the groups with strong and weak optimism bias (p = .025). The NFI values of the unrestricted model and the restricted model also differed by .007, and the absolute value of the critical ratio in the unrestricted model was 2.25, exceeding 1.96, indicating that the difference between the two groups was significant at the .05 level. These results suggest that there is a difference between the model with strong optimism bias and the model with weak optimism bias. As shown in Figure 3, for groups with strong optimism bias, only the attitudes → behavior path was significant, while for groups with weak optimism bias, only the perceived behavioral control → behavior path was significant.

The χ^2 value of the model with present bias included as a moderating variable was 2.84 (df = 2, p = .258), and the goodness-of-fit indices of this model were GFI = .997, TLI = .990, CFI = .999, and RMSEA = .032 (.000 ~ .115); most of these values were better than those of the original adoption model, and in particular the RMSEA value was less than .05, the criterion for an excellent model. This result suggests that there is a significant difference between the model with strong present bias and that with weak present bias. As shown in Figure 4, for groups with strong present bias, the proposed model was significant, while for groups with weak present bias, alternative model II was significant.

Discussion

In situations in which prescription drugs play an important role in treatment, the patient's medication adherence is as important as the medicinal effect of the drug. Therefore, if health psychologists can improve the level of patients' medication adherence, this could increase their likelihood of being cured. Thus, the present study investigated the psychological variables that might affect medication adherence and produced meaningful results.

The correlational analysis found that attitudes toward medication adherence and perceived behavioral control were closely related to behavioral intention of medication adherence, but the covariance with medication adherence was to that of behavioral intention. As mentioned in the introduction, many studies [22, 24] have found that among the variables of the TPB, the behavior of perceived behavioral control accounts for the greatest variance in behavior, but in this study, the accountability of the attitude for medication adherence behavior was similar to perceived behavioral control in this regard. It was also shown that attitudes and perceived behavioral control could account for as much variance in medication adherence behavior as behavioral intention of medication adherence.

Thus, a model including the attitude → medication adherence and perceived behavioral control → medication adherence paths showed model conditions as good as the TPB model for medication adherence in this study. In this model, the path of behavioral intention → behavior, i.e., medication adherence, was not significant. This may be because the attitude and perceived behavioral control were determinant variables for medication adherence in this model. Some studies [42] found low levels of accountability of behavioral intention in actual behavior. However, these results might vary depending on the TPB model for any particular behavior. What can only be concluded from this study is that Korean adults' behavioral intention is significantly influenced by their attitudes toward it and perceived behavioral control. Although Hale, Household, and Greene [43] pointed out that the theory of reasoned action was developed because of "frustration with traditional attitude–behavior research, much of which found weak correlations between attitude measures and performance of volitional behaviors" (p. 259), the present study suggests that attitudes toward medication may play a direct role in ensuring that individuals take the medicine.

It was found that the subjective norms in adopted model did not directly affect the behavioral intention to medication adherence in this study. Therefore, the indirect path between subjective norms → behavioral intention → medication adherence was also not significant. However, the subjective norms in this model shared large amount of variance with attitude and perceived behavioral control, so it is believed that subjective norms would indirectly affect the behavior of medication adherence anyway, because people are influenced by the judgment of significant others [44] and subjective norms in this study are certain to interact with attitude toward medication adherence or perceived behavioral control.

Importantly, this study found that optimistic bias could moderate the TPB model for medication adherence. In other words, the TPB model for predicting medication adherence of Korean adults shows significant differences in paths depending on the level of optimistic bias. This result suggests that optimistic bias could moderate the TPB model for health behaviors, especially medication adherence behavior, beyond the results of previous studies [24, 25, 32] finding that optimistic bias makes individuals less likely to practice health behavior. In the present study, for those with weak optimism bias, attitudes in the TBP model did not directly affect medication adherence, but only perceived behavioral control. On the other hand, for those with strong optimism bias, perceived behavioral control was not directly affecting medication adherence, but attitudes did directly affect it. In the TPB model of both groups, the direct path from behavioral intention to behavior of medication adherence was not significant.

This means that it is difficult to apply the TPB model, proposed by Ajzen [9], in which perceived behavioral control was highlighted as influencing the medication adherence of those with strong optimism bias. To evaluate their medication adherence, one should thus identify whether they have a positive or negative attitude toward medication rather than examining other variables. In recent years, increasing self-efficacy is a common strategy for practicing health behaviors [45], but this study found that such a strategy does not work to improve the medication adherence of people with strong optimism bias. Of course, since there were relatively close relationships between attitudes, subjective norms, and perceived behavioral control, while they might indirectly affect medication adherence, the influence of these subjective norms and perceived behavioral control in the model will not be significant. In conclusion, the present study suggests that such a strategy is likely to produce the desired effects only in order to improve the medication adherence of those with weak optimism bias.

The present study found that the TPB model for medication adherence was also moderated by present bias. The TPB model for predicting the medication adherence of Korean adults was differentiated by whether there was delay discounting of expected medication effects. In the correlation analysis, the stronger the present bias, the less likely participants were to take medication, which extends research findings of the effects of delayed discounts of the results or effects of health risk behavior [34], smoking [35], and exercise [36] on medication adherence. Considering the moderating effects of present bias in the TPB model to predict medication adherence, the model proposed by Ajzen [9] was in fact significant for those with strong present bias. On the other hand, for those with weak present bias, the model adopted in this study (Alternative Model II) was significant.

The moderating effect of present bias on the TPB model for medication adherence found in this study is logically explainable. It is predictable that attitude or perceived behavioral control does not directly affect medication adherence for those who recognize more delay discounting on medication effects; thus such people should have a strong behavioral intention to take medicine. Therefore, medical or health professionals should focus on improving behavior intention in order to induce medication adherence in people with strong present bias. In this model, attitudes and perceived behavioral control had significant impacts on medication adherence behavior, so one such strategy is to have a positive attitude toward medicine and make behavioral control more perceptible to patients. In the case of people who are less likely to discount the effects of medication, if they have a positive attitude toward the medication or perceive themselves to have behavioral control, they are more likely to adhere to taking medication. In summary, while both groups show significant positive attitudes toward medication and perceived behavioral control, it is important for those with strong present bias to have a definite behavioral intention.

Conclusion

In this study, the TPB model for adult medication adherence was validated, and a modified alternative model slightly modified from that proposed by Ajzen [9] was adopted. In addition, the TPB model adopted in this study was moderated by optimistic bias or present bias. This study was conducted on a Korean sample, and as the data were collected by convenience sampling, the sample cannot be expected to be representative of the total Korean population. Therefore, the results of the present study of the TPB model for medication adherence should be re-verified. Since no conclusion can be reached from a single study, the role of optimistic bias and present bias in medication adherence should continue to be studied in the future. Also, as there may be cultural differences in the roles of such variables [37], I hope that comparative cultural studies will be conducted on these topics. Finally, it is expected that the findings of this study would provide useful information for future research and for medical or health professionals who wish to improve the medication adherence of their patients.

Abbreviations

TPB: Theory of Planned Behavior

SPSS: Statistical Package for Social Sciences

AMOS: Analysis of Moment Structure

TLI: Tucker-Lewis Index

CFI: Comparative Fit Index

GFI: Goodness of Fit Index

RMSEA: Root Mean Square Error of Approximation

Declarations

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Author's Contribution

Kyung-Hyun Suh designed the study, conducted the literature review, led the data collection, analyzed/interpreted the data, and write the final manuscript.

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Availability of supporting Data

Any queries regarding the data used in this study may be directed to the corresponding author. The dataset used in the present study is available on reasonable request.

Ethics approval and consent to participate

This study was approved by the Institutional Review Board (IRB) before conducting the study (approval number: 2-7001793-AB-N-012018113HR). Each participant was given a packet containing the questionnaire, a consent form, and a demographic sheet. Researcher and assistants employed an informed consent process. Research assistants disclosed information on the study to facilitate their understanding of it and to encourage their participation. Participants were informed that even those who agreed to participate could withdraw at any time while responding to the survey.

Consent for publication

Not applicable.

Competing interests

The author has declared that no competing interests exist.

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Figures

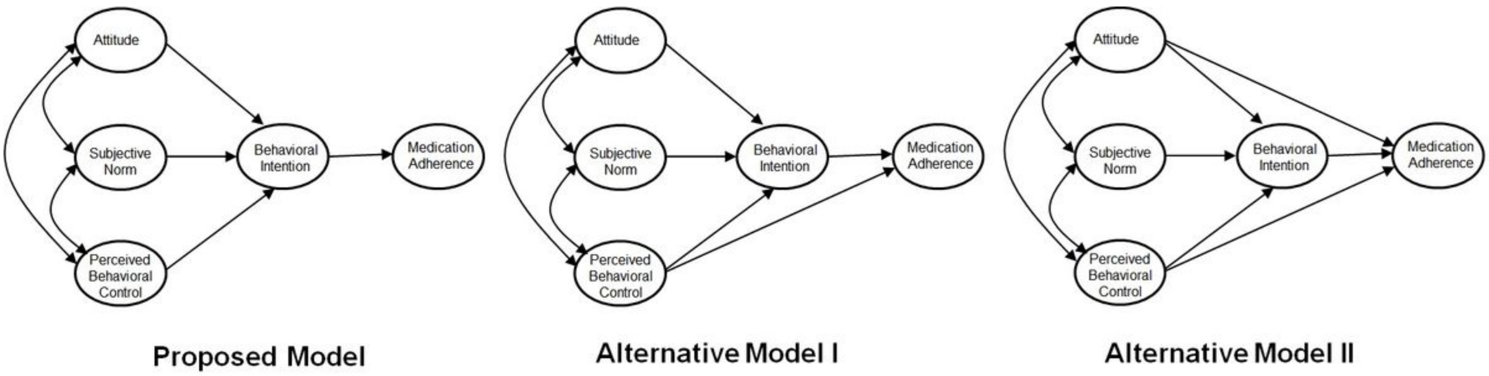

Figure 1

Proposed and Alternative Models of TPB for Medication Adherence

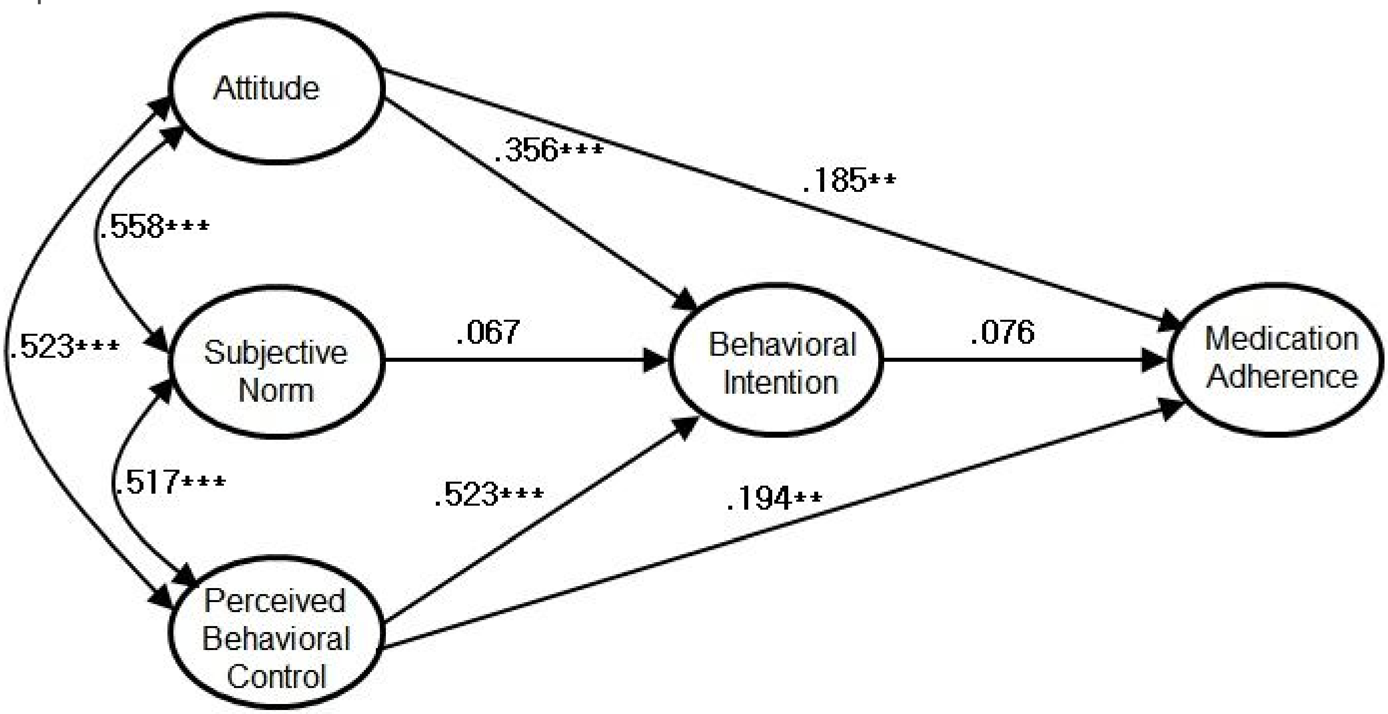

Figure 2

Path Map of Alternative Model II of TPB for the Medication Adherence (**p < .01, ***p < .001)

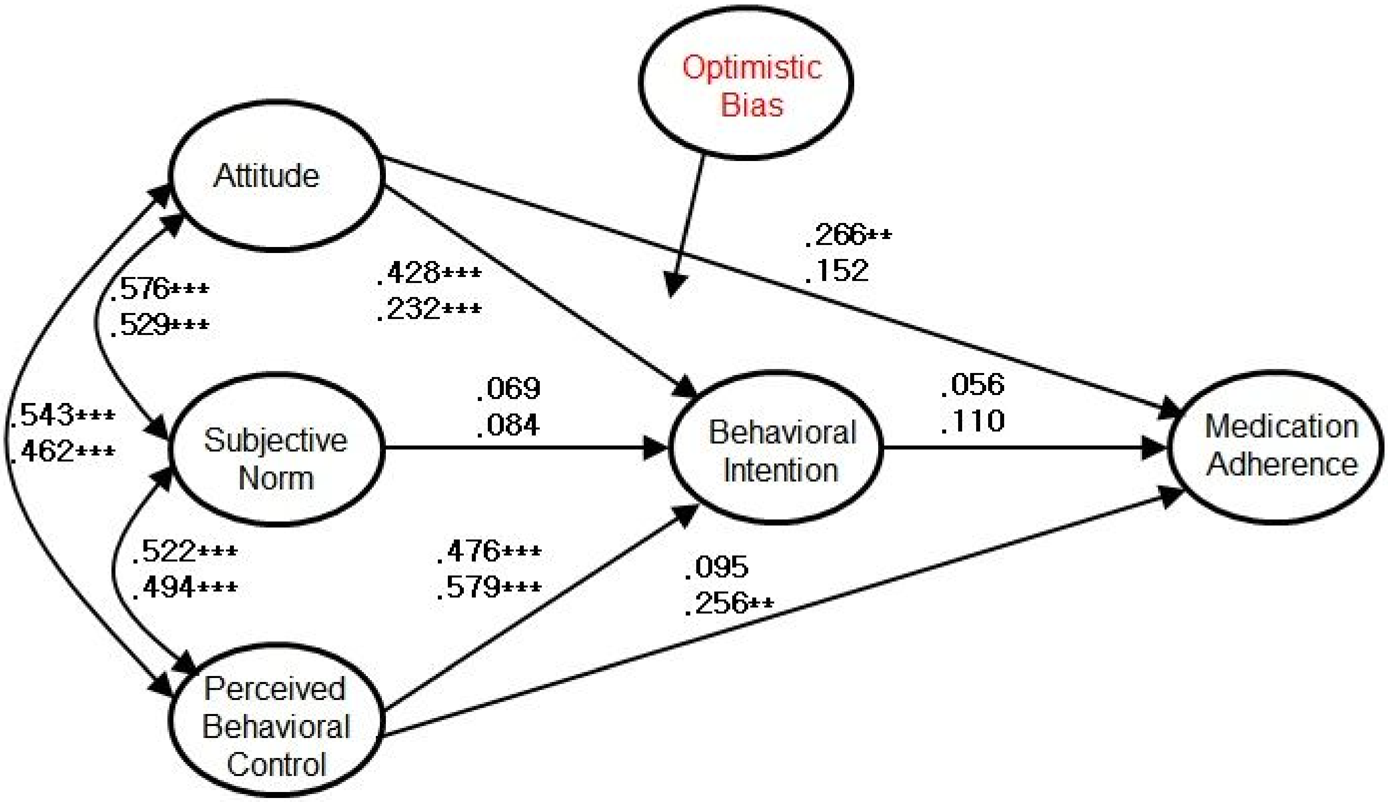

Figure 3

Path Map of the Model with a Moderating Effect of Optimistic Bias (**p < .01, ***p <. 001) Note. Upper is for those with high optimism bias, lower is for low optimism bias

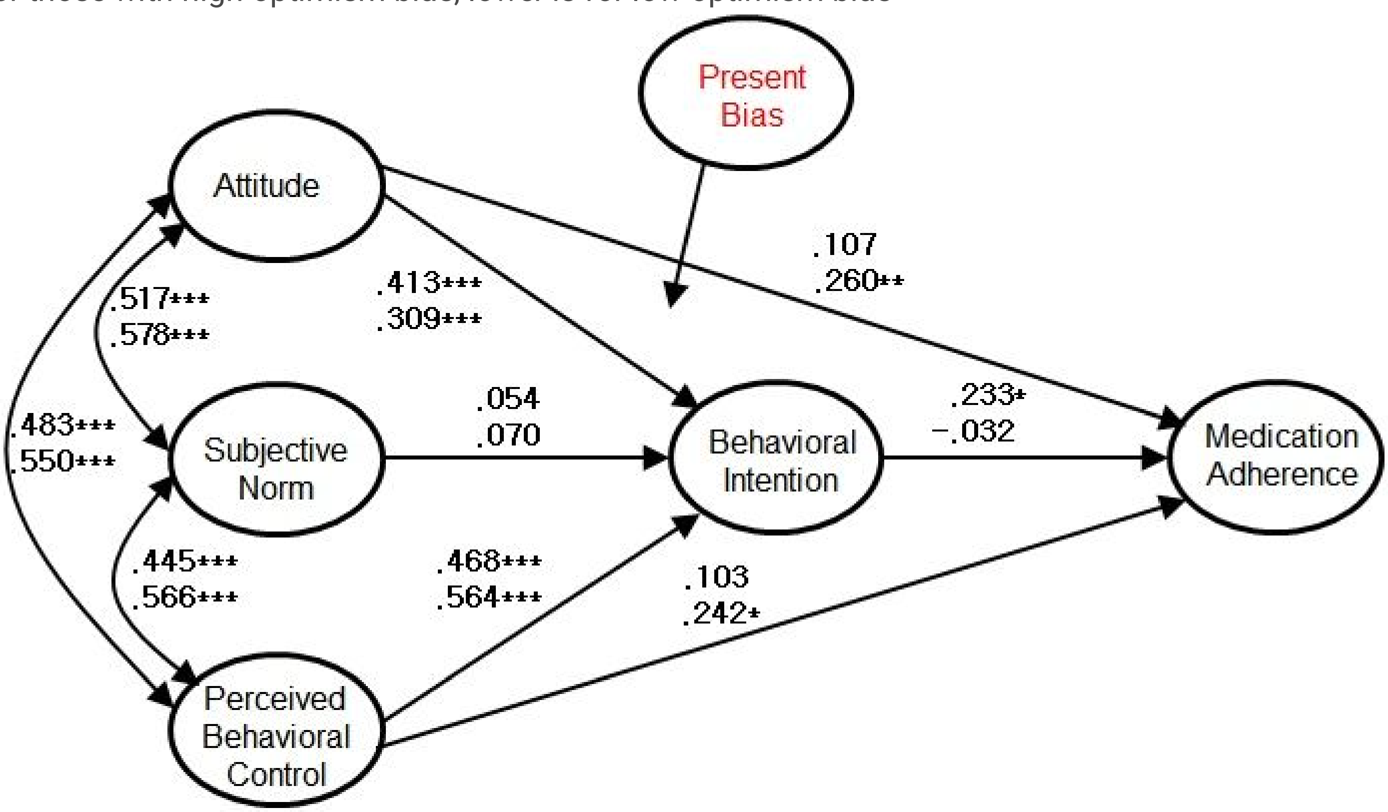

Figure 4

Path Map of Model with Moderating Effect of Present Bias (*p < .05, **p < .01, ***p < .001) Note. Upper is for those with high present bias, lower is for low present bias.