Postprint: Analysis of Medication Adherence and Influencing Factors among Older Adults in Shandong Province under a Proactive Health Management Model

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Abstract

Background Older adults often suffer from multiple chronic diseases and require multiple medications. Many patients have difficulty adhering to medication continuously or appropriately due to various factors, leading to poor disease control and undesirable medical outcomes. Therefore, understanding the current status of medication adherence behaviors and their influencing factors among older adults is of great significance for improving and enhancing medication adherence. As one of China' s most populous provinces, Shandong leads the nation in aging degree, with an overall poor status of medication adherence manifested by frequently changing medication timing, missed doses, or incorrect dosing. Consequently, the issue of medication adherence among older adults in Shandong has become a critical factor affecting treatment efficacy and quality of life. Objective To investigate the medication adherence status of older adults in Shandong under the active health management model and analyze the factors influencing their medication adherence, thereby providing an effective reference basis for medication behavior management among older adults in this region. Methods A multi-stage random sampling method was employed to select 5,447 elderly individuals aged 65 and above from 100 basic community units in Shandong for a questionnaire survey. The survey content mainly included basic sociodemographic information, health-related knowledge, health-related attitudes, health-related behaviors, medication adherence, and quality of life. The 2 test was used to compare scores on chronic disease knowledge, attitudes, practices, and quality of life among older adults, while multivariate Logistic regression analysis was employed to explore the influencing factors of medication adherence among older adults in Shandong. Results A total of 5,447 older adults were included in the study, with a Morisky scale score of (6.33$±$1.31) points. Among them, 4,480 cases (82.25%) had good

medication adherence, while 967 cases (17.75%) had poor medication adherence. Multivariate Logistic regression analysis indicated that gender (OR=0.86, 95%CI=0.74~0.99, P=0.038), marital status (OR=0.90, 95%CI=0.82~0.98, P=0.017), health-related attitudes (OR=0.78, 95%CI=0.68~0.90, P<0.001), willingness to change behavior (OR=0.51, 95%CI=0.41~0.65, P<0.001), and quality of life (OR=0.66, 95%CI=0.57~0.77, P<0.001) were influencing factors of medication adherence among older adults. Conclusion Medication adherence among older adults in Shandong was generally good, and multiple factors including health-related attitudes, willingness to change behavior, and quality of life significantly influenced medication adherence. When developing intervention strategies for medication adherence among older adults, management of these factors should be strengthened.

Full Text

Analysis of the Current Situation and Influencing Factors of Medication Adherence among the Elderly in Shandong Province Under an Active Health Management Model

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Abstract

Background: The elderly often suffer from multiple chronic diseases requiring long-term pharmacotherapy, yet many struggle to maintain consistent or proper medication use due to various factors, resulting in poor disease control and suboptimal health outcomes. Understanding the current status and determinants of medication adherence among older adults is therefore crucial for improving adherence and treatment efficacy. As one of China' s most populous provinces with a rapidly aging population, Shandong faces particularly severe challenges with medication non-adherence, including frequent timing changes, missed doses, and incorrect administration, making this a critical factor affecting therapeutic outcomes and quality of life for its elderly residents.

Objective: This study examines medication adherence among elderly individuals in Shandong Province under an active health management model and iden-

tifies its influencing factors to provide evidence-based recommendations for improving medication behavior management in this population.

Methods: Using multi-stage random sampling, we surveyed 5,447 elderly individuals aged 65 and older across 100 basic community units in Shandong. The questionnaire covered sociodemographic characteristics, health-related knowledge, attitudes, behaviors, medication adherence, and quality of life. Chi-square tests compared scores across chronic disease knowledge-attitude-practice domains and quality of life, while multivariate logistic regression analysis identified factors influencing medication adherence.

Results: Among 5,447 participants, the mean Morisky Medication Adherence Scale (MMAS-8) score was (6.33$±$1.31). Overall, 4,480 individuals (82.25%) demonstrated good medication adherence, while 967 (17.75%) showed poor adherence. Logistic regression revealed that gender (OR=0.86, 95%CI=0.74-0.99, P=0.038), marital status (OR=0.90, 95%CI=0.82-0.98, P=0.017), health-related attitudes (OR=0.78, 95%CI=0.68-0.90, P<0.001), willingness to change behavior (OR=0.51, 95%CI=0.41-0.65, P<0.001), and quality of life (OR=0.66, 95%CI=0.57-0.77, P<0.001) were significant determinants of medication adherence.

Conclusion: While medication adherence among Shandong' s elderly population is generally good, health-related attitudes, behavioral change willingness, and quality of life significantly influence adherence. Intervention strategies should prioritize these modifiable factors to enhance medication adherence among older adults.

Keywords: Medication adherence; Chronic disease; Aged; Cross-sectional studies; Shandong Province

Introduction

Chronic non-communicable diseases, commonly referred to as chronic diseases, represent a broad category of conditions characterized by slow onset, insidious progression, and complex etiologies [1]. Epidemiological evidence demonstrates that chronic disease prevalence increases progressively with age [2]. Older adults frequently suffer from multiple chronic conditions requiring polypharmacy, yet they often exhibit suboptimal medication adherence. Various methods exist for assessing adherence, among which the eight-item Morisky Medication Adherence Scale (MMAS-8) has been widely validated as a self-management tool [3]. Research indicates that medication adherence is a complex process influenced by numerous factors; one meta-analysis incorporating 569 studies identified over 200 variables associated with adherence behavior [3].

Both domestic and international studies [5-9] have shown that even when receiving pharmacological treatment, many chronic disease patients struggle to maintain consistent or proper medication use due to diverse factors, leading to

poor disease control and undesirable health outcomes, including reduced quality of life, increased hospital readmission rates, and worse clinical prognosis [10]. Therefore, understanding the current status and determinants of medication adherence among older adults is essential for improving adherence, disease management, and quality of life.

As one of China' s most populous provinces, Shandong is at the forefront of population aging nationwide. By the end of 2022, Shandong' s population aged 60 and above reached 22.5 million, accounting for over 20% of the province' s total population, indicating a severe aging trend [11]. This demographic shift has led to significantly increased incidence of chronic and multiple diseases among Shandong' s elderly, with hypertension, diabetes, and other conditions becoming highly prevalent and requiring long-term medication [12]. However, research reveals that medication adherence among elderly chronic disease patients in Shandong is generally poor, characterized by frequent changes in dosing times, missed doses, and incorrect administration. Consequently, medication adherence has become a critical factor affecting treatment efficacy and quality of life for Shandong' s older adults. This study analyzes the current status and influencing factors of medication adherence among Shandong residents aged 65 and older under an active health management model, providing evidence and recommendations for targeted interventions to improve adherence.

1.1 Survey Subjects

Based on Shandong' s GDP levels in the first half of 2023, we randomly selected two cities from high, medium, and low economic tiers, totaling six cities as active health demonstration areas. Within these areas, we implemented an integrated chronic disease active health management model that, while adhering to national basic public health service principles, employed advanced "one-brain, multi-terminal" online integrated real-time prediction and early warning technology for chronic diseases. Through the "Active Health Cloud Intelligent Management System—Chronic Disease Management Terminal," we provided personalized risk assessment and chronic disease management information 推送 services specifically for elderly individuals aged 65 and above to enhance their health management capabilities.

Using multi-stage random sampling, we randomly selected 10 counties from Shandong' s active health demonstration areas, then one township from each county (10 townships total), and subsequently 10 basic community units (village committees/residents'committees) from each township. From each selected community, we randomly sampled 50 elderly individuals aged 65 and older based on population size, yielding 5,460 eligible participants from 100 community units. Inclusion criteria were: (1) age 65 years or older; (2) clear thinking with adequate reading and comprehension abilities; (3) informed consent from participants and their families. Exclusion criteria included: (1) hearing loss or

language communication barriers; (2) non-cooperation or severe illnesses (e.g., cancer) that would affect survey participation. During field surveys, we excluded 13 individuals who could not attend due to hospitalization or travel, ultimately conducting face-to-face interviews with 5,447 participants, with surveyors completing questionnaires on their behalf. All 5,447 questionnaires collected were valid. This study was approved by the Shandong University Public Health Ethics Committee (Approval No.: LL20230702), and all participants provided informed consent before the survey.

1.2.1 Questionnaire Design

Our research team developed the "Active Health Chronic Disease Management Model Effectiveness Evaluation Questionnaire," which included sociodemographic characteristics, health-related knowledge, attitudes, behaviors, medication adherence, behavioral change willingness, satisfaction, injury-related information, and quality of life. Specifically: (1) Sociodemographic information included gender, birth date, ethnicity, birthplace, marital status, and living arrangement. (2) Health-related knowledge assessed participants' understanding of specific health issues and preventive measures, including disease knowledge, healthy lifestyles, and preventive health screenings. (3) Health-related attitudes evaluated perspectives on health issues, including the importance of healthy lifestyles, disease prevention attitudes, and health risk awareness. (4) Health-related behaviors examined daily health practices, including dietary habits, exercise frequency, smoking and alcohol consumption, and sleep quality. (5) Medication adherence assessed medication-taking under medical guidance, including timeliness, dosage accuracy, and adherence to medical advice. (6) Behavioral change willingness measured motivation to improve unhealthy behaviors, including smoking cessation, increasing physical activity, and improving dietary habits. (7) Quality of life comprehensively evaluated physical health, mental health, social functioning, and role functioning.

After questionnaire development, we established clear scoring criteria to ensure validity and reliability. For chronic disease knowledge-attitude-practice and behavioral change willingness questions, responses of "yes" or "know" were scored as 1 point, while "no" or "don' t know" or non-responses were scored as 0. Using the median as the cutoff, scores $\geq$ median were considered passing, while scores below median were failing [13]. For quality of life, each item was scored 1–5 points, with domain scores calculated such that higher scores indicated better quality of life [14].

1.2.2 Medication Adherence Scale

We used the Morisky Medication Adherence Scale, developed by Morisky et al. [15], which comprises eight items forming a single dimension and has demon-

strated good reliability in China [16]. This scale assesses medication adherence among older adults, with each "yes" response scoring 1 point and each "no" response scoring 0, yielding total scores from 0–8. Lower scores indicate poorer adherence. The maximum score is 8, with scores <6 indicating poor adherence and scores $ $6 indicating good adherence [17]. Based on Morisky scores, participants were categorized into good and poor adherence groups.

1.3 Survey Process and Quality Control

The questionnaire employed an interview-style method, with trained surveyors asking questions individually and participants responding based on their circumstances. Before implementation, surveyors received professional training. The research team explained survey objectives and significance in detail, emphasizing data confidentiality and ensuring surveyors understood the importance of protecting personal information. Surveyors were also briefed on questionnaire content and structure to familiarize them with question types and estimated completion time for proper scheduling.

During administration, when participants expressed confusion, surveyors provided clear, accurate explanations based on their training while maintaining neutrality to avoid leading or suggestive responses, ensuring authentic and objective answers. Questions were documented for subsequent analysis and questionnaire improvement. After completion, surveyors checked for unanswered items and verified clarity and accuracy, confirming and correcting errors with participants and supplementing missing items on-site. A quality control team supervised the entire process to ensure standardized data collection and smooth implementation. Following data collection, all questionnaires underwent secondary review. Questionnaires with >10% unanswered items, inconsistent responses to the same question, or clearly unrealistic answers were deemed invalid. Invalid questionnaires were flagged by the quality control team, which decided whether to re-survey or supplement information. Missing data were completed through telephone follow-up, while unrealistic responses triggered re-surveying to ensure data integrity and reliability.

1.4 Statistical Methods

Data were analyzed using R version 4.3.1. Descriptive statistics for continuous variables were presented as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Group comparisons used chi-square tests. Using medication adherence as the dependent variable, we employed stepwise regression to screen variables, incorporating statistically significant factors from univariate analysis into multivariate logistic regression to explore determinants of medication adherence among Shandong' s elderly. Statistical significance was set at $P<0.05$.

2.1 General Demographic Characteristics

Among 5,447 participants, 2,368 (43.47%) were male and 3,079 (56.53%) were female. Age distribution showed 3,862 individuals (70.90%) aged 65–74 years, 1,463 (26.86%) aged 75–84 years, and 122 (2.24%) aged 85 and older. The majority were of Han ethnicity (5,415; 99.41%). Regarding marital status, 4,442 (81.55%) were married, while living arrangements showed 3,737 (68.61%) living with a spouse. Detailed demographic data are presented in Table 1 .

2.2 Chronic Disease Knowledge-Attitude-Practice and Quality of Life Scores

The total possible score for the "Active Health Chronic Disease Management Model Effectiveness Evaluation Questionnaire" was 30 points, with participants achieving a mean score of (23.22$\pm$5.58).$Domainscoreswere: health-relatedknowledge(possible10points, mean7.38\pm2.96), health-relatedattitudes(possible10points, mean8.57\pm2.31), andhealth-relatedbehaviors(possible10points, mean6.25$ and a passing threshold of 19 points.

2.3 Current Status of Medication Adherence

Among 5,447 elderly participants, the mean Morisky scale score was (6.33$\pm$1.31), indicating generally good medication adherence. Specifically, 4,480 individuals (82.25%) demonstrated good adherence, while 967 (17.75%) showed poor adherence.

2.4 Univariate Analysis of Medication Adherence Factors

Univariate analysis revealed statistically significant differences between good and poor adherence groups in gender, marital status, health-related attitudes, behavioral change willingness, and quality of life ($P<0.05$). No significant differences were observed for age, ethnicity, living arrangement, health-related knowledge, or health-related behaviors ($P>0.05$). Detailed results are presented in Table 2 .

2.5 Logistic Regression Analysis of Medication Adherence Factors

Multivariate logistic regression analysis was performed with medication adherence as the dependent variable (poor adherence=0, good adherence=1).

Independent variables included: gender (female=0, male=1), age (65-74 years=1, 75-84 years=2, $ $85 years=3), ethnicity (minority=0, Han=1), marital status (unmarried=1, married=2, divorced=3, widowed=4, other=5), living arrangement (living alone=1, living with spouse=2, living with children=3), health-related knowledge (failing=0, passing=1), health-related attitudes (failing=0, passing=1), health-related behaviors (failing=0, passing=1), behavioral change willingness (failing=0, passing=1), and quality of life (failing=0, passing=1). Results showed that gender (OR=0.86, 95%CI=0.74-0.99, P=0.038), marital status (OR=0.90, 95%CI=0.82-0.98, P=0.017), health-related attitudes (OR=0.78, 95%CI=0.68-0.90, P<0.001), behavioral change willingness (OR=0.51, 95%CI=0.41-0.65, P<0.001), and quality of life (OR=0.66, 95%CI=0.57-0.77, P<0.001) were significant determinants of medication adherence. Detailed regression results are presented in Table 3 .

Discussion

Our findings indicate that 82.25% of elderly individuals in Shandong' s active health management model demonstrated good medication adherence, suggesting a willingness to follow medical advice, though room for improvement remains. This proportion aligns with Han et al.' s study on the relationship between health self-management cognition and medication adherence among rural elderly chronic disease patients [18]. These results underscore that when older adults follow healthcare providers' medication guidance and maintain long-term adherence, positive health outcomes and improved quality of life can be achieved.

Multivariate logistic regression identified gender, marital status, health-related attitudes, behavioral change willingness, and quality of life as important determinants of medication adherence. We found that men exhibited higher adherence than women, possibly because women often receive more medications and have greater clinical complexity [19]. Suo et al. suggested that women hold more negative perceptions about medications and experience more frequent and severe adverse drug reactions. Others propose that women's lower adherence may stem from their primary caregiving responsibilities within families, causing them to neglect self-care and forget medications [20]. Gender differences in adherence have been documented across various conditions including hypertension, diabetes, hyperlipidemia, depression, asthma, and chronic obstructive pulmonary disease, warranting gender-specific considerations in future adherence research [21].

Our results also indicate that married elderly individuals showed higher adherence than their unmarried, divorced, or widowed counterparts. This may be attributed to two mechanisms: first, married seniors typically receive support from spouses or family members who provide reminders, supervision, and encouragement; second, greater social support and companionship motivates older

adults to prioritize their health, including medication adherence, thereby significantly improving safety. Additionally, family care reduces negative emotions and fosters positive psychology, helping maintain medication regimens [22-23]. Therefore, encouraging elderly individuals to maintain close contact with family, friends, and community organizations to share health information and needs can enhance support and improve adherence.

Health-related attitudes were closely associated with medication adherence, as personal health perspectives directly influence medication attitudes and behaviors. Older adults with positive health attitudes who believe antihypertensive or hypoglycemic medications can improve their health are more likely to take medications as prescribed. Conversely, those with negative attitudes who fear side effects or discomfort may reduce medication use. Healthcare providers and family members can enhance adherence by offering lifestyle recommendations regarding balanced diet, appropriate exercise, salt reduction, smoking cessation, limited alcohol consumption, and timely medication use, thereby improving health literacy, self-management awareness, disease knowledge, and recognition of treatment benefits [24-25]. Moreover, improved lifestyle habits can effectively prevent and control many chronic diseases, further supporting medication adherence.

Behavioral change willingness also correlated with adherence, reflecting individuals' readiness and motivation to adopt specific health behaviors. These intentions directly influence whether older adults adjust their lifestyles, avoid risk factors, adhere to pharmacological treatments, and follow medical advice. Our findings suggest that Shandong' s elderly are willing to adopt proactive coping strategies to address physical, psychological, and social aging pressures, actively engaging in health behaviors and developing correct medication attitudes [26]. Healthcare providers can also help by addressing negative emotions and implementing positive measures to build confidence and security, thereby enhancing life satisfaction.

Quality of life encompasses physical health, mental health, social functioning, and environmental factors. Elderly individuals who feel well in these domains may be more willing to follow medical advice and take medications as prescribed. However, those experiencing functional limitations or decline—such as difficulties mastering complex medication schedules, methods, and frequencies, or experiencing discomfort after medication—may exhibit reduced adherence through underuse, missed doses, or incorrect administration [27]. Previous research [28] suggests that higher quality of life correlates with more positive life attitudes and greater willingness to treat diseases, producing favorable impacts on long-term survival. Therefore, we conclude that further improvements in quality of life among Shandong' s elderly are needed to enhance medication adherence.

In summary, personalized educational guidance based on these determinants can help elderly individuals balance medication adherence with daily life, representing an important strategy to improve adherence and enabling 95% of older adults to achieve high adherence levels.

This study has several limitations. First, although we used multi-stage random sampling, our sample only covered Shandong' s active health demonstration areas and may not fully represent medication adherence in other regions. Future research should expand sampling to include more areas for greater generalizability. Second, data relied primarily on self-reporting, which may be subject to recall bias or social desirability bias, potentially affecting accuracy. Future studies should incorporate medical records or objective monitoring data to enhance reliability. Third, while we analyzed gender, marital status, health-related attitudes, behavioral change willingness, and quality of life, other important factors such as economic status or healthcare accessibility were not included. Future research should incorporate these variables to comprehensively explore medication adherence determinants.

Author Contributions: CHEN Yingying was responsible for study implementation, data collection and analysis, figure and table preparation, and manuscript writing. ZHU Gaopei proposed the research objectives, designed the study, and revised the manuscript. XUE Fuzhong and CHEN Yingying were responsible for quality control and review, with overall responsibility and supervision of the project.

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