



中老年人疼痛和抑郁症状的关系:一项交叉滞后的纵向分析*

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【摘要】目的 探究我国中老年人疼痛与抑郁症状之间的纵向关联,为中老年人疼痛与抑郁的管理提供科学依据。**方法** 利用中国健康与养老追踪调查(China Health and Retirement Longitudinal Study, CHARLS)2011-2020年共5次随访数据,纳入年龄 ≥ 45 岁且完整参与5次调查的中老年人7 876例。采用随机截距交叉滞后后面板模型(random intercept cross-lagged panel model, RI-CLPM)分析疼痛与抑郁症状在5个时间点的纵向关系。模型分步控制了以下混杂因素:非时变因素包括性别、户口和婚姻状况;时变因素包括年龄、共病、日常生活活动能力评分、吸烟、饮酒及体力活动情况。**结果** RI-CLPM模型拟合良好(CFI=0.906, TLI=0.879, RMSEA=0.036, SRMR=0.060)。在控制个体间差异后,RI-CLPM结果显示疼痛对抑郁症状的滞后效应在T1 $\rightarrow$ T5各时间段均具有统计学意义[T1 $\rightarrow$ T2: $\beta=0.043$ (95% CI: 0.020~0.067); T2 $\rightarrow$ T3: $\beta=0.047$ (95% CI: 0.023~0.070); T3 $\rightarrow$ T4: $\beta=0.056$ (95% CI: 0.034~0.078); T4 $\rightarrow$ T5: $\beta=0.050$ (95% CI: 0.028~0.071)];抑郁症状对疼痛的滞后效应在T2 $\rightarrow$ T5阶段有统计学意义,且抑郁症状对疼痛的预测作用更大[T2 $\rightarrow$ T3: $\beta=0.121$ (95% CI: 0.099~0.143); T3 $\rightarrow$ T4: $\beta=0.112$ (95% CI: 0.091~0.134); T4 $\rightarrow$ T5: $\beta=0.070$ (95% CI: 0.049~0.090)]。**结论** 疼痛与抑郁症状在时间上存在双向预测关系,疼痛对抑郁症状的预测效应稳定存在,而抑郁症状对疼痛的预测效应更强,提示在疼痛患者的诊疗过程中应注重抑郁症状的筛查。

【关键词】 中老年人 疼痛 抑郁症状 随机截距交叉滞后后面板模型

Relationship Between Pain and Depressive Symptoms in Middle-aged and Older Chinese Adults: A Cross-Lagged Longitudinal Analysis

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[Abstract] Objective To investigate the longitudinal association between pain and depressive symptoms in middle-aged and older adults in China, and to provide a scientific basis for the management of pain and depression in this population. **Methods** Data from 5 follow-up waves (conducted between 2011 and 2020) of the China Health and Retirement Longitudinal Study (CHARLS) were used in the study. A total of 7876 middle-aged and older adults aged 45 years or older who completed all 5 surveys were enrolled. A Random Intercept Cross-Lagged Panel Model (RI-CLPM) was applied to analyze the longitudinal relationship between pain and depressive symptoms across the 5 time points. The potential confounders controlled for in the model in a stepwise manner included time-invariant variables (sex, marital status, and household registration) and time-varying covariates (age, comorbidity, activities of daily living scores, smoking, drinking, and physical activity). **Results** The RI-CLPM demonstrated a good model fit (Comparative Fit Index [CFI] = 0.906, Tucker and Lewis Index [TLI] = 0.879, Root Mean Square Error of Approximation [RMSEA] = 0.036, and Standardized Root Mean Square Residual [SRMR] = 0.060). After controlling for between-person differences, the RI-CLPM results showed that the lagged effects of pain on depressive symptoms were statistically significant across all time points from T1 to T5 (T1 to T2: $\beta = 0.043$, 95% CI [0.020-0.067]; T2 to T3: $\beta = 0.047$, 95% CI [0.023-0.070]; T3 to T4: $\beta = 0.056$, 95% CI [0.034-0.078]; T4 to T5: $\beta = 0.050$, 95% CI [0.028-0.071]). Additionally, the lagged effects of depressive symptoms on pain were statistically significant from T2 to T5 (T2 to T3: $\beta = 0.121$, 95% CI [0.099-0.143]; T3 to T4: $\beta = 0.112$, 95% CI [0.091-0.134]; T4 to T5: $\beta = 0.070$, 95% CI [0.049-0.090]), and the predictive effects of depressive symptoms on pain were greater. **Conclusion** Pain and depressive symptoms have a bidirectional predictive relationship

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over time. The predictive performance of pain for depressive symptoms remains stable over time, while the predictive performance of depressive symptoms for pain is stronger. These findings suggest that screening for depressive symptoms should be emphasized in the diagnosis and treatment of patients presenting with pain.

[Key words] Middle-aged and older adults Pain Depressive symptoms Random Intercept Cross-Lagged Panel Model

当前,我国老龄化进程日益加快,第七次人口普查数据显示我国已达中度老龄化水平^[1]。在此背景下,与老龄化息息相关的心理健康问题也日益凸显。世界卫生组织数据显示,全球约有3.32亿人罹患抑郁^[2],我国中老年人抑郁患病率约为20.0%^[3]。同时抑郁也是导致自杀、自残等不良健康结局的重要风险因素,给照护者和社会带来沉重的疾病负担^[2,4]。

疼痛亦是中老年人群常见的就诊问题之一^[5-6]。疼痛不仅会显著降低人们的身体功能和生活质量,同时也与抑郁、焦虑等心理障碍的发生密切相关^[7]。既往多项研究表明,疼痛与抑郁症状间存在关联^[8-11],二者的合并发生率高达30%~50%^[10,12],提示二者间可能存在复杂的相互作用。目前,尽管国内外已开展关于疼痛与抑郁症状间关系的研究,但多局限于横断面水平,且缺乏长期随访的纵向研究证据。

交叉滞后面板模型(cross-lagged panel model, CLPM)是一种基于纵向数据、旨在检验变量间潜在因果关系与时序先后的重要方法,但该模型在估计变量间的动态关联时,未能有效区分不随时间变化的个体稳定特质(如遗传或个性特质)与变量随时间的短期波动,可能导致将个体间存在的固有差异混淆为变量在个体内层面的因果效应,从而造成因果推断上的偏差^[13]。相比之下,随机截距交叉滞后面板模型(random intercept cross-lagged panel model, RI-CLPM)通过引入随机截距项,有效

控制了由个体稳定特质构成的潜在异质性,从而实现对个体间差异与个体内波动的有效分离,更有利于揭示变量在个体内层面的真实动态关系^[14-15]。

因此,本研究拟采用中国健康与养老追踪调查(China Health and Retirement Longitudinal Study, CHARLS)的五波纵向数据,构建疼痛和抑郁症状的RI-CLPM,从个体层面探究疼痛与心理健康的相互作用,阐明疼痛和抑郁症状间的长期动态机制,为中老年人疼痛与抑郁的管理提供科学依据。

1 对象与方法

1.1 数据来源

本研究数据来自CHARLS。该项目于2011年启动,旨在评估我国年龄 ≥ 45 岁中老年人群及其家庭成员的社会、经济与健康状况。采用多阶段概率比例规模抽样方法,以面对面访问形式进行调查,调查范围覆盖中国28个省150个县的450个村级单位^[16]。项目于2013年、2015年、2018年、2020年进行了4次随访。本研究选取2011年(T1)、2013年(T2)、2015年(T3)、2018年(T4)、2020年(T5)共计5次调查数据展开分析。本研究经北京大学伦理委员会审查批准(伦理审批编号:IRB00001052-11015),所有研究对象在调查前均签署知情同意书。

本研究对象筛选流程见图1。本研究纳入年龄 ≥ 45 岁的研究对象。排除标准包括:①研究对象未完整参

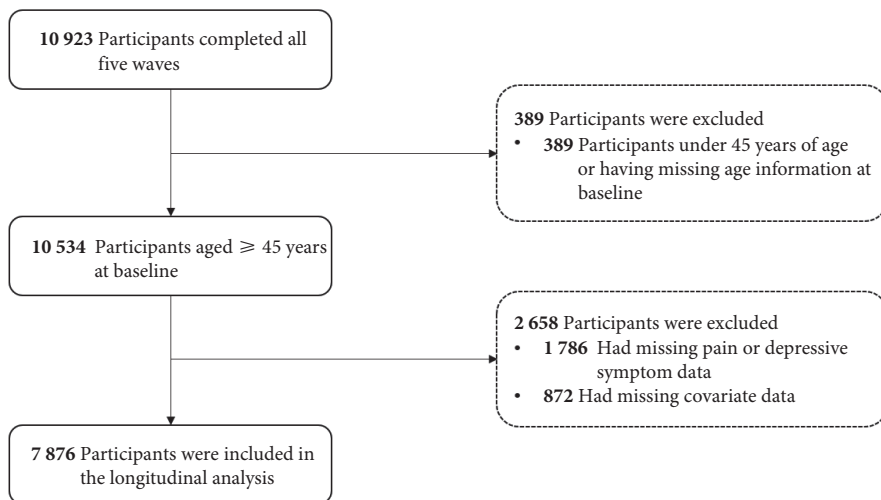


图1 研究对象筛选流程

Fig 1 Participant screening flow chart

与5次调查;②基线及随访过程中主要变量及协变量缺失者。最终纳入7 876例研究对象。

1.2 变量及定义

1.2.1 疼痛

本研究通过计算疼痛部位的数量来反映疼痛情况。疼痛信息基于研究对象的自我报告,通过以下2个问题进行评估:①您的身体是否疼痛?②您感觉身体的哪个部位疼痛(头、肩膀、胳膊、手腕、手指、胸、胃、背、腰、臀、腿、膝盖、脚踝、脚趾、脖子)?根据患者自报疼痛状况进行计分,每出现一个疼痛部位记1分,得分范围为0~15分。

1.2.2 抑郁症状

本研究采用流行病学研究中心抑郁量表(Center for Epidemiological Survey Depression Scale, CESD-10)对受试者的抑郁症状进行评估。该量表共包含10个条目,用于调查研究对象在过去1周内自我报告的抑郁症状发生频率。每个条目包括4个选项:“很少或没有(<1 d)”“偶尔(1~2 d)”“经常(3~4 d)”和“大多时间(5~7 d)”,分别对应0~3分。条目中“我对未来充满了希望”和“我感到很愉快”两个条目为反向计分条目。CESD-10总分范围为0~30分,得分越高反映抑郁症状越严重^[17]。CESD-10量表已广泛应用于我国中老年人人群中^[18],具有广泛的适用性和良好的信度(Cronbach $\alpha=0.815$)^[19]。

1.2.3 协变量

为减少疼痛和抑郁症状间关联的估计偏差,参考既往研究,本研究将以下因素纳入模型进行调整^[17,20-21]。①社会人口学因素:年龄、性别、婚姻状况、户口;②生活方式及行为因素:吸烟、饮酒、体力活动;③健康状况:包括共病、日常生活活动能力(basic activities of daily living, BADL)评分。BADL通过评估个体在进食、穿衣、洗澡、起床、如厕及控制大小便6项日常活动中的自理情况进行评分。每项活动的自理情况分为4个等级:“无困难”“有困难但可独立完成”“有困难需协助才能完成”和“无法完成”。任何一个方面回答“无困难”者赋0分,否则赋1分,BADL得分范围为0~6分。6个方面均为0分者视为BADL正常,否则视为日常功能障碍^[22]。将同时患有≥2种慢性病者定义为共病。

1.3 统计学方法

根据变量类型对参与者的基线特征进行描述性分析,连续变量采用均数±标准差表示,分类变量采用频数和构成比表示。采用Spearman相关分析检验不同时间点疼痛与抑郁症状间的关联强度。最后,通过构建随机截距交叉滞后面板模型分析疼痛与抑郁症状间的纵向相互

作用关系。

传统的CLPM拟合过程中混杂了个体间效应和个体内效应,因此可能会影响结果的准确性。在此基础上,RI-CLPM通过将观测变量 X_{it} 和 Y_{it} 分别分解为个体间成分(IX_i, IY_i)和个体内成分(WX_{it}, WY_{it}),有效分离了自回归效应与交叉滞后效应中的个体间差异与个体内波动(如公式1.3-1.6所示)^[23-24]。其中, IX_i 表示个体 i 在基线时的平均水平,即不随时间变化的个体间差异; WX_{it} 表示个体 i 在时间 t 时的 X 的观测值减去个体间差异 IX_i ,即随时间变化的个体内差异。这种分解能够更准确地揭示变量在个体水平上的动态相互作用,减少因忽略个体异质性导致的估计偏差。

$$WX_{it} = \beta X_{(t-1)}WX_{it-1} + \gamma X_{(t-1)}WY_{it-1} + \epsilon X_{it} \quad (1)$$

$$WY_{it} = \beta Y_{(t-1)}WY_{it-1} + \gamma Y_{(t-1)}WX_{it-1} + \epsilon Y_{it} \quad (2)$$

$$X_{it} = IX_i + WX_{it} \quad (3)$$

$$Y_{it} = IY_i + WY_{it} \quad (4)$$

为保证疼痛和抑郁症状在不同时间点的稳定性,本研究限制疼痛和抑郁症状各波次间的自回归系数相等,构建模型1,即约束自回归系数的RI-CLPM。在模型1的基础上,将性别、婚姻状况、BADL作为非时变混杂因素进行控制,将年龄作为时变混杂因素进行控制,构建模型2;最后,在模型2的基础上,进一步将体力活动、吸烟、饮酒作为时变混杂因素进行控制,构建模型3。

模型拟合优度通过比较模型拟合指数进行判断。比较拟合指数(comparative fit index, CFI)和塔克-刘易斯指数(Tucker and Lewis index, TLI)均>0.90则提示模型拟合良好;近似误差均方根(root mean square error of approximation, RMSEA)和标准化均方根残差(standardized root mean square residual, SRMR)均<0.06则表明模型拟合较好^[25]。既往研究显示 $TLI \leq CFI$,因此在TLI略低于临界值时,可根据TLI做判断^[26-27]。数据清洗和描述性统计分析在R 4.5.1软件中完成,随机截距交叉滞后面板模型在Mplus 8.3软件中完成,假设检验采用双侧检验, $\alpha=0.05$ 。

2 结果

2.1 研究对象的基线特征

本研究共纳入7 876名研究对象,基线特征详见表1。其中女性占53.56%,男性占46.44%,研究人群平均年龄为(57.10±7.79)岁。大部分研究对象居住在农村(83.19%),

表 1 参与者的基线特征 (n=7 876)

Table 1 Basic characteristics of the participants of baseline (n = 7 876)

Variables	Case (%) or $\bar{x} \pm s$
Sex	
Female	4 218 (53.56)
Male	3 658 (46.44)
Age/yr.	57.10 $\pm$ 7.79
Household registration	
Rural	6 552 (83.19)
Urban	1 324 (16.81)
Marital status	
Married/living with a partner	7 168 (91.01)
Unmarried/divorced/widowed	708 (8.99)
Education	
Illiterate	1 941 (24.64)
Primary school	3 269 (41.51)
Middle school	1 744 (22.14)
High school and above	922 (11.71)
Smoking	
No	5 484 (69.63)
Yes	2 392 (30.37)
Alcohol consumption	
No	4 803 (60.98)
Yes	3 073 (39.02)
Comorbidity	
< 2	4 970 (63.10)
$\geq$ 2	2 906 (36.90)
Physical activity	
Low	4 988 (63.33)
Moderate	593 (7.53)
High	2 295 (29.14)
Sleep time/h	6.38 $\pm$ 1.84
Sleep disturbance	
< 1 d	3 897 (49.48)
1–2 d	1 308 (16.61)
3–4 d	1 180 (14.98)
5–7 d	1 491 (18.93)
BADL	
Normal	6 781 (86.10)
Disability	1 095 (13.90)

BADL: basic activities of daily living.

且处于在婚状态(91.01%)。11.71%的研究对象文化程度为高中及以上。

2.2 疼痛与抑郁症状间的相关性分析

相关性分析显示,不同时间点老年人的疼痛、抑郁症状之间均存在正相关关联,差异均有统计学意义($P < 0.001$)。见图2。

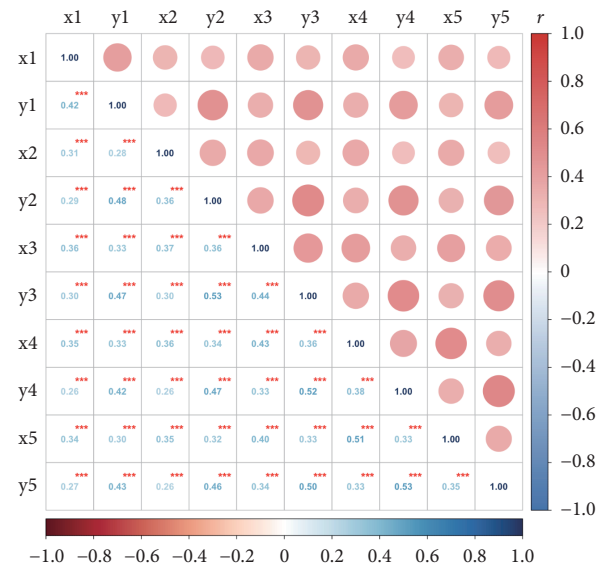


图 2 不同时间点老年人疼痛与抑郁症状的相关性分析

Fig 2 Correlation between pain and depressive symptoms in the older adults at different time points

x1, x2, x3, x4, and x5 represent pain scores in 2011, 2013, 2015, 2018, and 2020, respectively; y1, y2, y3, y4, and y5 represent depressive symptom scores in the corresponding years. *** $P < 0.001$.

2.3 RI-CLPM分析

见表2。调整性别、年龄、户口和婚姻状况后的模型2比模型1拟合更好。进一步调整共病、日常活动能力、体力活动、吸烟、饮酒后的模型3,其AIC、BIC、TLI、

表 2 中老年人疼痛和抑郁症状的随机截距交叉滞后面板模型拟合和比较

Table 2 Random Intercept Cross-Lagged Panel Model fitting and comparison of pain and depressive symptoms in middle-aged and older adults

Model	χ^2	df	CFI	TLI	RMSEA	SRMR	AIC	BIC
1	2 083.717	27	0.921	0.869	0.098	0.084	431 092.959	431 357.879
2	2 290.190	91	0.919	0.889	0.055	0.059	430 276.809	430 653.274
3	3 290.929	291	0.906	0.879	0.036	0.060	426 326.138	427 051.182

df: degrees of freedom; CFI: comparative fit index; TLI: Tucker–Lewis index; RMSEA: root mean square error of approximation; SRMR: standardized root mean square residual; AIC: Akaike information criterion; BIC: Bayesian information criterion. Model 1: RI-CLPM with constrained autoregression coefficients. Model 2: Model 1 adjusted for sex, age, household registration, and marital status. Model 3: Model 2 additionally adjusted for comorbidity, BADL, physical activity, smoking, and alcohol consumption.

RMSEA均低于模型1和模型2,提示模型3拟合良好(CFI=0.906, TLI=0.879, RMSEA=0.036, SRMR=0.060)。

图3展示了以5个时间点的疼痛和抑郁症状构建的随机截距交叉滞后面板模型。结果显示,在自回归效应中,抑郁症状与抑郁症状间、疼痛与疼痛间在5个时间点上均具有较强的稳定性,且前一波次的疼痛对下一波次的疼痛、抑郁症状对抑郁症状均有预测作用。在个体内水平的交叉滞后效应中, T1→T2期间,抑郁症状对疼痛的预测作用无统计学意义($\beta = -0.012$, 95%CI: $-0.036 \sim 0.012$), T2→T5期间预测作用有统计学意义[T2→T3: $\beta = 0.121$, 95%CI: $0.099 \sim 0.143$; T3→T4: $\beta = 0.112$, 95%CI: $0.091 \sim 0.134$; T4→T5: $\beta = 0.070$, 95%CI: $0.049 \sim 0.090$],提示抑郁症状加重可能对疼痛的发生有预测作用。T1→T5期间,疼痛对抑郁症状的预测作用均具有统计学意义(T1→T2: $\beta = 0.043$, 95%CI: $0.020 \sim 0.067$; T2→T3: $\beta = 0.047$, 95%CI: $0.023 \sim 0.070$; T3→T4: $\beta = 0.056$, 95%CI: $0.034 \sim 0.078$); T4→T5: $\beta = 0.050$, 95%CI: $0.028 \sim 0.071$),且抑郁症状对疼痛的预测作用更强。相关路径结果显示,个体间疼痛和抑郁症状间呈正相关,说明疼痛数量越多的人往往伴随更严重的抑郁症状。详见网络资源附件附表1。

3 讨论

本研究基于CHARLS的5次随访数据,通过构建RI-CLPM模型,揭示了中老年人疼痛与抑郁症状间的纵向关联。结果显示,在控制个体间稳定性差异后,疼痛对抑郁

症状的预测效应持续存在,抑郁症状对疼痛的预测作用在T2~T5有统计学意义,且抑郁症状对疼痛的预测效应大于疼痛对抑郁症状的预测效应。

本研究发现疼痛和抑郁症状间存在双向关联。有研究显示,持续疼痛会直接导致个体社会参与减少、日常生活功能受限及自我效能感下降,进而引发无助感和负面情绪,促使抑郁症状的发生发展^[20,28]。一项Meta分析指出,疼痛与抑郁之间的动态关系常源于认知、行为、疼痛与情绪间的持续相互作用^[29]。疼痛通常是慢性的过程,在此过程中往往伴随着炎症因子水平的升高,炎症因子通过血脑屏障进入中枢神经系统,从而抑制神经递质的代谢,增加抑郁的风险^[30-31]。另一方面,抑郁症状也会作用于疼痛感知。基于疼痛恐惧-回避模型理论,抑郁个体往往存在认知扭曲与灾难化思维,倾向于将轻微不适解释为剧烈疼痛,从而放大主观痛感^[32-33]。此外,抑郁相关的神经生理改变亦会降低疼痛抑制系统的效率,使疼痛体验被进一步强化^[34]。

此外,本研究发现抑郁症状对疼痛的预测作用大于疼痛对抑郁症状的预测作用。既往研究表明,积极的情绪会降低疼痛感知的严重程度^[29],而严重的抑郁症状则会增加疼痛的风险^[35],进一步反映了情绪因素在疼痛发生发展中的重要作用。尤其在我国中老年人人群中,抑郁情绪常较为隐匿,多通过疼痛等躯体化症状显现。因此,在诊疗过程中主诉疼痛的患者,医生应注重该群体抑郁症状的筛查;而针对有长期慢性疼痛的患者,也应关注其心理健康。

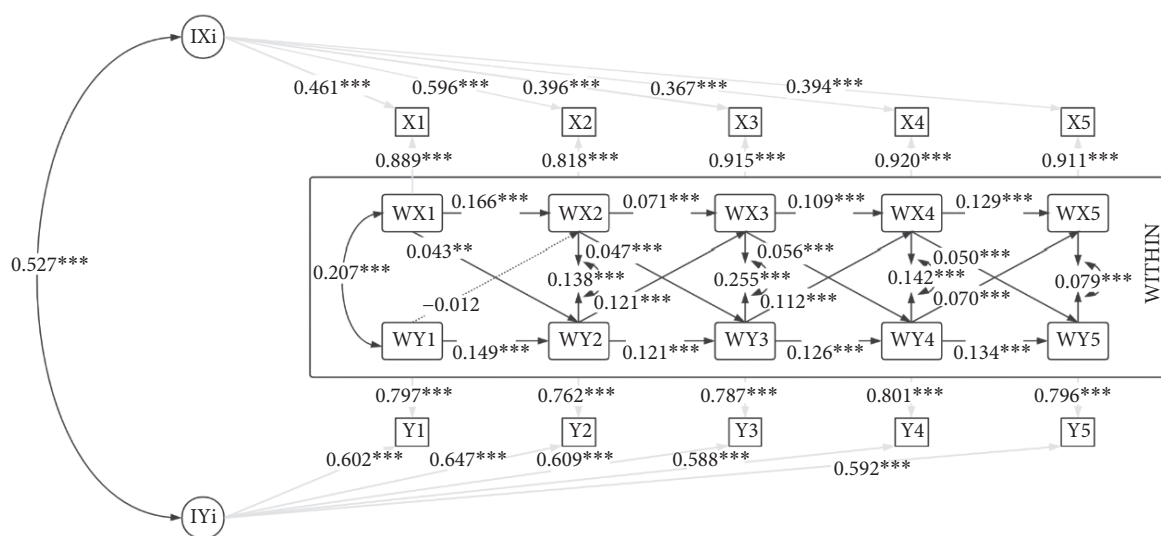


图3 随机截距交叉滞后面板模型

Fig 3 Random Intercept Cross-Lagged Panel Model

The model is adjusted for sex, age, marital status, household registration, comorbidity, BADL, physical activity, smoking, and alcohol consumption. I_{xi} / I_{yi} = between-person random intercepts; W_{xi} / W_{yi} = within-person deviations. Solid lines indicate statistically significant associations; dashed lines indicate non-significant associations. *** $P \leq 0.001$; ** $P < 0.01$.

本研究采用具有全国人群代表性的5波纵向面板数据,样本量大,随访时间长,可在一定程度上反映疼痛与抑郁症状间的真实关系。通过构建RI-CLPM模型探讨个体内和个体间层面疼痛和抑郁症状间的双向关联,增强了结果的稳健性。但本研究仍存在以下局限性:首先,疼痛信息及部分变量基于受试者自我报告,可能存在测量偏倚;其次,由于数据收集类型的限制,未能对疼痛类型(急性或慢性)进行区分,因此无法进一步探究不同疼痛性质与抑郁症状之间的纵向关系;此外,尽管在分析中对较多协变量进行了调整,但仍不能完全排除未观测到的混杂因素的影响;最后,由于随访时间间隔较长,无法检验疼痛与抑郁症状间关联的短期波动。

综上所述,本研究表明中老年人群的疼痛与抑郁症状之间存在复杂的双向关系。在个体内层面,疼痛对抑郁症状的预测作用稳定存在,且抑郁症状对疼痛的预测作用更强。这一发现提示,在临床与公共卫生实践中,应重视疼痛患者抑郁症状的早期识别与干预,并在后期关注二者的共病管理,以提高中老年人健康水平。

* * *

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Author Contribution Xia Honghong is responsible for conceptualization, formal analysis, methodology, software, writing-original draft, and writing-review and editing. Wangmu and Zhang Hongxia are responsible for formal analysis and writing-review and editing. Fu Ming is responsible for visualization and writing-review and editing. Wan Yang is responsible for conceptualization, methodology, supervision, and writing-review and editing. Qiu Peiyuan is responsible for conceptualization, funding acquisition, methodology, supervision, and writing-review and editing. All authors consented to the submission of the article to the Journal. All authors approved the final version to be published and agreed to take responsibility for all aspects of the work.

利益冲突 所有作者均声明不存在利益冲突

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