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Factors affecting compliance with oral anticoagulant medication for secondary prevention in middle-aged and young patients with coronary heart disease after percutaneous coronary intervention and the establishment of a prediction model

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Abstract: Patients with coronary heart disease (CHD) who undergo percutaneous coronary intervention (PCI) may exhibit suboptimal adherence to oral anticoagulant therapy due to various factors. This study aims to investigate the determinants influencing adherence to oral anticoagulant therapy in middle-aged and young CHD patients following PCI. We conducted a retrospective analysis on the clinical data of 310 middle-aged and young CHD patients who underwent PCI treatment at The Fourth Affiliated Hospital of Zhejiang University School of Medicine between 6 month 2023 and 8 month 2024, monitored for 6 months and categorized them into a non-compliance group (n=86) and a compliance group (n=224). Results indicated that factors such as older average age, longer duration of CHD, lower educational level, lower income, and rural residence significantly impacted adherence in the non-compliance group. Univariate and multivariate logistic regression analyses identified age, duration of CHD, medication adherence score, non-compliance behavior score, marital status, income and employment status as key influencing factors. The predictive model developed demonstrated strong predictive capability (AUC=0.882) and was validated through decision curve analysis and calibration curves. These findings provide important insights for improving adherence to anticoagulant therapy among middle-aged and young CHD patients.

Keywords: Coronary heart disease, percutaneous coronary intervention, anticoagulant medication, secondary prevention, compliance.

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INTRODUCTION

In the past few years, due to ongoing shifts in dietary habits, lifestyle choices and work schedules, along with rising societal and personal stresses, the prevalence of coronary heart disease (CHD) in China has been escalating steadily and is increasingly affecting younger individuals (Peng and Yu 2021). CHD is a substantial contributor to mortality and disability in the elderly and is progressively emerging as a prominent factor in middle-aged and young populations. The disease necessitates a considerable allocation of healthcare resources and places a significant strain on societal progress and the enhancement of living conditions for individuals (Bramsved, *et al.,* 2024; Cao, *et al.,* 2022). With the ongoing enhancements and extensive clinical utilization of treatment methods for CHD (including pharmacotherapy, interventional therapy and surgical treatment), the advancement of the condition in patients with CHD has been notably postponed, leading to enhancements in their quality of life and outlook. Consequently, there has been a remarkable decrease in both short-term and long-term mortality rates (Hao *et al.,* 2021). At present, percutaneous coronary intervention (PCI) is considered the least invasive and most efficient initial therapy for CHD (Qian *et al.,* 2022). Numerous clinical trials have demonstrated that promptly performing PCI in individuals with acute coronary syndrome, with the aim of completely and consistently reopening the blocked vessel and reinstating normal blood flow in the coronary arteries, can preserve at-risk myocardium from necrosis, deter left ventricular restructuring, and notably enhance both short-term and long-term outcomes for patients (Abdelaziz *et al.,* 2024; Kirov *et al.,* 2022).

Even though PCI can swiftly and efficiently dilate narrowed coronary arteries, prevent vascular elastic recoil and negative remodeling and enhance clinical symptoms, the procedure involves changing the luminal geometry mechanically. The act of implanting a stent can potentially harm the vascular intima, incite an inflammatory reaction, prompt the migration of vascular smooth muscle cells to the intima, leading to excessive hyperplasia and thickening of the neointima, ultimately resulting in restenosis of the affected blood vessel. Consequently, the occurrence of coronary restenosis post stent implantation remains as high as 20%-30%, with the mortality rate from coronary restenosis even surpassing this figure (Pelliccia *et al*., 2023; Xiang *et al*., 2024). Therefore, the effectiveness of PCI in CHD patients across different age groups relies on the continuous and adherent use of antiplatelet medication post-operation. Improper

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utilization or early cessation of antiplatelet agents may result in the development of late stent thrombosis (Passacquale *et al.,* 2022; Tan *et al.,* 2024). Research indicates that it is recommended for all coronary heart disease (CHD) patients following percutaneous coronary intervention (PCI) to partake in secondary prevention measures. This includes receiving lifestyle guidance prior to discharge, actively managing blood pressure, addressing diabetes, ceasing smoking, regulating body mass index (BMI), participating in regular physical activity and closely monitoring blood lipids post-surgery. Moreover, patients are advised to adhere to long-term administration of antiplatelet medications, angiotensin-converting enzyme inhibitors/angiotensin receptor blockers (ACEI/ARB), beta-blockers and statins. These medications are pivotal in averting restenosis, decreasing mortality rates and lowering the probability of recurring major adverse cardiovascular and cerebrovascular incidents (Shan *et al.,* 2023). Despite the clear treatment guidelines for CHD patients after PCI provided by multiple domestic and international sources, clinical evidence indicates a high occurrence of adverse cardiac events among middle-aged and young CHD patients (Sigamani and Gupta 2022). Research on the frequency of medication adherence among CHD patients following PCI has revealed a generally low overall compliance rate, which tends to decline progressively following hospital discharge. It is frequently observed that many patients do not adhere to their cardiac rehabilitation program and fail to effectively manage risk factors associated with cardiovascular disease (Yin *et al.,* 2022).

Past research in the field has primarily concentrated on the elderly demographic when it comes to post-PCI secondary prevention in CHD patients. However, there is a lack of comprehensive studies examining the adherence to anticoagulant medication among middle-aged and young CHD patients following PCI. This study aims to fill this gap by investigating the determinants of oral anticoagulant medication adherence in this specific patient group through a retrospective analysis. By doing so, the research seeks to develop a reliable clinical prediction model that can enhance compliance rates among patients.

MATERIALS AND METHODS

Study design and participants

Conducted at The Fourth Affiliated Hospital of Zhejiang University School of Medicine between 6 month 2023 and 8 month 2024, this research is a retrospective study that is analytical, observational and open-label in nature. The experiment designer, data collectors and statistical analysts operated independently of each other, with the data collectors and statistical analysts remaining blinded to the experimental design. The study reviewed the clinical data of 310 CHD patients, comprising both middle-aged and young individuals, who underwent PCI treatment.

Criteria for inclusion: (1) Participants aged 18 to 59, categorized as middle-aged and young adults; (2) Participants who meet the CHD diagnostic criteria set forth by the International Society and Federation of Cardiology and the World Health Organization in 1979 (1979), with CHD diagnosis established based on clinical symptoms, electrocardiogram findings, and alterations in the myocardial enzyme profile; (3) Participants who have undergone coronary angiography that confirmed at least one major coronary artery with luminal diameter stenosis exceeding 70% and have received successful PCI intervention.

Criteria for exclusion from the study: ① In-hospital mortality; ② Diagnosis of malignant neoplasms or a prognosis of <1 year during hospital stay; ③ Patients with autoimmune disorders and/or receiving hormonal therapy at present; ④ History or current admission with serum creatinine levels ≥265 μmol/L or renal insufficiency; ⑤ Individuals exhibiting extremely low adherence to treatment; ⑥ Insufficient clinical records or incomplete coronary angiography findings. This research solely performed a retrospective statistical analysis on the historical inpatient database while ensuring the confidentiality of patient identities and contact details. The study was exempt from any paperwork submission requirements by the ethics committee.

Secondary prevention and grouping

Following discharge, patients were instructed to adhere to a medication regimen consisting of aspirin tablets, clopidogrel tablets, ACEI/ARB, beta-blockers and statins. Patients were categorized according to their adherence to aspirin and/or clopidogrel tablets in the first six months post-surgery, with non-adherence defined by instances of missed or delayed doses. Patients who missed or delayed their medication intake for one day or less per week and for less than three months per year were classified as the compliance group, while those failing to meet these criteria were assigned to the non-compliance group.

Observed index

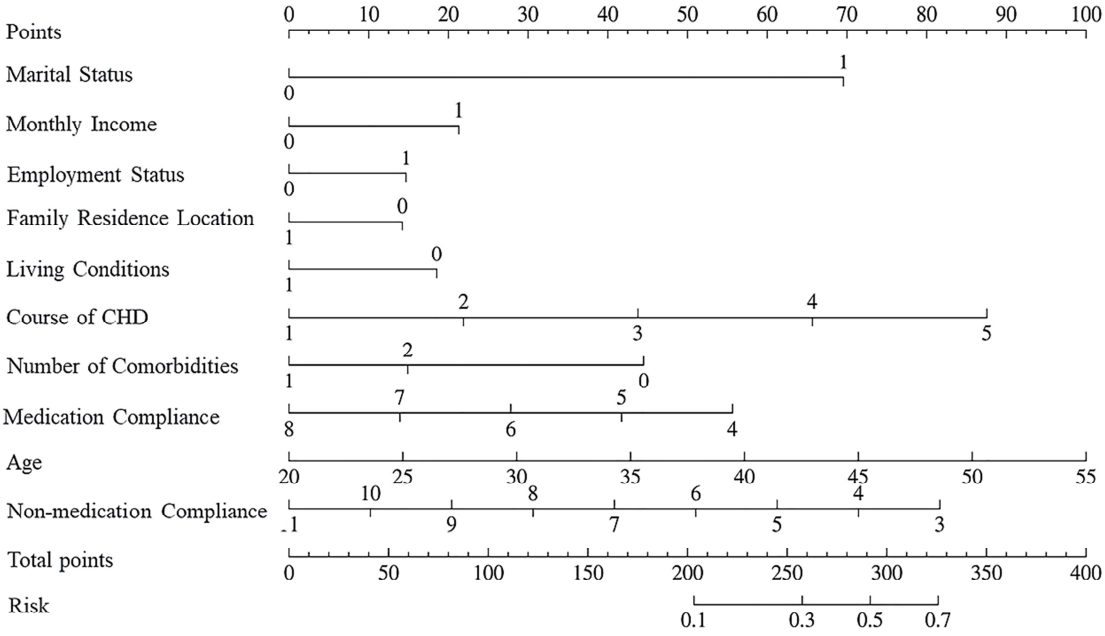
Demographic data

Data on demographic characteristics such as age, gender, BMI, marital status (presence or absence of a spouse), educational attainment (less than primary school, junior high school or senior high school, college degree or higher), monthly income (<2000 yuan, ≥2000 yuan), employment status (unemployed, employed), occupation (none, farmer, worker, cadre), residential area (rural, urban), household composition (living alone, living with family) and type of health insurance coverage (self-funded, insured) were gathered and analyzed for both groups.

Table 1: General demographic data comparison between the two groups

Index	Non-compliance group (n=86)	Compliance group (n=224)	t/χ^2	*P*
Age (years)	38.33±5.98	36.09±6.01	2.933	0.004
Gender			0.138	0.710
Female	36(41.9)	99(44.2)		
Male	50(58.1)	125(55.8)		
BMI(kg/m^2)	22.66±0.20	22.68±0.23	0.476	0.634
Marital Status			5.418	0.020
Married	47(54.7)	154(68.8)		
Unmarried	39(45.3)	70(31.3)		
Education Level			7.311	0.026
Bachelor's degree or above	32(37.2)	121(54.0)		
High school or junior high school	34(39.5)	69(30.8)		
Primary school or below	20(23.3)	34(15.2)		
Monthly Income			5.796	0.016
2000 yuan or above	38(44.2)	133(59.4)		
Below 2000 yuan	48(55.8)	91(40.6)		
Employment Status			5.180	0.023
Unemployed	31(36.0)	113(50.4)		
Employed	55(64.0)	111(49.6)		
Occupation			6.891	0.075
None	31(36.0)	113(50.5)		
Farmer	23(26.7)	37(16.5)		
Worker	22(25.6)	46(20.5)		
Cadre	10(11.7)	28(12.5)		
Family Location			5.444	0.020
Urban	40(46.5)	137(61.2)		
Rural	42(53.5)	87(38.8)		
Living Situation			4.924	0.026
Living with family	48(55.8)	155(69.2)		
Living alone	38(44.2)	69(30.8)		
Health Insurance Type			5.732	0.017
Insured	54(62.8)	171(76.3)		
Self-pay	32(37.2)	53(23.7)		

Note: BMI: body mass index.



Note: CHD: coronary heart disease.

Fig. 1: Predictive Nomogram Model for Poor Compliance with Oral Anticoagulant Medication for Secondary Prevention in Middle-Aged and Young CHD Patients After PCI

Table 2: Contrasting CHD and underlying disease traits among the two groups

Index	Non-compliance group (n=86)	Compliance group (n=224)	t/χ^2	P
Duration of CHD (years)	3.30±1.15	3.02±0.59	2.818	0.005
Number of coronary artery lesion branches			0.282	0.596
Single vessel	58(67.4)	158(70.5)		
Multiple vessels	28(32.6)	66(29.5)		
Number of stents implanted			0.655	0.418
Single	53(61.6)	149(66.5)		
Multiple	33(38.4)	75(33.5)		
Family history of CHD			0.044	0.833
None	67(77.9)	172(76.8)		
Yes	19(22.1)	52(23.2)		
Arrhythmia			0.018	0.892
None	64(74.4)	165(73.7)		
Yes	22(25.6)	59(26.3)		
Number of underlying diseases			6.930	0.031
None	47(54.7)	153(68.3)		
1 type	17(19.8)	40(17.9)		
More than 2 types	22(25.5)	31(13.8)		

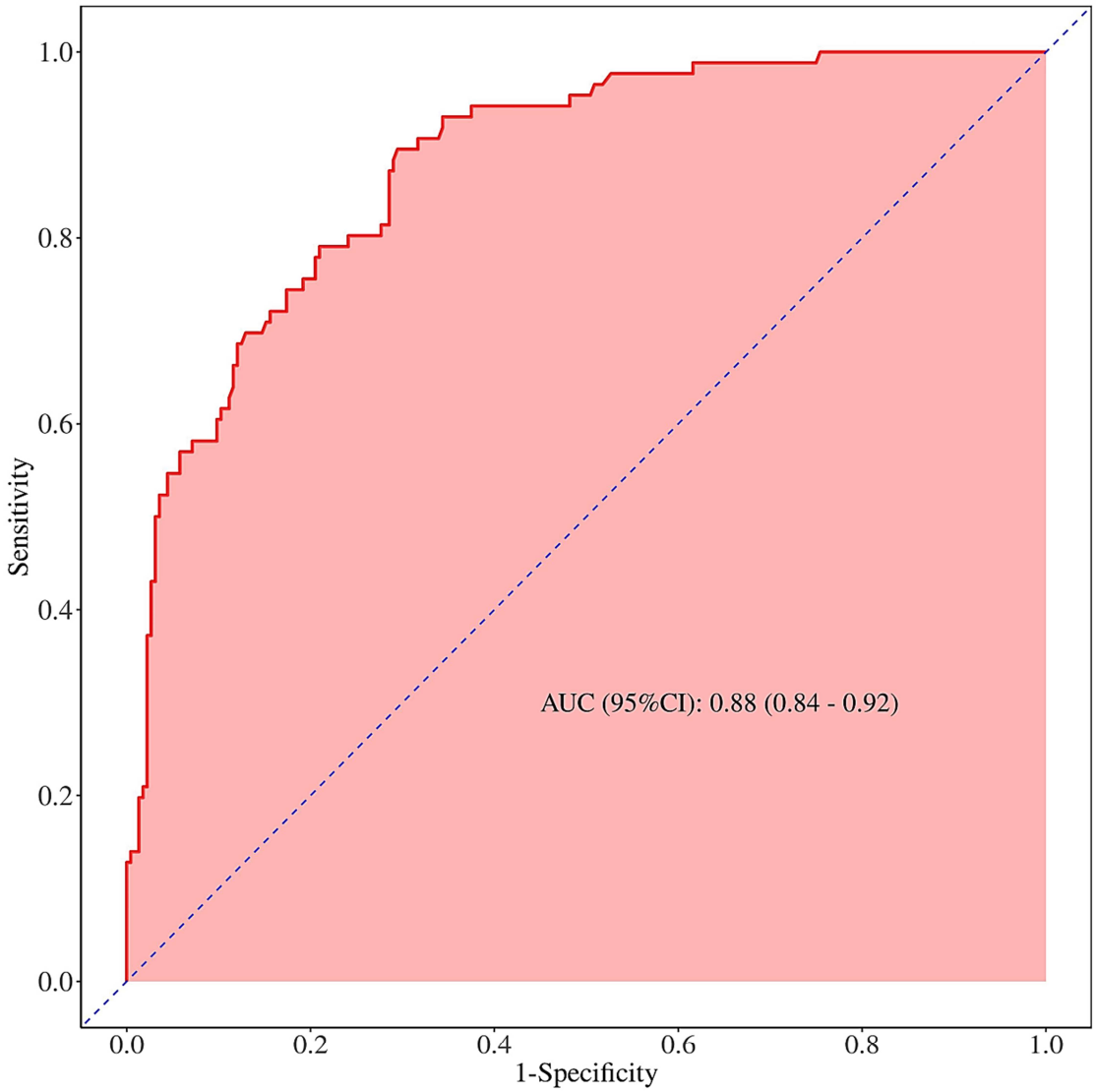
Note: CHD: coronary heart disease

Table 3: Comparing medication adherence and non-pharmacological adherence scores between the two groups

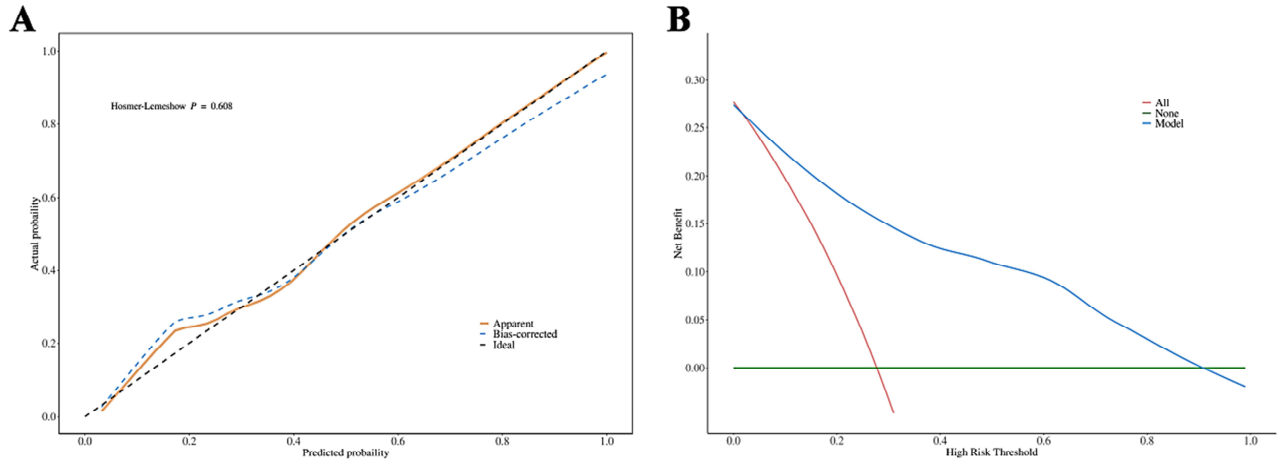
Index	Non-compliance group (n=86)	Compliance group (n=224)	t/Z	P
Medication compliance	5.99±1.39	6.33±0.69	2.866	0.004
Non-medication compliance	7.21±1.59	7.63±1.43	2.245	0.025
Smoking cessation and alcohol restriction	1(1,2)	2(1,2)	2.211	0.027
Reasonable diet	4(3,5)	4(3,5)	0.686	0.493
Physical exercise	1(0,1)	1(1,1)	2.303	0.021
Regular follow-up	1(0,1)	1(0,1)	2.237	0.025
Emotional regulation	1(0,1)	1(1,1)	2.193	0.028

Table 4: Methods for assigning values in regression analysis

Variable type	Variable Name	Assignment Method
Y(Dependent variable)	Compliance	Good compliance = 0, Poor compliance = 1
X1(Independent variable)	Age	Original value
X2(Independent variable)	Marital Status	Married =0, Unmarried =1
X3(Independent variable)	Education Level	Bachelor's degree or above = 0, High school = 1, Elementary school or below = 2
X4(Independent variable)	Monthly Income	2000 yuan or above = 0, Below 2000 yuan = 1
X5(Independent variable)	Employment Status	Unemployed = 0, Employed = 1
X6(Independent variable)	Family Location	Urban = 0, Rural = 1
X7(Independent variable)	Living Conditions	Living with family = 0, Living alone = 1
X8(Independent variable)	Health Insurance Type	Insured =0, Self-pay =1
X9(Independent variable)	Duration of CHD	Original value
X10(Independent variable)	Number of underlying diseases	None=0, 1 type =1, More than 2 types =2
X11(Independent variable)	Medication Compliance	Original value
X12(Independent variable)	Non-medication Compliance	Original value
X13(Independent variable)	Smoking cessation and alcohol restriction	Original value
X14(Independent variable)	Physical exercise	Original value
X15(Independent variable)	Regular follow-up	Original value
X16(Independent variable)	Emotional regulation	Original value



Note: ROC: receiver operating characteristic.
Fig. 2: ROC Analysis of the Predictive Efficacy of the Nomogram Model



Note: A: Calibration curve analysis of the nomogram model; B: DCA analysis of the nomogram model
Fig. 3: Calibration Curve and DCA Analysis of the Nomogram Model

Table 5: Univariate Logistic Regression Analysis of Poor Secondary Prevention Medication Compliance in Middle-Aged and Young CHD Patients After PCI

Variables	β	S.E	Z	P	OR (95%CI)
Age	0.062	0.022	2.864	0.004	1.064 (1.020 ~ 1.110)
Duration of CHD	0.459	0.167	2.755	0.006	1.582 (1.142 ~ 2.194)
Medication Compliance	-0.387	0.138	-2.802	0.005	0.679 (0.518 ~ 0.890)
Non-medication Compliance	-0.192	0.087	-2.216	0.027	0.825 (0.696 ~ 0.978)
Smoking cessation and alcohol restriction	-0.256	0.194	-1.318	0.187	0.774 (0.529 ~ 1.133)
Physical exercise	-0.624	0.272	-2.290	0.022	0.536 (0.314 ~ 0.914)
Regular follow-up	-0.588	0.264	-2.227	0.026	0.556 (0.331 ~ 0.932)
Emotional regulation	-0.598	0.274	-2.181	0.029	0.550 (0.321 ~ 0.941)
Marital Status					
0					1.000 (Reference)
1	0.602	0.260	2.313	0.021	1.826 (1.096 ~ 3.040)
Education Level					
0					1.000 (Reference)
1	0.622	0.289	2.155	0.031	1.863 (1.058 ~ 3.282)
2	0.799	0.345	2.318	0.020	2.224 (1.131 ~ 4.372)
Monthly Income					
0					1.000 (Reference)
1	0.613	0.256	2.393	0.017	1.846 (1.117 ~ 3.051)
Employment Status					
0					1.000 (Reference)
1	0.591	0.261	2.262	0.024	1.806 (1.082 ~ 3.014)
Family Location					
0					1.000 (Reference)
1	0.594	0.256	2.320	0.020	1.811 (1.096 ~ 2.991)
Living Conditions					
0					1.000 (Reference)
1	0.576	0.261	2.206	0.027	1.778 (1.066 ~ 2.966)
Health Insurance Type					
0					1.000 (Reference)
1	0.648	0.273	2.375	0.018	1.912 (1.120 ~ 3.264)
Number of underlying diseases					
0					1.000 (Reference)
1	0.325	0.334	0.972	0.331	1.384 (0.719 ~ 2.663)
2	0.837	0.325	2.578	0.010	2.310 (1.222 ~ 4.367)

Characteristics of CHD and underlying diseases

The study compared various factors related to CHD and underlying conditions in the two groups. These factors included the length of time the individuals had been living with CHD, the presence of single or multiple coronary artery lesions, the number of stents inserted (single or multiple), a family history of CHD, the occurrence of arrhythmia and the number of underlying diseases (none, one, or more than two). The underlying conditions taken into consideration encompassed hypertension, diabetes, hyperlipidemia, chronic bronchitis, among others.

Medication compliance and non-medication compliance scores

The medication compliance of all patients was evaluated by utilizing the Chinese revised edition of the MMAS-8 scale, which is a user-friendly tool developed based on the original MMAS-8 scale introduced by Morisky *et al.,* in 2008 (Iranpour *et al.,* 2022). This scale is widely recognized for its simplicity and effectiveness in measuring patient adherence to medication post-discharge, demonstrating high levels of reliability and validity (Zhu *et al.,* 2024). Comprising 8 questions, the MMAS-8 scale employs a scoring mechanism to gauge medication adherence, assigning a total score within the 0 to 8 range. Scores below 6 suggest subpar compliance, while a score falling between 6 to 8 indicates moderate adherence and a perfect score of 8 signifies excellent compliance.

The non-medication compliance behavior questionnaire for CHD secondary prevention was developed by the research team, incorporating insights from the "CHD Secondary Prevention Guidelines" and expert input gathered through consultations and interviews. Demonstrating strong internal consistency, the questionnaire achieved a reliability coefficient of 0.845.

Comprising 12 items across 5 dimensions namely smoking cessation and alcohol restriction, physical exercise, reasonable diet, emotional regulation and regular re-examination - each item was rated with 1 point for affirmative responses and 0 for negative responses. Higher total scores on the questionnaire reflect greater adherence to the recommended behaviors.

STATISTICAL ANALYSIS

The data analysis in this research was carried out utilizing IBM SPSS Statistics for Windows, version 28.0 (IBMCorp., Armonk, N.Y., USA) software. Measurement data such as the mean ± standard deviation was presented as ($\bar{x} \pm s$) or median [interquartile range (IQR)]. Statistical analyses were performed using either the *t*-test or Mann-Whitney test. Categorical variables were represented as frequencies (%) and compared utilizing the χ^2 test. Univariate and multivariate logistic regression analyses were utilized to verify the variances between groups, aiming to ascertain their impacts on the inadequate adherence to oral anticoagulant therapy among middle-aged and young patients with CHD following PCI. Subsequently, a nomogram model was developed incorporating the key influencing factors. The effectiveness of the model in predicting outcomes was examined using the ROC, with the precision of the predictive model being determined through decision curves and calibration curves. Statistical significance was defined as a *P*-value of less than 0.05.

RESULTS

General demographic data

The two groups did not show any notable variances in terms of gender distribution, occupational ratios, and average BMI ($P>0.05$). However, the non-compliance group exhibited notably higher average age, a greater percentage of individuals without a spouse, lower educational attainment, monthly income below 2000 yuan, employment status, rural living arrangements, sole residency, and proportion of self-payment compared to the compliance group ($P<0.05$, table 1).

CHD and underlying disease traits

The comparison revealed no notable variances between the two sets concerning the count of coronary artery lesion branches, the quantity of stents inserted and familial CHD history ($P>0.05$). In contrast, the non-adherent group displayed a notably extended mean CHD duration and a larger ratio of individuals with over two underlying ailments in comparison to the adherent group ($P<0.05$, table 2).

Medication adherence and non-pharmacological adherence scores

Statistically, there was no notable variance in the scores related to appropriate dietary habits between the two groups ($P>0.05$). In contrast, the group exhibiting non-adherence demonstrated notably lower mean scores in terms of adherence to medications, adherence to non-pharmacological interventions, cessation of smoking and restriction of alcohol consumption, engagement in physical exercise, attendance of regular follow-up appointments and management of emotional well-being compared to the adherent group ($P<0.05$, table 3).

Analysis of factors impacting low compliance with secondary prevention medication

In this study, the adherence to oral anticoagulant medication for secondary prevention among middle-aged and young CHD patients after PCI was considered the dependent variable, while indicators of intergroup differences were treated as independent variables. table 4 provides detailed information on the specific allocation methods. The outcomes of both univariate and multivariate logistic regression analyses revealed that variables such as age, duration of CHD, medication adherence score, non-pharmacological adherence score, marital status, monthly income, employment status, family residence, living conditions and the number of comorbidities were identified as influential factors contributing to poor compliance with secondary prevention medication among middle-aged and young CHD patients after PCI ($P<0.05$, tables 5-6).

Nomogram model for predicting poor secondary prevention medication compliance

Taking into account the findings from the multivariate logistic regression analysis, we proceeded to develop a prognostic nomogram model aimed at predicting suboptimal adherence to secondary prevention medications among middle-aged and young coronary heart disease patients following percutaneous coronary intervention, as illustrated in fig. 1. The specific model parameters are: $P(Y=1|X) = -1.899 + 0.066 \times \text{age} + 0.449 \times \text{CHD disease duration} - 0.430 \times \text{medication compliance score} - 0.689 \times \text{non-medication compliance score} + 0.861 \times \text{marital status} + 1.168 \times \text{monthly income} + 1.024 \times \text{employment status} + 1.280 \times \text{family location} + 1.551 \times \text{living conditions} + 1.096 \times \text{health insurance type} + 1.661 \times \text{number of underlying diseases}$.

Predictive efficacy of the model

The results from the ROC analysis demonstrate that the model's predictive performance yields an AUC of 0.882 with a 95% (CI) ranging from 0.842 to 0.918, as illustrated in fig. 2. These findings strongly suggest that the predictive model possesses a high level of efficacy.

Accuracy of the predictive model

As illustrated in fig. 3, the validation curve reveals that the Hosmer-Lemeshow test P-value of the model is 0.608. This indicates that there is no noteworthy distinction

Table 6: Multivariate Logistic Regression Analysis of Poor Secondary Prevention Medication Compliance in Middle-Aged and Young CHD Patients After PCI

Variables	β	S.E	Z	P	OR (95%CI)
Intercept	-1.899	0.674	-2.537	0.012	0.407 (0.015 ~ 0.832)
Duration of CHD	0.066	0.025	2.624	0.009	1.069 (1.017 ~ 1.123)
Medication Compliance	0.449	0.188	2.391	0.017	1.566 (1.084 ~ 2.262)
Non-medication Compliance	-0.430	0.153	-2.809	0.005	0.651 (0.482 ~ 0.878)
Smoking cessation and alcohol restriction	-0.689	0.350	-1.968	0.049	0.502 (0.253 ~ 0.997)
Physical exercise	-0.498	0.335	-1.487	0.137	0.608 (0.315 ~ 1.172)
Regular follow-up	-0.094	0.123	-0.764	0.445	0.911 (0.716 ~ 1.158)
Emotional regulation	-0.545	0.335	-1.627	0.104	0.580 (0.300 ~ 1.118)
Marital Status					
0					1.000 (Reference)
1	0.861	0.204	2.505	0.013	2.364 (1.084 ~ 6.689)
Education Level					
0					1.000 (Reference)
1	1.030	0.913	0.026	0.979	1.121 (0.452 ~ 1.556)
2	1.008	0.513	0.731	0.474	1.739 (0.254 ~ 2.538)
Monthly Income					
0					1.000 (Reference)
1	1.168	0.247	2.160	0.032	1.282 (1.152 ~ 3.209)
Employment Status					
0					1.000 (Reference)
1	1.024	0.225	2.021	0.036	1.224 (1.113 ~ 2.284)
Family Location					
0					1.000 (Reference)
1	1.280	0.153	2.266	0.023	1.756 (1.096 ~ 3.947)
Living Conditions					
0					1.000 (Reference)
1	1.551	0.413	2.025	0.035	1.225 (1.093 ~ 2.123)
Health Insurance Type					
0					1.000 (Reference)
1	1.096	0.884	0.144	0.632	6.657 (0.177 ~ 7.664)
Number of underlying diseases					
0					1.000 (Reference)
1	1.251	0.312	1.371	0.170	0.286 (0.048 ~ 1.710)
2	1.661	0.276	2.754	0.006	1.516 (1.093 ~ 2.878)

Note: CHD: coronary heart disease, OR: Odds Ratio, CI: Confidence Interval

between the predicted outcomes and the actual observations, affirming a good fit of the model. Moreover, the DCA curve of the nomogram prediction model surpasses the majority of threshold levels, highlighting the clinical utility of the model.

DISCUSSION

As medical technology continues to progress, healthcare professionals now have a more comprehensive understanding of the development and advancement of CHD. Various treatment modalities such as pharmacological therapy, interventional procedures, and surgical interventions are commonly utilized in clinical settings. Among these options, the implementation of secondary prevention strategies for CHD is crucial in diminishing the occurrence of cardiovascular events and lowering rates of rehospitalization among patients (Redfern, *et al.,* 2024). It has been previously indicated by research that sticking to medication regimens among patients with coronary heart disease (CHD) is crucial not only for maintaining long-term effectiveness but also for cutting down on hospitalization expenses, conserving medical resources, and easing the financial strain on families. Nevertheless, recent research conducted both domestically and internationally reveals a prevalent underutilization of secondary prevention medications for CHD in clinical settings(Ni, *et al.,* 2019). The results of the PURE study, involving 150,000 individuals from 17 countries with varying income levels, revealed that a small percentage of patients were utilizing antiplatelet medications, statins, beta-blockers and ACEI/ARB treatments. Particularly in countries with middle and low incomes, up to 69.3% and 80.2% of patients, respectively,

were not taking any prescribed medications. Furthermore, medication usage rates were even lower among rural residents, younger individuals, smokers, women, those with lower education levels, and patients without diabetes (Yusuf, *et al.,* 2011). A study conducted by Kulkarni SP *et al.,* on 1326 patients who underwent PCI revealed that, after 12 months of discharge, the adherence rates to antiplatelet medications, beta-blockers, ACEI/ARBs, and statins for lowering lipids were 82.1%, 77.9%, 72.3%, and 72.7% respectively. It was observed that patients showed the highest compliance with antiplatelet drugs and the lowest with ACEI/ARBs (Kulkarni, *et al.,* 2006). Among 310 middle-aged and young coronary heart disease (CHD) patients who underwent percutaneous coronary intervention (PCI) in this study, 86 individuals demonstrated inadequate adherence to oral anticoagulant therapy for secondary prevention within the first 6 months post-procedure. Existing research also indicates a gradual decline in medication adherence as the time elapsed since discharge increases. The overall trend suggests a suboptimal adherence rate to secondary prevention medications in discharged middle-aged and young CHD patients. Accordingly, it is crucial to explore additional factors influencing adherence to oral anticoagulant therapy for secondary prevention in post-PCI patients and implement tailored early interventions to address this issue effectively, given its clinical significance (Gast and Mathes 2019; Kvarnström, *et al.,* 2021; Mondesir, *et al.,* 2019).

The univariate analysis in this study revealed that middle-aged and young patients with CHD who showed poor adherence to secondary prevention measures after PCI tended to have several distinguishing characteristics when compared to patients with better compliance. These characteristics included older age, longer duration of CHD, higher prevalence of being single, lower levels of education, monthly income below 2000 yuan, employment, rural residency, living alone, self-funded medical expenses and a greater prevalence of two or more comorbidities. Furthermore, the assessment of medication and non-medication compliance scores among these patients indicated that individuals with lower compliance exhibited significantly reduced scores in areas such as medication adherence, adherence to non-pharmacological measures, smoking cessation and alcohol restriction, engagement in physical exercise, attendance at regular follow-up appointments and emotional management techniques. Consistent with the results of this study, prior investigations have indicated a negative correlation between age and comorbidities and adherence among CHD patients. This could be attributed to age-related factors such as diminishing memory and cognitive functions, the increased probability of having multiple illnesses, heightened occurrences of adverse effects from medication, challenges with mobility and inconveniences in keeping up with scheduled appointments. With an increase in comorbid conditions and medication regimen complexity, the likelihood of experiencing drug-related adverse reactions rises, subsequently amplifying the challenges of medication adherence due to memory issues and financial strain. Ultimately, these factors contribute to a decline in compliance (Krueger, *et al.,* 2015; Mondesir, *et al.,* 2019; Yu, *et al.,* 2022). There was a positive association between educational attainment and adherence to medication among patients, possibly because individuals with lower levels of education tend to face financial difficulties, lack awareness regarding diseases and medications, have limited understanding of the advantages of adhering to prescribed treatments and the consequences of non-compliance and harbor concerns about potential adverse reactions to drugs. Consequently, these factors may contribute to lower levels of medication adherence (Marselin, *et al.,* 2023; Mondesir, *et al.,* 2019; Zhao, *et al.,* 2015). Patients with a spouse often exhibit better medication adherence due to the support and help provided by their partners, in contrast to those who lack a spouse. This might be attributed to the prevailing trend of individuals living away from their children and receiving fewer visits, underscoring the influence of family support on medication adherence. Moreover, the elevated expenses associated with medications and the disparities in healthcare services available at various levels contribute to lower medication adherence among economically disadvantaged patients, as opposed to those covered by medical insurance or benefiting from complimentary medical services (Guo, *et al.,* 2023; Shahin, *et al.,* 2021; Shen, *et al.,* 2022).

Additionally, we performed both univariate and multivariate Logistic regression analyses on the aforementioned intergroup differences indicators. Our findings indicated that factors such as age, duration of CHD, medication adherence rating, non-medication adherence rating, marital status, monthly income, employment situation, family residence, living environment and comorbidities count all played a role in affecting the sub-optimal adherence to oral anticoagulant therapy for secondary prevention in middle-aged and young coronary heart disease patients following PCI. As individuals grow older, regardless of their age group, there is a noticeable decline in several physiological functions within the body. The aging process is frequently associated with an increase in both the severity and prevalence of chronic illnesses. Many individuals diagnosed with CHD commonly present with multiple coexisting conditions, necessitating the simultaneous intake of multiple medications. Owing to the marked decrease in multi-organ metabolic capacity among the elderly, the occurrence of adverse drug reactions and interactions becomes more prevalent, while drug tolerance diminishes (Mondesir *et al.,* 2019; Ni, *et al.,* 2019). Simultaneously, many individuals with CHD (particularly those with recently diagnosed conditions and

those receiving surgical interventions) are susceptible to experiencing mental health challenges like anxiety, depression and trepidation because of insufficient knowledge about their condition and its management. These psychological issues may impact adherence to prescribed medications and ultimately influence the prognosis (Kvarnstrom *et al.,* 2021). Patients with coronary heart disease who have a partner exhibit improved adherence to medication post- PCI, highlighting the significance of fostering a robust family and social support network (Ekman *et al.,* 2006). Several researches have indicated a direct relationship between the educational attainment of individuals with CHD and their adherence to medication. However, the majority of these studies have concentrated on older CHD patients. While individuals with lower educational backgrounds may encounter challenges related to reading, understanding, and assimilating new information, it is worth noting that middle-aged and younger populations typically exhibit better comprehension skills and are more open to unfamiliar concepts. As a result, the impact of educational level on medication adherence may not be particularly pronounced in these age groups (Dugunchi *et al.,* 2024; Zhao *et al.,* 2015). Nevertheless, inadequate medication knowledge among CHD patients can lead to subpar medication adherence. Research conducted both domestically and internationally has highlighted that individuals with lower income levels are more likely to exhibit poor adherence, particularly among CHD patients residing in remote or rural areas with limited access to medical insurance and scarce healthcare resources. In contrast, patients with higher and more stable incomes typically have consistent work routines, better access to healthcare services and are more receptive to health education on diseases, medications and treatments (Studer, *et al.,* 2023; Wilder, *et al.,* 2021). It is worth noting that patients who are in employment exhibit lower adherence to medication compared to those who are retired or unemployed. This difference in medication compliance may be attributed to the ongoing work-related stress faced by middle-aged and young patients with coronary heart disease even post-PCI surgery. The demanding work environment often leads to irregular routines, neglect of health priorities and a lack of focus on managing their condition. Additionally, the challenges of busy work schedules might result in patients forgetting to take their medication, missing doses, or unintentionally leaving their medication behind when traveling for work (Dugunchi, *et al.,* 2024; Kvarnström, *et al.,* 2021).

Nevertheless, given that this research is based on a limited sample size and conducted at a single center, it is important to exercise caution when extrapolating and implementing the findings. Subsequent studies involving larger sample sizes, multiple centers and a prospective design are imperative to confirm the clinical relevance of the identified risk factors for suboptimal adherence to oral anticoagulants in secondary prevention. Additionally, it is essential to develop and optimize management approaches aimed at enhancing medication compliance among post-PCI patients with coronary heart disease across varying age groups.

CONCLUSION

In conclusion, this research indicates that various factors such as age, duration of CHD, adherence to prescribed medications, relationship status, income level, employment status, family residence, living environment, and the presence of other health conditions play significant roles in influencing middle-aged and young CHD patients' adherence to oral anticoagulant therapy for secondary prevention following PCI. The predictive model developed utilizing these variables demonstrates notable effectiveness and precision.

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