

Supplementary material

Article title: Association between physical activity, sleep quality and diabetes: a population-based analysis

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1 Supplementary Figures

1.1 Inclusion and exclusion criterion I

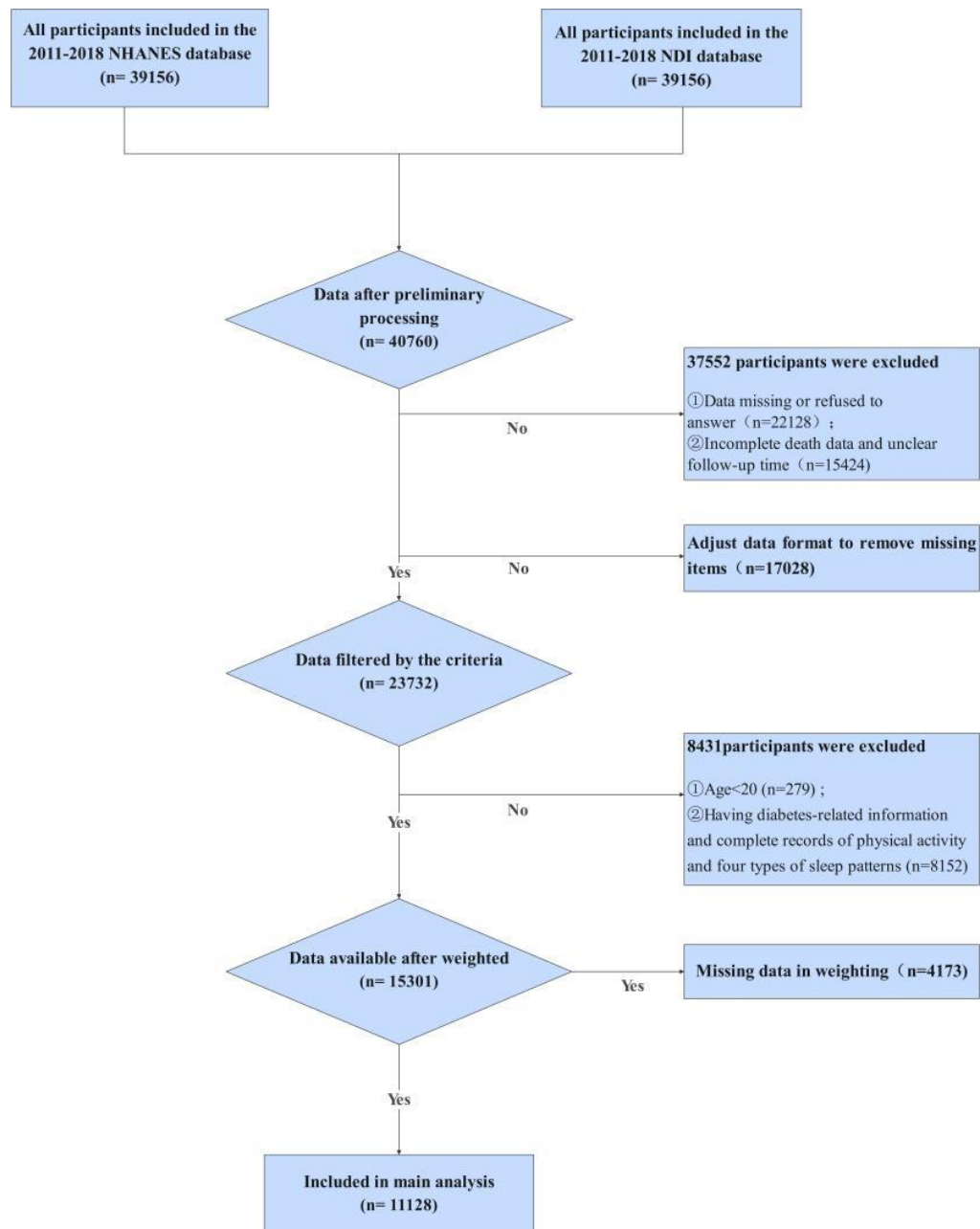


Fig. 1 The process of inclusion and exclusion criteria for participants from 2011 to 2018

1.2 Three conditions

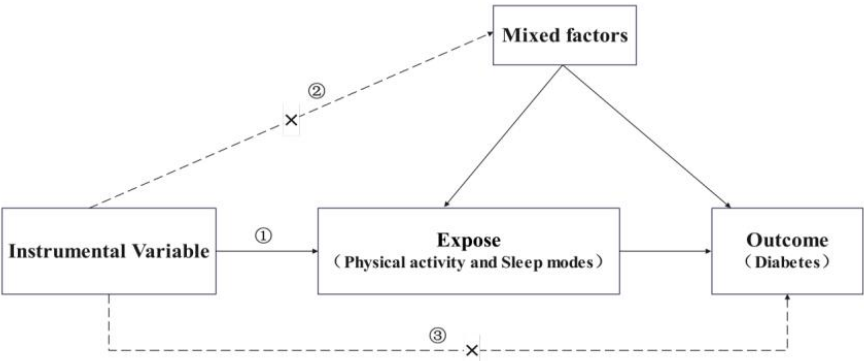


Fig. 2 Three conditions of Mendelian randomization in this study

1.3 Age distribution

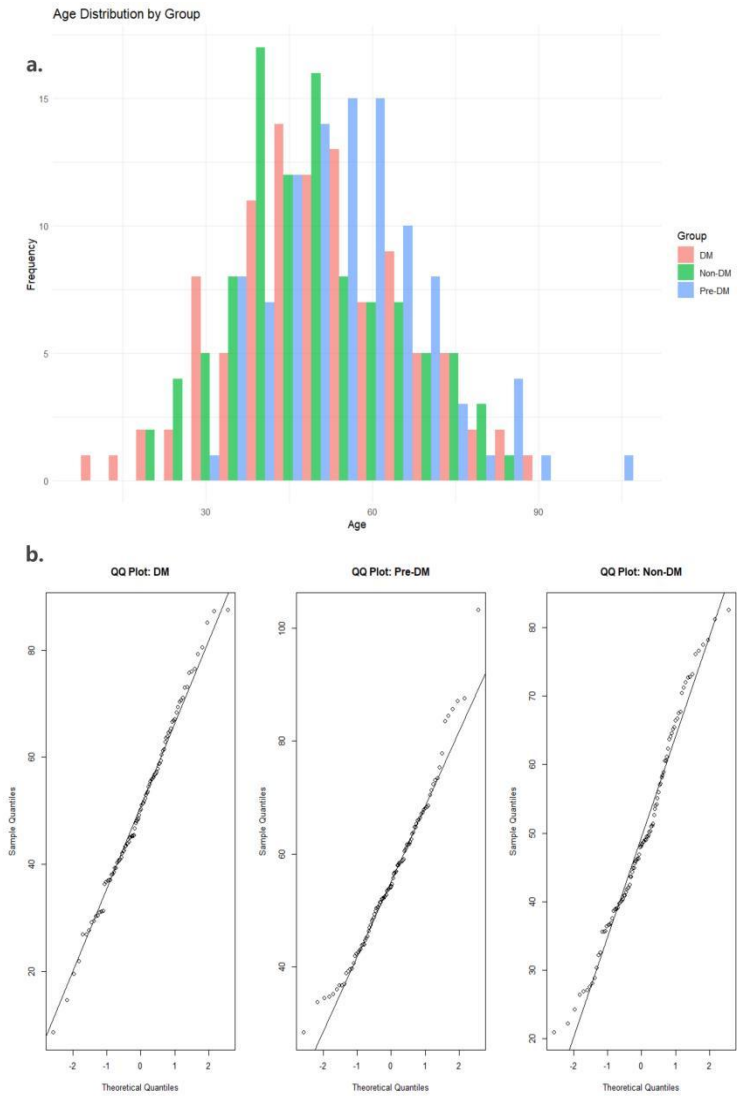


Fig. 3 Age distribution of different types of diabetes status. **Fig. a** is histogram. **Fig.b** is QQ-plot

1.4 ROC curve of binary and multiple logistic regression models

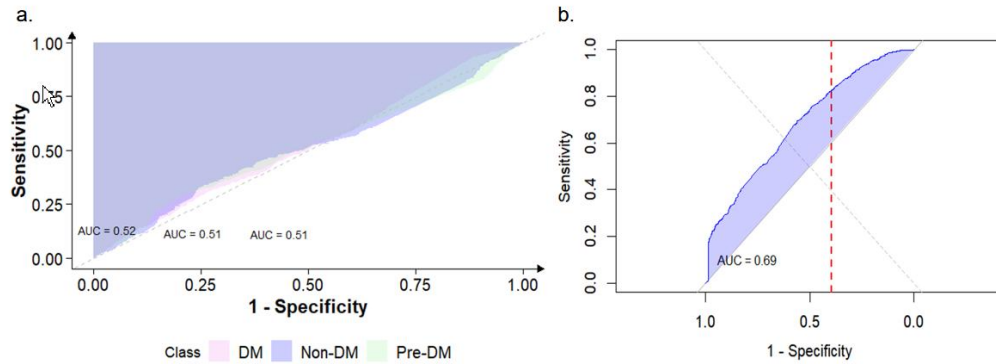


Fig. 4 **Fig. a** shows the ROC plot of the multinomial logistic regression model. **Fig. b** shows the ROC plot of the binary logistic regression model with a threshold value of 0.4. X-axis: Sensitivity, i.e., the proportion of positive classes that the model can correctly identify. Y-axis: 1-Specificity, i.e., the proportion of negative classes that the model incorrectly identifies as positive classes

1.5 Interaction between physical activity and sleep quality

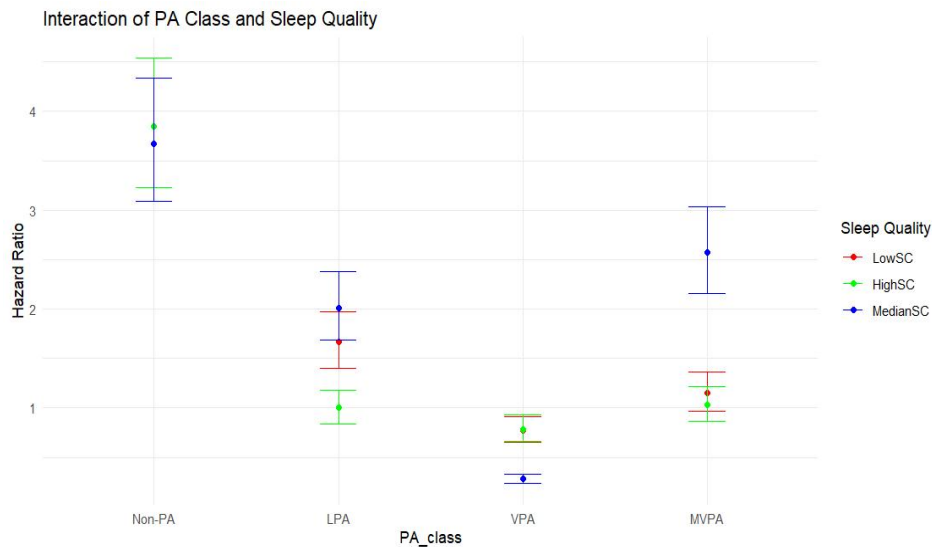


Fig. A5 The interaction between physical activity classification and sleep quality categories under weighted multivariate COX risk regression model

1.6 Forest plot of physical activity and other sleep patterns

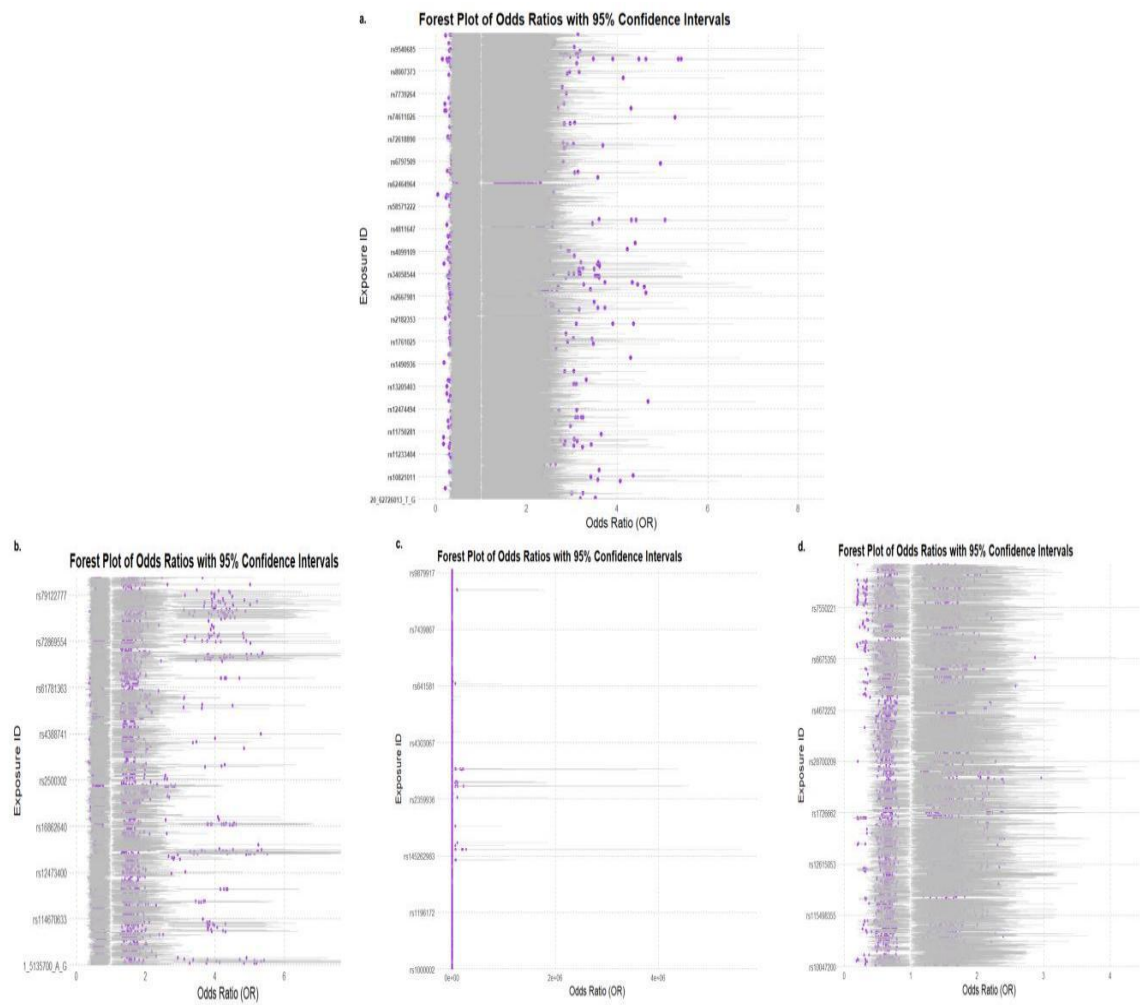


Fig. A6 **Fig. a** represents physical activity, **Fig. b** represents snoring, **Fig. c** represents sleep apnea and **Fig. d** represents daytime sleepiness

2 Supplementary Table

2.1 Revised measurement index and diagnostic criteria

Table 1 Revised measurement index and diagnostic criteria of diabetes status

Measurements	Diagnosis mmol/L (mg/dL)		
	Normal	Pre-diabetic	Diabetic
Fasting blood glucose(FPG)	< 5.6 (< 100)	5.6–6.9(100-125)	≥ 7.0 (≥126)
Glycosylated haemoglobin(HbA1c)	<5.7%	5.7%-6.4%	≥ 6.5%

Notes: diagnosis of diabetes is confirmed by several measurements with consistent and standardised results, accompanied by typical symptoms of diabetes (e.g., polyuria, thirst, weight loss, etc.)

2.2 Basic characteristics of the total participants

Table 2 The basic characteristics of study participants

	Total	with diabetes	with prediabetes	without diabetes	<i>p-value</i>
Age , mean (SD),years	49.37(17.43)	49.09(17.58)	57.37(14.14)	47.62(15.23)	<0.001 ^{*1}
Age , n (%)					<0.001*
20-40	3999(35.9)	3860 (36.8)	54 (12.9)	85 (39.9)	
40-60	3752(33.7)	3490 (33.3)	182 (43.3)	80 (37.6)	
≥60	3377(30.4)	3145 (30.0)	184 (43.8)	48 (22.5)	
Gender , n (%)					0.002*
Male	5612(50.4)	5336 (50.8)	187 (44.5)	89 (41.8)	
Female	5516(49.6)	5159 (49.2)	233 (55.5)	124 (58.2)	
Race/Hispanic origin, n (%)					0.609
Mexican American	1652(14.8)	1555 (14.8)	59 (14.0)	38 (17.8)	
Non-Hispanic Black	2774(24.9)	2617 (24.9)	113 (26.9)	44 (20.7)	
Non-Hispanic White	4880(43.9)	4610 (43.9)	175 (41.7)	95 (44.6)	
Other Race - Including Multi-Racial	1822(16.4)	1713 (16.3)	73 (17.4)	36 (16.9)	
Education level, n (%)					0.401
Less than high school	1215(10.9)	828 (7.9)	252 (60.0)	135 (63.4)	
High school grad or equivalent	3809(34.2)	3610 (34.4)	138 (32.9)	61 (28.6)	
College or above	6104(54.9)	6057 (57.7)	30 (7.1)	17 (8.0)	
Marital status, n (%)					0.064
Living alone	4430(39.8)	4205 (40.1)	153 (36.4)	72 (33.8)	
Married/Living with partner	6698(60.2)	6290 (59.9)	267 (63.6)	141 (66.2)	
BMI, n (%)					<0.001*
Underweight	179(1.6)	177 (1.7)	1 (0.2)	1 (0.5)	
Normal	3165(28.4)	3050 (29.1)	65 (15.5)	50 (23.5)	
Overweight	3606(32.4)	3402 (32.4)	134 (31.9)	70 (32.9)	
Obese	4178(37.6)	3866 (36.8)	220 (52.4)	92 (43.2)	
Smoking status, n (%)					0.003*
Never smoker	6221(55.9)	5890 (56.1)	218 (51.9)	113 (53.1)	
Past smoker	2615(23.5)	2426 (23.1)	123 (29.3)	66 (31.0)	
Current smoker	2292(20.6)	2179 (20.8)	79 (18.8)	34 (16.0)	
Physical activity, n (%)					0.210
none,Non-PA	2772(24.9)	2614 (24.9)	97 (23.1)	61 (28.6)	
Light,LPA	1722(15.5)	1619 (15.4)	76 (18.1)	27 (12.7)	
Moderate,MVPA	3373(30.3)	3172 (30.2)	140 (33.3)	61 (28.6)	
High,VPA	3261(29.3)	3090 (29.4)	107 (25.5)	64 (30.0)	
Sleep, mean ± SD	4.12 ± 3.49	4.07 ± 3.47	5.15 ± 3.67	4.60 ± 3.58	<0.001*
Sleep Quality, n (%)					<0.001*
Low	1219(11.0)	1016 (9.7)	73 (17.4)	130 (61.0)	
Median	7670(68.9)	7408 (70.6)	226 (53.8)	36 (16.9)	
High	2239(20.1)	2071 (19.7)	121 (28.8)	47 (22.1)	

¹ * indicates that there is a statistically significant difference between the variable and the outcome.

2.3 Basic characteristics of sleep patterns

Table A3 The basic characteristics of study participants in sleep patterns

	Total	with diabetes	with prediabetes	without diabetes	<i>p-value</i>
Sleep duration level, n (%)	n=7662	n=7318	n=216	n=128	0.622
<6	2079(27.1)	1990 (27.2)	52 (23.7)	37 (28.9)	
6-8	4017(52.4)	3825 (52.3)	126 (57.5)	66 (51.6)	
≥8	1569(20.5)	1503 (20.5)	41 (18.7)	25 (19.5)	
snoring, n (%)	n=3457	n=3172	n=200	n=85	0.222
Never	959(27.7)	895 (28.2)	43 (21.5)	21 (24.7)	
Rarely - 1-2 nights a week	949(27.5)	873 (27.5)	55 (27.5)	21 (24.7)	
Occasionally - 3-4 nights a week	660(19.1)	603 (19.0)	43 (21.5)	14 (16.5)	
Frequently - 5 or more nights a week	889(25.7)	801 (25.3)	59 (29.5)	29 (34.1)	
Sleep apnea, n (%)	n=3457	n=3172	n=200	n=85	0.071
Never	2547(73.7)	2354 (74.2)	134 (67.0)	59 (69.4)	
Rarely - 1-2 nights a week	260(7.5)	214 (6.7)	33 (16.5)	13 (15.3)	
Occasionally - 3-4 nights a week	478(13.8)	448 (14.1)	24 (12.0)	6 (7.1)	
Frequently - 5 or more nights a week	172(5.0)	156 (4.9)	9 (4.5)	7 (8.2)	
Daytime sleepiness, n (%)	n=3457	n=3172	n=200	n=85	0.524
Never	609(17.6)	570 (18.0)	27 (13.5)	12 (14.1)	
Sometimes - 1-4 times a month	1960(56.7)	1786 (56.3)	124 (62.0)	50 (58.8)	
Often- 5-15 times a month	617(17.9)	569 (17.9)	31 (15.5)	17 (20.0)	
Almost always - 16-30 times a month	271(7.8)	247 (7.8)	18 (9.0)	6 (7.1)	

2.4 HR and 95%CI in the subgroups

Table 4 HR and 95%CI for each group in the three subgroups

	HR(95%CI)		<i>P-value</i>
	Physical activity	Sleep quality	
Age group			<0.001*
20-40	0.06(0.05,0.09)	0.05(0.04,0.07)	
40-60	0.22(0.18,0.26)	0.20(0.16,0.23)	
Gender group			<0.001*
Male	1.58(1.38,1.81)	1.30(1.13,1.49)	
BMI group			<0.001*
Normal	0.52(0.35,0.76)	0.48(0.33,0.70)	
HighBMI	0.47(0.32,0.67)	0.48(0.33,0.69)	

3 STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies

	Item No	Recommendation
Title and abstract	1	Association between physical activity, sleep quality and diabetes: a population-based analysis
Introduction		
Background/rationale	2	Many studies have shown that physical activity and sleep quality are risk factors for diabetes and its complications. Although many studies have examined the relationship between physical activity and sleep quality and diabetes, most of these studies are observational, making it difficult to establish a causal relationship.
Objectives	3	This study investigates how physical activity and sleep quality influence diabetes status using statistical methods and causal analysis.
Methods		
Study design	4	physical activity, sleep quality, sleep patterns and diabetes
Setting	5	Collecting the data from three database.
Participants	6	Inclusion and exclusion criterion I and II.
Variables	7	Outcomes: diabetes status, exposures: physical activity, sleep quality, sleep patterns, potential confounders: age, gender, BMI and other factors.
Data sources/ measurement	8*	Collecting the data from three database. And physical activity and sleep quality are classified according to indicators M and S, respectively.
Bias	9	lasso Regression, regularization, oversampling and standardization.
Study size	10	The size of the study was determined by screening available participants according to the inclusion and exclusion criteria.
Quantitative variables	11	Physical activity and sleep quality were grouped by the range of M and S because there was no uniform indicator in the selected data set.
Statistical methods	12	(a) binary and multinomial logistic regression, COX proportional hazards regression, subgroup analyses and Two-sample Mendelian randomization
		(b) subgroup analyses
		(c) Multiple interpolation and random forest model interpolation
		(d) statistical methods and causal analysis
		(e) ROC curve, Q-tests and MR-Egger tests
Results		
Participants	13*	(a) we include 11,128 participants through I (67,184 are excluded)
		(b) Inclusion and exclusion criterion I and II
		(c) Supplementary Figures 1,1

Descriptive data	14*	(a) The baseline characteristics (b) diabetes status: 0(interpolation)
Outcome data	15*	Diabetic:10495, pre-diabetic:420 normal:213
Main results	16	Physical activity: inactivity (0), light activity (0-600), moderate activity (600-3000), and vigorous activity (>3000) Sleep quality: high ($9 \leq S \leq 12$), medium ($5 \leq S \leq 8$) and low ($1 \leq S \leq 4$)
Other analyses	17	subgroups and interactions analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	This work was supported by Chongqing Medical and Pharmaceutical College University-level Research Project [grant numbers ygzrc2024109]. And Jie Fan is the Corresponding authors.