The influence of supervisor on medication adherence of their children in China：an online investigation based on health belief model

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Abstract

Objective： To explore the influence of supervisor on medication adherence of their children, and provide references for improving medication adherence of children by educating their supervisor. **Methods:** Questionnaires were designed based on Morisky-Green medication adherence scale& health belief model (HBM) and collected online through multi-stage stratified sampling. The influence of supervisors' general characteristics on medication adherence of their children were analysed by multiple linear regression and structural equation model (SEM) was constructed to explore the relationship of the supervisor's health belief and their children's medication adherence. **Results:** A total of 573 questionnaires were analysed, with an effective rate of 62.97%. According to multiple linear regression results, the influence of general characteristics of supervisors on their children's medication adherence is remarkable.There are statistical differences in the impact of the respondent's provinces per capita GDP level(Lower than average VS higher than average) on medication adherence scores(b=-0.245, t=-2.671, p=0.008). There are statistical differences in the

impact of number of children in the respondent family(more than one VS one) on medication adherence scores(b=-0.255, t=-2.720, p=0.007). Also, There are statistical differences in the impact of permanent domicile of the respondents(village VS town) on medication adherence scores(b=0.209, t=2.085, p=0.038). The structural equation model has been revised several times to fit the best model of factors affecting medication adherence. The fitting indices are as follows: CMIN/DF=2.334<3, GFI=0.992>0.9, AGFI=0.968>0.9, CFI=0.986>0.9, RMSEA=0.048<0.08, NFI=0.977>0.9, TLI=0.959>0.9, indicating that the model fits the data, and the model is scientific and effective. The structural equation model shows that self-efficacy (λ=0.177) and perceived severity(λ=0.243) have significant positive direct impacts on medication adherence. Perceived susceptiblity (λ=-0.244) has a significant negative direct impact on medication adherence. Mediating effects are widespread in the model. The indirect effects on medication adherence are as follows: objective constraints (λ=0.009, P<0.001), perceived severity (λ=0.057, P<0.001), perceived susceptiblity (λ=-0.009, P<0.001), perceived barriers (λ=-0.033, P<0.001), perceived benefits(λ=0.049,P<0.001).

Conclusion: Regional GDP per capita, the number of children in the family, permanent domicile could influence children's medication adherence. Supervisors' perceived severity, perceived susceptiblity and self-efficacy will directly affect children's medication adherence, and objective constraints , perceived barriers, perceived benefits, perceived severity, perceived susceptiblity will indirectly affect children's medication adherence. The medication education for parents in families with multi-children should be strengthened, so as to improve the medication adherence of the children. Supervisors' self-efficacy and the perceived severity of children's non-adherence with medication should also be improved during the medication education by pediatrician, pediatric clinical pharmacist and pediatric nurse.

Keywords：Medication Adherence; Children; Health Belief Model; Influencing Factor; Supervisor; China

The medication adherence of children refers to the consistency between the medication behaviors of the sick children and the doctors' prescriptions, in other words, it means the degree of implementation of the drug treatment plan by the sick child. It greatly affects the efficacy of the drug and the prognosis. Poor medication adherence in children may lead to serious problems such as impaired physical and mental health, increased family burden, waste of medical resources, and so on[1–3]. Medication adherence can be problematic for the pediatric population. Rates of children's medication adherence are extremely variable; ranging from 11% to 93%, with an estimated average of around 50%[4]. Nonadherence in pediatric patients with chronic illnesses increases the number of emergency department visits and hospitalizations and is costly to the US health care system. Children who suffer from chronic conditions account for 16% of the youth of America, however, they are responsible for 53% of the pediatric hospitalization days.Seven studies showed that nonadherent asthmatic children and adolescents had increased emergency department visits. These

data should foster further investigation into methods to improve adherence in children with asthma which would reduce overall health care costs and possibly decrease morbidity and mortality resulting from nonadherence[1]. The medication adherence of children is affected by various factors such as disease type, drugs, supervisor's intervention and children's psychology[5]. Supervisors have direct and significant influence on children's medication adherence[6]. Questionnaires which aimed at investigating supervisors' influence on children's medication adherence were designed based on health belief model (HBM) and distributed, so as to give targeted suggestion to improve children's medication adherence from the perspective of their supervisors.

1 Participants and methods

1.1 Participants

Inclusion criteria: (1) Supervisors aged 21 years and above and those who are responsible for the medication of children in their family; (2) The age of the respondents' children should be below 12 years old; (3) Supervisors with independent thinking ability and accurate expression ability; (4) Supervisors who can understand the meaning of each item in the questionnaire; (5) Supervisors who volunteer to participate in this research.

Exclusion criteria: (1) Medical workers(doctors, pharmacists, nurses, etc). (2) Supervisors who are suffering from serious mental, hearing and visual impairment and those who can not think independently or express clearly. (3) Supervisors whose children have chronic diseases (hypertension, diabetes, congenital heart disease, asthma, chronic kidney disease, epilepsy, etc.) As the factors affecting the medication adherence of children with chronic diseases are more complex, this study only studied the medication adherence of children with non-chronic diseases.

1.2 Methods

1.2.1 Design of the Questionaire

The questionnaire was designed based on health belief model(HBM). The hypothesis of HBM is that whether a person adopts health behaviors is mainly related to six factors, including perceived susceptiblity, perceived severity, perceived benefits of the health behavior, perceived barriers of the health behavior, cues to action and self-efficacy. The questionaire includes four parts. The first part is the informed consent. The second part is the basic information of the respondent, including gender, age, province, career, education background, marital status, number of children under his or her care, domicile(town or village), average monthly income per person. The third part is a self-administered questinnaire based on health belief model which include 26 items[7–10]. Each item is scored by a Likert 5-level scale ranging from l to 5. The forth part aims to evaluate the medication adherence of the children under the care of the respondent, which consists of adapted Morisky-Green Scale(four items)[11] and self-administered items(three items). Each item is scored 1-2 points , with a maximum score of 14 points.

1.2.2 Sampling Method

A multi-stage stratified sampling method was used to conduct an online questionnaire investigation. According to the characteristics of Chinese geographical distribution, 2 cities were selected from each administrative Chinese region which includes North China, Northeast China, East China, Central China, South China, Southwest China, and Northwest China. A total of 14 cities were selected(1 provincial capital city, 1 prefecture-level city per province). The selected cities are as follows: Jinan and Jining in Shandong Province, Hefei and Xuancheng in Anhui Province, Baiyin and Lanzhou in Gansu Province, Guangzhou and Shenzhen in Guangdong Province, Nanning and Qinzhou in Guangxi Province, Guiyang and Tongren in Guizhou Province, Shijiazhuang and Tangshan in Hebei Province, Zhengzhou and Pingdingshan in Henan Province, Harbin and Jiamusi in Heilongjiang Province, Wuhan and Xiantao in Hubei Province, Changchun and Siping in Jilin Province, Taiyuan and Jinzhong in Shanxi Province, Xi'an and Ankang in Shaanxi Province, Chengdu and Luzhou in Sichuan Province. One volunteered investigator was recruited in each city, and each investigator was required to distribute and recover at least 30 questionnaires. After conducting standardized training for the investigators from August 15, 2020 to September 5, 2020, the investigators conducted the investigation by forwarding the questionnaire link one by one. If the respondent had problems answering the questionnaire, the investigator would conduct one-on-one inquiry and upload the respondents' answers instead.

1.2.3 Ethics Review

This research has passed the ethical review of Shaanxi Health Culture Research Center, the ethics number is JKWH-2020-17.

1.2.4 Quality Control

A pilot study was conducted from July 16th to July 21st, 2020, and the questionnaire was revised according to the pilot study data and expert opinions. The reliability and validity of the questionnaire were tested before the questionnaire was issued, and the final questionnaire was settled after excluding irrelevant items. Uniform training for investigators was conducted to ensure the standardization and uniformity of the questionnaire distribution process. Supervisors filled out the questionnaire anonymously to reduce their concerns about privacy leakage, so as to ensure the authenticity of the data as much as possible; after the questionnaires were retrieved, invalid questionnaires were first eliminated through verification, including questionnaires that took less than 1 minute to answer, and questionnaires with inconsistent content.

1.2.5 Statistical Method

SPSS21.0 was used to test the reliability and validity of the questionnaire, and the Cronbach'α was used to measure the reliability. After calculating KMO value, the questionnaire items were adjusted or factored. After the questionnaires were collected, the valid data was imported into SPSS 21.0 for statistical analysis. Mean ± standard was used to describe the scores of each dimension. Multiple linear regression was used to explore the relationship between the basic information and children's medication adherence. Categorical variables were set as dummy variables, the first category of each group was set as the control group for analysis. The medication adherence score was set as the

dependent variable, and the respondents basic information was used as the independent variable. Multiple linear regression analysis was performed to explore the factors affecting the medication adherence score of the children. IBM AMOS 24.0 was used to establish the structural equation model for the latent variable analysis. The per capita GDP data of each province comes from the 2019 report of the National Bureau of Statistics. The top ten provinces are “higher than the average”, the other twenty-one provinces are classified as “lower than the average. (excluding Hong Kong, Macau and Taiwan). Male, 21-30 years old, low Per capita GDP of the province where the respondent is located, one child in the family, living in towns, monthly income per capita in the household(Unit: RMB) above 4000 yuan, no job were set as control group, therefore, there are no p value for these groups. The common evaluation indicators for the rationality of the structural equation model are Chi-square/DF (Chi squared over degrees of freedom), GFI (Goodness of Fit Index), AGFI (Adjusted Goodness of Fit Index), CFI (Comparative Fit Indexes), RMSEA (Root Mean Square Error of Approximation), with α=0.05 as the statistical test standard for significance.

2. Results

This study finally retrieved 910 questionnaires, of which 573 were valid, with an effective rate of 62.97%. Due to the impact of the COVID-19 epidemic, this study was conducted by online survey, which may be the reason for the low efficiency of the questionnaires.

2.1 Reliability and Validity Test of the Questionnaire

The Cronbach’α of the questionnaire is 0.821, which proves it has good reliability. The KMO value is 0.875, and the Bartlett sphere test $p<0.001$, indicating that it is suitable for factor analysis. After factor analysis, the questionnaire can be divided into 6 dimensions, the dimensional division is basically consistent with the theoretical framework and the cumulative variance explanation rate is 58.19% (>50%), indicating good validity of the questionaire.

2.2 Demographic Characteristics of the supervisors and the Medication adherence of the Children Cared for by the supervisors

The score of the medication adherence scale was 12.56±1.07 (mean±SD). 19.02% of the supervisor have a total score of 14, 38.22% get 13, 27.40% get 12, 11.34% get 11, and 4.01% get 10 or less. The Demographic sociological characteristics of the sample population are shown in Table 1.

Table 1 Demographic characteristics of respondents

Item	Option	Number of people who chose this option	Percentage(%)
Gender	Male	178	31.06
	Female	395	68.94
Age group	21-30	164	28.62
	31-40	318	55.50

	Over 40	91	15.88
Per capita GDP of the province where the respondent is located	Higher than the average	223	38.92
	Lower than the average	350	61.08
Education level	Junior middle school and below	139	24.26
	Technical secondary school	45	7.85
	Senior middle school	52	9.08
	Junior college	78	13.61
	Undergraduate	208	36.30
	Postgraduate	51	8.90
Number of children in the family	1	289	50.44
	More than 1	284	42.58
Domicile	Town	388	67.71
	Village	185	32.29
Monthly income per capita in the household(Unit: RMB)	Above 4000	195	34.03
	4000-6000	165	28.80
	6000-8000	84	14.66
	More than 8000	129	22.51
Occupation	No job	75	13.09
	Office staff of enterprises and institutions	89	15.53
	Business/service personnel	100	17.45
	Professional technicians (except medical workers)	66	11.52
	Others	243	42.41

Table 2 Multiple linear regression analysis of factors affecting children medication adherence

Item	Option	Number of people	Percentage	b	t	β 95%CI	P value	VIF for collinearity diagnosis
Per capita GDP of the province where the respondent is located	Higher than the average	223	38.92					
	Lower than the average	350	61.08	-0.245	-2.671	-0.112 [-0.426,-0.065]	0.008*	1.020
Number of children in the family	1	289	50.44					
	More than 1	284	42.58	-0.255	-2.720	-0.119 [-0.439,-0.071]	0.007*	1.116
Permanent domicile	Town	388	67.71					
	Village	185	32.29	0.209	2.085	0.091 [0.012,0.406]	0.038*	1.121

*Significant at 0.05 level.

The results of multiple linear regression analysis are shown in Table 2. The forward method is used to establish the model, and the results obtained by the backward method and the forward method are the same. The Durbin-Watson coefficient is 1.961, which is close to the median 2, which eliminates the possibility of serial correlation in error terms and satisfies the premise that the multiple regression model can be established. The adjusted R-square value of the model is 0.023. The F test was performed on the regression sum of squares and residual sum of squares. The calculated F value is 5.418, the p value is 0.001, less than 0.05, indicating that the regression model established was statistically significant. The collinearity diagnosis of the independent variables shows that the VIF values of the independent variables in the model are all less than 10, and there is no collinearity in the independent variables in the model.

After linear regression analysis, it is found that there are significant differences between Per capita GDP of the province where the respondent is located, the number of children in the household and permanent domicile on medication adherence scores and the control group. There are statistical differences in the impact of the respondent's provinces per capita GDP level(Lower than average VS higher than average) on medication adherence scores(p=0.008). There are statistical differences in the impact of number of children in the respondent family(more than one VS one) on medication adherence scores(p=0.007). Also, There are statistical differences in the impact of domicile (village VS town) on medication adherence scores(p=0.038).

2.2 Structural Equation Model of the Factors Affecting Medication adherence in Children

Cared for by the supervisor

The structural equation model has been revised several times to fit the best model of factors affecting medication adherence. The fitting indices are as follows: CMIN/DF=2.334<3, GFI=0.992>0.9, AGFI=0.968>0.9, CFI=0.986>0.9, RMSEA=0.048<0.08, NFI=0.977>0.9, TLI=0.959>0.9, indicating that the model fits the data, and the model is scientific and effective. The value on the one-way arrow is the coefficient in the structural equation model, indicating the magnitude of the former's influence on the latter. If the value on the one-way arrow is positive, it means that the former has a positive influence on the latter. If the value on the one-way arrow is negative, it means that the former has a negative influence on the latter. e2 to e9 are residual items, representing confounding factors independent of the established structural equation model. The structural equation model shows that self-efficacy (λ=0.177) and perceived severity(λ=0.243) have significant positive direct impacts on medication adherence. Perceived susceptiblity (λ=-0.244) has a significant negative direct impact on medication adherence.

Mediating effects are widespread in the model. The indirect effects on medication adherence are as follows: objective constraints (λ=0.009, P<0.001), perceived severity (λ=0.057, P<0.001), perceived susceptiblity (λ=-0.009, P<0.001), perceived barriers (λ=-0.033, P<0.001), perceived benefits(λ=0.049,P<0.001).

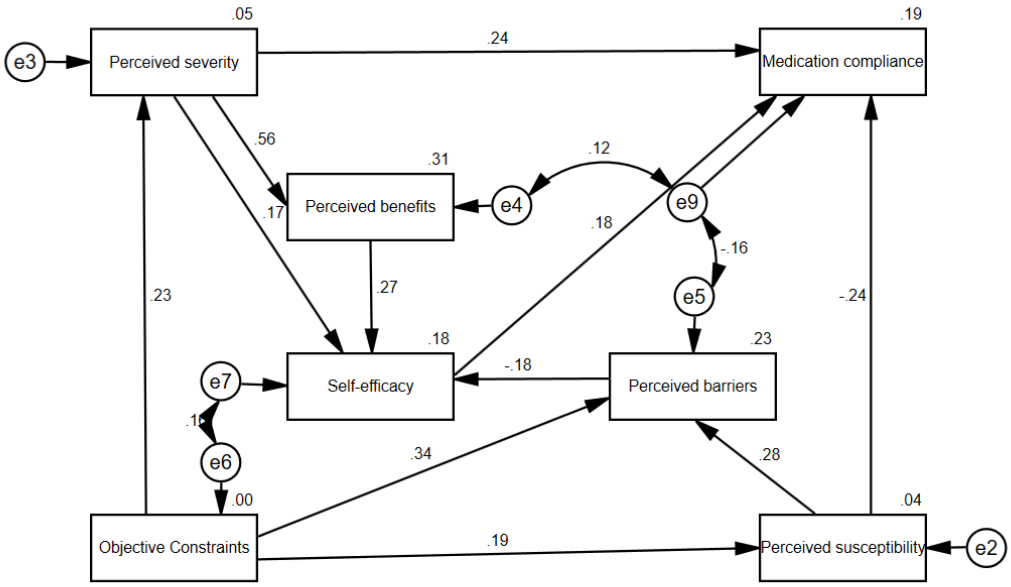

Figure 1 Structural equation model of supervisor's influence on their children's medication adherence

3. Discussion

3.1 Analysis of medication adherence of children under the care of supervisor

According to the results of the Morisky-Green scale, the proportion of the supervisor's children with good medication adherence is 57.24%(Medication Adherence Scale scores 13 or 14), the general proportion is 27.40%(Medication Adherence Scale scores 12), and the poor proportion is 15.36%(Medication Adherence Scale scores 11 or less). The results are consistent with the results of many studies[12–15] . Vasylyeva et al.[15] investigated the medication adherence of children with chronic kidney disease who had taken at least three medications for more than 3 months, and found that 41.1% of the children did not adhere to the doctor's advice. Miner et al.[13] conducted a cross-sectional study on the medication adherence of 100 children with epilepsy between 2 and 14 years old and found that only 28% of the children had good medication adherence. Nazziwa et al.[16] used two methods (self-report method and blood drug concentration monitoring method) to evaluate the medication adherence of 122 children with epilepsy, and the results showed that the medication adherence from the self-report method is 79.5%, which is higher than the results of this study, which may be related to the different questionnaires used and cultural differences. However, the medication adherence obtained by monitoring the blood concentration was 22.1%, which is similar to the results of this study. Blood concentration monitoring is an objective method to measure medication adherence, and its results are not much different from the results of this study, which further confirms the reliability of the results of this study. The above results suggest that children's medication adherence need to be improved, which should arouse the attention of relevant personnel.

3.2 Analysis of multiple linear regression results

Taking the basic information of the supervisors as independent variables, and the total score of the medication adherence of the children as the dependent variable, the results of multiple linear regression are as follows. The supervisor's per capita GDP level of the province, number of children in the family, domicile and family's per capita monthly income have impacts on the medication adherence of the children. Compared with supervisors in low per capita GDP provinces, supervisors in high per capita GDP provinces have relatively higher medication adherence scores. On the one hand, families with good financial status can afford the medical expenses of their children and can insist on treatment. On the other hand, doctors and pharmacists in economically developed areas may pay more attention to medication education for supervisors. Compared with the supervisor with only one child in the family, supervisors with two or more children in the family have lower medication adherence scores of their children, which is consistent with the results of a study by Yang [17] in 2006. This may be because that if parents have more than one chlid, it is not easy to take care of every child. Also, the experience of raising children makes parents think that they can decide the duration and dosage of medicine for their children, which may lead to poor medication adherence. Compared with supervisors living in cities and towns, those who live in rural areas have relatively higher medication adherence of their children. This may be because medical resources in rural areas are relatively scarce. Therefore, people in rural areas have higher degree of trust and dependence on doctors.

3.3 Analysis of Influencing Factors Based on Structural Equation Model

Structural equation model shows that supervisors' perceived susceptibility, perceived severity and

self-efficacy have significant direct effects on children's medication adherence. The direct effect of perceived susceptibility is negative. Perceived susceptibility refers to subjective assessment of risk of developing a health problem. Supervisors with higher scores on the perceived susceptibility dimension have a higher risk of non-adherence with medication. Perceived severity has a direct positive effect which is the supervisor's subjective perception of potential harm. When the supervisors realize that non-adherence with medication will damage children's health, they will be more likely to follow the doctor's advice. Self-efficacy refers to an individual's perception of his or her competence to successfully perform a behavior. Supervisor with higher scores on the self-efficacy dimension have higher subjective initiative in improving children's medication adherence, so their children's medication adherence scores are relatively higher[18] .

In addition, there are a wide range of mediating effects in the model, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and objective constraints are all mediating variables of the model. Perceived severity not only has a direct impact on the medication adherence, but also is the most important mediating variable. Perceived severity, perceived benefits and perceived barriers can all affect the self-efficacy and thereby affect the medication adherence of the children.

3.4 Limitation

The limitations of the study are as follows. Firstly, as the research data is in the form of self-reporting, it is difficult to eliminate some recall bias. Secondly, this was a cross-sectional research, so the conclusions are only the dimensional factors of the current health belief model and the supervisor's children medication adherence relationship. At the same time, because of the use of cross-sectional data, it is impossible to judge the causal relationship between the supervisor's children medication adherence and health beliefs. Due to the impact of the COVID-19, offline questionnaire investigations cannot be conducted, so the convenience of sampling by investigators cannot be completely randomized. Inevitable selection bias may exist which may affect the results. Finally, the influence of family economic status on medication adherence of children is still unclear, and further research is needed.

4. Conclusion

Supervisors have an impact on their children's medication adherence. Per capita GDP level of the province, the number of children in the family and domicile may affect the children's medication adherence. From the structural equation model, the supervisors' perceived severity and self-efficacy have positive direct effects, while supervisors' perceived susceptibility has negative direct effect on their children's medication adherence.

5. Prospect

In the practice of pediatric pharmacy, it is necessary to strengthen the medication education for supervisors especially those who have more than one child, so that they can realize the importance

of their children's medication adherence and the serious consequences of non-adherence, then their self-efficacy would be improved so as to improve children's medication adherence.

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