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Research paper

Bidirectional association between clustering of health-related behaviours and depression in mid- and older-aged adults: A longitudinal study in China and Japan

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ABSTRACT

Objectives: To disentangle the direction between health-related behaviours (HRBs) and depression in East Asia, we examined the bidirectional longitudinal relationship of HRBs clustering and depression in Chinese and Japanese ageing populations gender-specifically.
Methods: Data were drawn from the China Health and Retirement Longitudinal Study (CHARLS) ($N = 18{,}739$) (2011–2015) and the Japan Study of Ageing and Retirement (JSTAR) ($N = 7116$) (2007–2011). Cross-lagged panel models (CLPM) were applied to assess bidirectional longitudinal relationships between HRB clustering and depression in adjacent waves, stratified by cohort and gender. Sensitivity analyses were conducted to explore key risk factors in risky clusters.
Results: The prevalence of baseline depression was approximately 20 % in China and 4 % in Japan, with over 70 % of participants belonging to the risky cluster. A unidirectional negative association between the risky cluster and depression was observed only in Chinese females ($\beta_{standardized} = -0.039$, 95%*CI*: −0.054 to −0.024, $P < 0.001$). However, no association was found in Japanese females or males in either country. Further sensitivity analyses revealed that this association was primarily driven by overweight/obesity cluster. Sensitivity analyses also identified a positive effect of depression on the smoking and drinking cluster and a negative effect on the overweight/obesity cluster in Chinese females.
Limitation: This study was limited by reliance on self-report data, the CES-D cannot be used to diagnose depression and some other confounding factors were not considered (e.g., use of antidepressants).
Conclusions: Our findings highlight a unidirectional negative association of the risky cluster on depression in Chinese females, with notable variations observed across different countries and genders.

1. Introduction

Depression, a common mental health disorder associated with heavy disease burden (Lancet, 2022), is becoming more and more prevalent in East Asia. Population-scale data show that the prevalence of depression among older people in China raised from 3.6 % in 2010 to 3.9 % in 2021, whereas the corresponding prevalence in Japan also increased from 2.8 % in 2010 to 3.2 % in 2021 (Global Burden of Disease Collaborative Network, 2022).

Evidence suggested that the "SNAP" risk factors, the four major modifiable health-related behaviours (HRBs) of smoking, nutrition, alcohol consumption and physical activity (The Royal Australian College of General Practitioners, 2004), exert a significant influence on the onset and development of late-life depression (Firth et al., 2020). Accumulated reviews and meta-analyses have underscored that smoking (Fluharty et al., 2017; Taylor et al., 2021) and alcohol use disorder (Kim et al., 2022) are associated with higher depression incidence in later life; whereas smoking cessation (Taylor et al., 2021), being physically active (Pearce et al., 2022), and having a healthy diet (Firth et al., 2019) are associated with reduced prevalence and symptomatic improvement.

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Moreover, a growing body of epidemiological study suggests that HRBs tend to cluster together (Liao et al., 2019) and have synergistic effects on health (Johnson et al., 2018). Our previous studies have identified three common clusters in the Chinese and Japanese middle-aged and old-aged populations: smoking and drinking, overweight/obese and healthy lifestyle (Wu et al., 2023). Research into the joint impact of HRB clusters have yielded valuable insights into the complex dynamics underlying late-life depression. Unhealthy clusters, characterized by the presence of one or more adverse HRBs such as smoking, heavy alcohol consumption, physical inactivity, and poor dietary habits, have been associated with an elevated risk of subsequent depression compared to healthier clusters (Champion et al., 2018; Collins et al., 2023; Jao et al., 2019; Vermeulen-Smit et al., 2015; Ye et al., 2016). It is notable, however, that much of the existing literature is cross-sectional in nature, offering limited insights into the directionality of associations. Furthermore, the bulk of evidence originates from studies conducted in Europe and the United States, with a paucity of research focusing on Asia (Ye et al., 2016), particularly among older adults (Feng et al., 2022).

Depression, on the other hand, may influence HRBs. Compelling evidence suggests that people with major depression are less likely to quit smoking and more susceptible to relapse to smoking (Weinberger et al., 2017). Similarly, individuals with depression have a doubled risk of alcohol use disorder, a lower likelihood of eating a healthy diet (Boden and Fergusson, 2011; Chegini et al., 2022), and are more likely to be sedentary (Schuch et al., 2018) compared to those without depression. The compounding effect of depression on multiple HRBs is underscored by research such as that conducted by Trudel-Fitzgerald et al. (2018), suggesting that depression may precipitate an increase in unhealthy lifestyle choices over time. However, existing studies employing additive indices to measure HRBs have limitations in capturing potential synergistic effects among these behaviours, thus warranting further investigation into their combined impact.

In a complex interplay, depression not only correlates with certain HRBs but also influences their trajectory, shedding light on the potentially possible bidirectional relationship between the both. Several studies using HRBs as independent risk factors have delved into their bidirectional relationship with depression, but heterogeneity remains. Evidence from Western population-based cohorts indicates that people who smoked had higher risks of depression at follow-up, and people who were depressed had lower risks of smoking at follow-up (Tran et al., 2023). However, cohort studies based on the East Asian population have yielded contrasting results, suggesting a negative bidirectional association between smoking or drinking and depression (H. G. Cheng et al., 2016). Furthermore, investigations into the bidirectional relationship between mental health and multiple HRBs reveal interesting findings. Research by Trudel-Fitzgerald et al. (2019) found that those with higher levels of well-being and optimism at baseline were more likely to maintain healthy lifestyles at follow-up and vice versa. Thus, given the synergistic effects among HRBs, the direction of the association between co-occurring HRB clustering and depression remains unclear.

Therefore, to disentangle the direction between HRBs and depression in East Asia, we aimed to examine the bidirectional longitudinal relationship of HRB clustering and depression in Chinese and Japanese ageing populations gender-specifically.

2. Methods

2.1. Study population

Data were derived from two nationally representative longitudinal cohorts of middle-aged and older adults, namely the China Health and Retirement Longitudinal Study (CHARLS) (Zhao et al., 2014) and the Japanese Study of Ageing and Retirement (JSTAR) (Ichimura and Hashimoto, 2009). The study utilized available harmonized data with a total follow-up of 4 years across three waves, collected data from 2011 – 2012, 2013–2014, 2015–2016 and 2007, 2009, 2011 in CHARLS and JSTAR, respectively. Participants included were 1) 50 years and older; 2) had information on at least one HRB indicator per wave; and 3) had information on depression for at least one wave. The final analysis samples were 18,739 for CHARLS and 7116 for JSTAR.

2.2. Measures

2.2.1. HRB clustering

This variable was based on a latent categorical variable derived from our previous work (Wu et al., 2023). This latent categorical variable was identified using Latent Transition Analysis in the two cohorts. This technique measured clustering patterns and transition trends for four HRBs: smoking, alcohol consumption, body mass index (BMI), and physical activity. Although BMI is not considered an HRB, it is often widely used in prior studies as a proxy variable for diet (Campostrini and Mcqueen, 2003). The latent categorical variable consisted of three clusters that were common in CHARLS and JSTAR: smoking and drinking, overweight or obese and healthy lifestyle. The healthy lifestyle cluster was characterized by more positive health behaviour patterns, i.e., not smoking, not drinking alcohol, having a normal BMI, and being physically active. The smoking and drinking cluster was characterized by a higher probability of being a smoker or a drinker. The overweight or obese cluster has no unhealthy behaviours other than being overweight/obese. For the analysis of the present study, we created it as a binary HRB variable, with healthy lifestyle as the reference category, and combined other categories into a risky cluster.

2.2.2. Depression

Depression was measured using the Centre for Epidemiologic Studies Depression (CES—D) scale in both cohorts, which comprises 10 items. A 4-point Likert scale was used to evaluate the frequency of symptoms associated with depression during the preceding week (0: little or no time < 1 day, 1: some or little time 1–2 days, 2: occasional or moderate time 3–4 days, and 3: most or all time 5–7 days). Two of the 10 items assessing positive emotions were reverse-coded. The total score ranged from 0 to 30, with a cut-off of 12 utilized to generate the binary depression variable (no = 0, yes = 1). As previous research (S. T. Cheng and Chan, 2005), a threshold of 12 points was deemed optimal for classifying clinically significant depression, offering a relatively balanced sensitivity (0.76) and specificity (0.55) in older populations, compared to 10 points, which yielded higher sensitivity (0.85) but lower specificity (0.37).

2.2.3. Sociodemographic variables

The sociodemographic variables of age (continuous/in years), gender (male = 0; female = 1), education level (less than lower secondary = 0; upper secondary & vocational training =1; tertiary = 2), and chronic diseases status (no chronic disease = 0; only one chronic disease = 1; with multiple chronic diseases = 2) were included in this study.

2.3. Statistical analysis

The bidirectional longitudinal associations between HRB clustering and depression were investigated using a cross-lagged panel model (CLPM). The hypothesized CLPM was analysed using Mplus version 8 (Muthén and Muthén, 2017). The CLPM consists of three components. The first one is the autoregressive effect, which indicates the causal relationship of the same variable at different waves (e.g., depression scores in wave 1 and wave 2). The second component is the correlation or covariance, which represents the correlation of different variables at the same wave (e.g., depression scores in wave 1 and HRB cluster in wave 1); the third component, the cross-lagged effect, represents the causal relationship between different variables at different waves (e.g., depression scores in wave 1 and HRB cluster in wave 2). *P* values <0.05 were considered to be statistically different.

We developed three adjusted models based on gender and cohort, respectively. Model 0 was unadjusted; Model 1 adjusted age at baseline; Model 2 further adjusted education level at baseline; and in Model 3, we further adjusted chronic disease status over time. We then used the fully adjusted model (i.e. Model 3) to compare the unconstrained model against the model where the cross-lagged paths were constrained to be equal over time. Missing data were handled by adding the covariance between the dependent and independent variables to avoid listwise deletion. Multiple fit indices were used to assess the fit of the models, including the Log-likelihood ratio test, Akaike information criterion (AIC), Bayesian information criterion (BIC), Tucker–Lewis index (TLI), the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standard root mean square residual (sRMR). Values for TLI and CFI close to 0.95 and values for RMSEA and sRMR less than or equal to 0.06 were considered a good model fit.

Based on the best-fitting model, we conducted two sensitivity analyses. The first analysis involved separating the overweight/obesity cluster and the smoking and drinking cluster from the risky cluster, to explore key risky factor leading to the main findings. The second analysis addressed missing data, particularly for depression, by incorporating a continuous depression score into the model. We employed the Maximum Likelihood Robust (MLR) method to handle missing data using Full Information Maximum Likelihood (FIML), utilizing all available information under the missing at random assumption (Enders, 2010).

3. Results

3.1. Descriptive statistics

Table 1 displays gender-specific descriptive statistics of the major variables over time. The analysis included a total of 18,739 participants in CHARLS and 7116 in JSTAR. The mean age at baseline for both cohorts was around 60 years and approximately 49 % of the participants were male. Participants in CHARLS showed lower levels of education and a higher prevalence of chronic disease prevalence and depression compared to JSTAR individuals. Both cohorts demonstrated a higher prevalence of depression among females compared to males ($p < 0.001$ for CHARLS; $p = 0.093$ for JSTAR). In the distribution of HRB clusters, females were more likely to be in the healthy or overweight/obesity cluster, while over 70 % of males were in the smoking and drinking cluster ($p < 0.001$).

3.2. CLPM results

Supplementary Table S1 gives a comparison of the fit indices for the three adjusted models. Model 3 was chosen based on the fit indices (TLI and CFI closest to 0.95 in both cohorts, and RMSEA and SRMR were <0.06 in CHARLS and <0.08 in JSTAR). The fit indices for the unconstrained model (i.e. where cross-lagged paths were allowed to vary over time) and the constrained model (i.e. where cross-lagged paths were equal over time), both based on Model 3, are given in Supplementary Table S2. Based on these fit indices, the constrained model was chosen

Table 1
Descriptive statistics among major variables for the CHARLS ($N = 18,739$) and the JSTAR ($N = 7116$).

Variable	Definition	CHARLS (N = 18,739)				P	JSTAR (N = 7116)				P
		Male ($n = 9201$)		Female ($n = 9538$)			Male ($n = 3422$)		Female ($n = 3694$)		
		n	%	n	%		n	%	n	%	
Age (W1)	Mean ± SD	60.05	9.48	59.63	9.93	<0.001	62.59	6.92	63.15	7.11	
Education (W1)	Less than lower secondary	7643	83.06	8671	90.91	<0.001	867	25.34	987	26.72	<0.001
	Upper secondary & vocational training	1228	13.34	741	7.76		1595	46.61	2041	55.25	
	Tertiary	321	3.48	120	1.25		945	27.62	641	17.35	
	Missing	9	0.09	6	0.06		15	0.44	25	0.68	
Chronic diseases status (W1)	0	2621	28.48	2336	24.49	<0.001	926	27.06	1040	28.15	<0.001
	1	2169	23.57	2234	23.42		626	18.29	546	14.78	
	≥2	2816	30.60	3341	35.02		296	8.65	257	6.96	
	Missing	1595	17.33	1627	17.05		1574	46.00	1851	50.11	
Chronic diseases status (W2)	0	1935	21.03	1682	17.63	<0.001	894	26.13	1038	28.10	<0.001
	1	2008	21.82	2050	21.49		669	19.55	651	17.62	
	≥2	3020	32.82	3526	36.96		433	12.65	356	9.64	
	Missing	2238	24.32	2280	23.90		1426	41.67	1649	44.64	
Chronic diseases status (W3)	0	1291	14.03	1041	10.91	<0.001	1055	30.83	1321	35.76	<0.001
	1	1688	18.34	1593	16.70		827	24.17	847	22.93	
	≥2	3573	38.83	4193	43.96		580	16.95	467	12.64	
	Missing	2649	28.79	2711	28.42		960	28.05	1059	28.67	
Depression (W1)	Yes	1414	15.36	2311	24.22	<0.001	137	4.00	164	4.44	0.093
	No	4662	50.66	4080	42.77		1664	48.63	1626	44.02	
	Missing	3125	33.96	3147	32.99		1621	47.37	1904	51.54	
Depression (W2)	Yes	1128	12.25	2029	21.27	<0.001	120	3.51	169	4.57	0.005
	No	5471	59.46	4849	50.83		1713	50.06	1704	46.13	
	Missing	2602	28.27	2660	27.88		1589	46.43	1821	49.30	
Depression (W3)	Yes	1441	15.66	2538	26.60	<0.001	177	5.17	248	6.71	0.004
	No	6152	66.86	5370	56.30		2140	62.54	2239	60.61	
	Missing	1608	17.47	1630	17.08		1105	32.29	1207	32.67	
Clustering of HRBs (W1)	Healthy cluster	825	8.96	3114	32.64	<0.001	371	10.84	1661	44.96	<0.001
	Smoking and drinking cluster	7002	76.10	793	8.31		2557	74.72	640	17.33	
	Overweight/obesity cluster	1374	14.93	5631	59.03		494	14.44	1393	37.71	
Clustering of HRBs (W2)	Healthy cluster	662	7.19	2938	30.80	<0.001	381	11.13	1699	45.99	<0.001
	Smoking and drinking cluster	7354	79.92	886	9.28		2560	74.81	640	17.33	
	Overweight/obesity cluster	1185	12.87	5714	59.90		481	14.06	1355	36.68	
Clustering of HRBs (W3)	Healthy cluster	584	6.34	2906	30.46	<0.001	386	11.28	1711	46.32	<0.001
	Smoking and drinking cluster	7460	81.07	920	9.64		2559	74.78	641	17.35	
	Overweight/obesity cluster	1157	12.57	5712	59.88		477	13.94	1342	36.33	

Notes: **HRBs,** health-related behaviours**; CHARLS,** the China Health and Retirement Longitudinal Study**; JSTAR,** the Japanese Study of Ageing and Retirement.

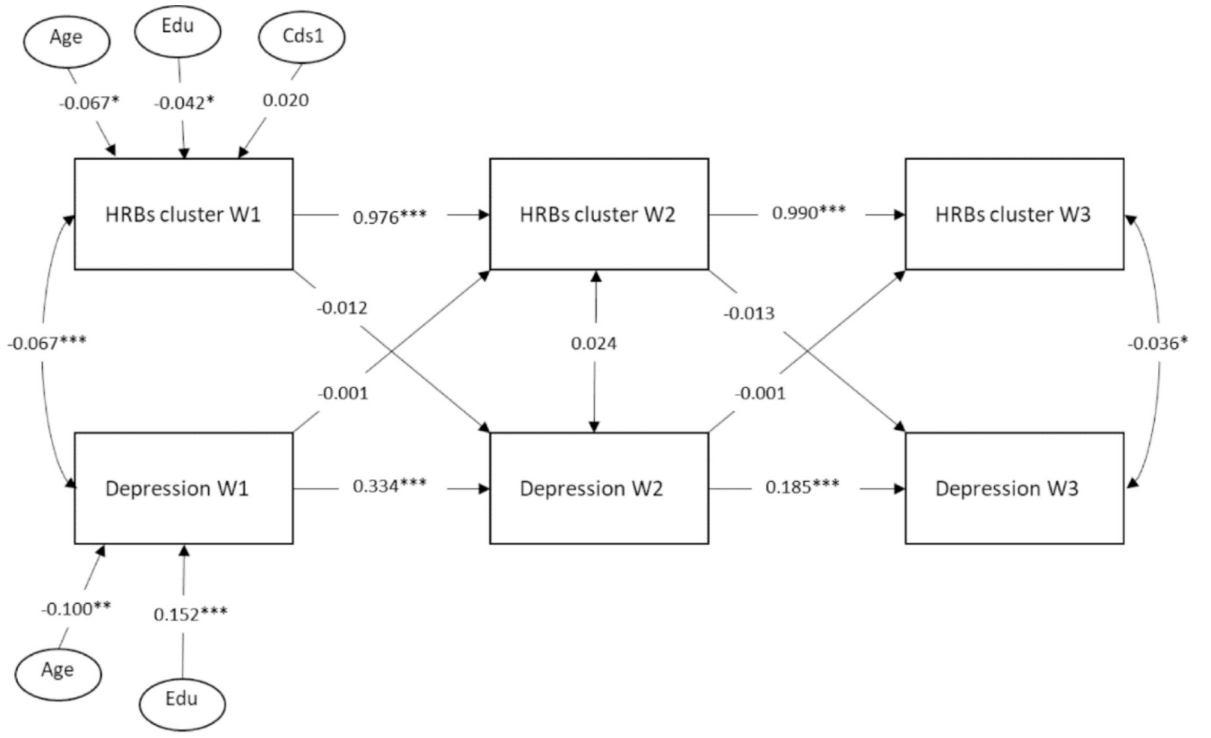
due to very little different in the two models, with the constrained model being more parsimonious.

The results of the constrained Model 3 of depression and HRB clustering are shown in Fig. 1 and Fig. 2. Autoregressive pathways in both cohorts and for each gender indicated longitudinal carry-over effects for both depression and clustering of HRB. The results of the cross-lagged pathways showed that a significant negative association for Chinese females, where being in the risky cluster at waves 1 and 2 was associated with reduced depression at waves 2 and 3 ($\beta_{standardized} = -0.039$, 95%*CI*: −0.054 to −0.024, $P < 0.001$). However, for males in CHARLS, no cross-lagged effects were observed. Depression at waves 1 and 2 did not influence HRB clustering at waves 2 and 3, nor did HRB clustering at waves 1 and 2 affect depression in subsequent waves. Similarly, in JSTAR, no significant longitudinal associations between HRB clustering and depression were identified for either gender after adjusting for covariates ($p > 0.05$). Supplementary Table S3 presents the standardized parameter estimates for the cross-lagged effects across the three adjusted models, highlighting that the results remained consistent across genders and cohorts under different covariate settings.

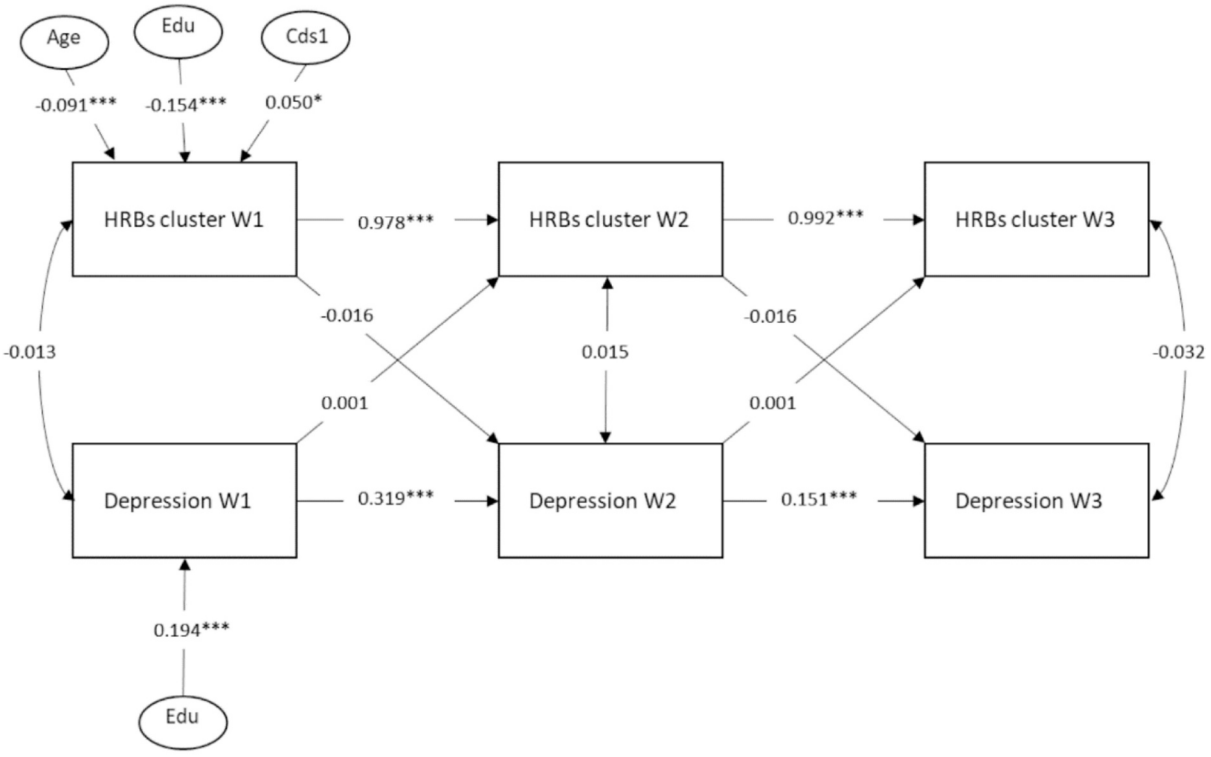
3.3. Results of sensitivity analysis

Further sensitivity analysis separating overweight/obesity and smoking and drinking clusters revealed a bidirectional negative association between the overweight/obesity cluster and depression among females in the CHARLS (overweight/obesity cluster on depression:

Fig. 1. Cross-lagged panel model of three waves of HRBs clustering and depression in the China Health and Retirement Longitudinal Study (CHARLS). Notes: Edu = education, Cds = chronic disease status. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.



Male



Female

Fig. 2. Cross-lagged panel model of three waves of HRBs clustering and depression in the Japanese Study of Ageing and Retirement (JSTAR).
Notes: Edu = education, Cds = chronic disease status. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

$\beta_{standardized} = -0.044$, 95%*CI*: −0.059 to −0.029, $P < 0.001$; depression on overweight/obesity cluster: $\beta_{standardized} = -0.002$, 95%*CI*: −0.004 to 0, $P < 0.01$). The positive impact of depression on smoking and drinking cluster ($\beta_{standardized} = 0.006$, 95%*CI*: 0.002 to 0.010, $P < 0.001$) may counteract its negative impact on overweight/obesity cluster, potentially explaining why the main effect did not reveal an influence of depression on risk behaviours in the risky cluster. Additionally, we observed a unidirectional negative effect of smoking and drinking cluster on depression among females in the JSTAR cohort ($\beta_{standardized} = -0.017$, 95%*CI*: −0.039 to −0.002, $P < 0.001$) (see Table 2). The results of the sensitivity analyses after processing the missing data using FIML were consistent with the original results (see Supplementary Table S4).

4. Discussion

4.1. Principal findings

Our study aimed to investigate the bidirectional relationship between HRB clustering and depression using two representative longitudinal cohorts from China and Japan. Gender- and country-specific findings show that a unidirectional negative correlation was found of risky cluster on depression in Chinese females only, which was mainly driven by overweight/obesity. No association was found among Japanese females or males in either country.

4.2. Findings relative to prior research

Our study highlighted a unidirectional influence of HRB clustering on depression, whereby risky cluster characterized predominantly by overweight/obesity led to lower depression. This finding contrasted with prior research indicating an increased risk of subsequent depression in unhealthy clusters (Champion et al., 2018; Collins et al., 2023). However, these differences may derive from variations in study populations and behavioural characteristics. Previous studies primarily focused on Western adolescents, where unhealthy clusters often included low physical activity, smoking, and drinking. In contrast, the risky cluster of our study was dominated by overweight/obesity, and further sensitivity analyses demonstrated its association with lower depression. Longitudinal studies across Asian cohorts revealed a negative association between obesity and depression among Korean (Yim et al., 2017), and Chinese (Yu et al., 2022) female populations, which was consistent with our finding. These intriguing findings in the Chinese females might be elucidated by the "jolly fat" hypothesis, initially posited by Crisp and colleagues (Crisp and McGuiness, 1976). According to this hypothesis, obese individuals might experience greater happiness due to fewer dietary restrictions that could otherwise precipitate depression. Another explanation may be related to the traditional Chinese cultural background, as obesity was often seen as a symbol of wealth and status (Li et al., 2004), especially within the middle-aged and older Chinese population.

Our investigation yielded no conclusive evidence to support the hypothesis that depression predicts subsequent changes in HRB clustering. Although a limited amount of literature suggested that depression may influence individual HRBs such as smoking and alcohol consumption, the majority of this evidence came from studies focused on adolescents and young adults (Fluharty et al., 2017; McCabe et al., 2023). In contrast, the middle-aged and older adults in our previous study demonstrated greater resistance to lifestyle behaviour changes (Wu et al., 2023). Further sensitivity analyses indicated that the positive effect of depression on the smoking and drinking cluster might have offset its negative effect on the overweight/obesity cluster, which may be the reason that non-significant effect of depression on the risky cluster in the main analysis. Such findings highlight the complex interplay between depression and distinct HRB clustering, emphasizing the importance of strategies tailored to the behavioural patterns of older populations.

In exploring the multifaceted nature of the association between depression and HRB clustering, our investigation unveiled disparities across genders and nationalities, which may result from differences in behavioural characteristics and cultural background (Salk et al., 2017). Our analysis revealed gender-specific patterns in the risky cluster: males favoured smoking and drinking, while females primarily exhibited overweight/obesity. In Chinese and Japanese societies, the motivation for drinking and smoking is not only for personal enjoyment but also meeting social expectations (H. G. Cheng et al., 2016), and both of which contribute to the improvement of males' depression (Misawa and Kondo, 2019). Besides, the prevalence of depression is higher in females than in males, and the gendered model of mental health (Eaton et al., 2012) suggests that females are more inclined to internalize negative emotions and change their behaviours, such as eating. Whereas men are

Table 2
Sensitivity analyses for sex-specific CLPM between separating clustering of HRBs and binary depression score.*

Models	Male				Female			
	Depression (W1) on clustering of HRBs (W2)	HRBs (W1) clustering of on Depression (W2)	Depression (W2) on clustering of HRBs (W3)	HRBs (W2) clustering of on Depression (W3)	Depression (W1) on clustering of HRBs (W2)	HRBs (W1) clustering of on Depression (W2)	Depression (W2) on clustering of HRBs (W3)	HRBs (W2) clustering of on Depression (W3)
	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)
CHARLS								
Overweight/obesity cluster	0 (−0.004, 0.004)	−0.015 (−0.031, 0.001)	0 (−0.004, 0.003)	−0.013 (−0.028, 0.001)	−0.002** (−0.004, 0.000)	−0.044 *** (−0.059. -0.029)	−0.002** (−0.004, 0.000)	−0.043 *** (−0.057. -0.028)
Smoking and drinking cluster	0.001 (−0.004, 0.006)	0.006 (−0.010, 0.021)	0.001 (−0.004, 0.006)	0.005 (−0.009, 0.019)	0.006** (0.002, 0.010)	0.01 (−0.005, 0.024)	0.006** (0.002, 0.009)	0.01 (−0.005, 0.025)
JSTAR								
Overweight/obesity cluster	0.001 (−0.003, 0.005)	−0.003 (−0.028, 0.023)	0.001 (−0.003, 0.005)	−0.002 (−0.026, 0.021)	−0.003 (−0.007, 0.001)	−0.005 (−0.028, 0.018)	−0.003 (−0.007, 0.001)	−0.005 (−0.027, 0.017)
Smoking and drinking cluster	0.001 (−0.002, 0.002)	0.018 (−0.006, 0.043)	0.001 (−0.002, 0.002)	0.017 (−0.006, 0.040)	0.001 (−0.002, 0.002)	−0.017*** (−0.039, −0.002)	0.001 (−0.002, 0.002)	−0.016*** (−0.041, −0.003)

Notes: **HRBs,** health-related behaviours**; CHARLS,** the China Health and Retirement Longitudinal Study**; JSTAR,** the Japanese Study of Ageing and Retirement.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

more likely to exhibit externalizing behaviours, such as risk-taking or impulsivity. This may explain why the relationship between HRB cluster and depression was observed in females but attenuated in males. Beyond gender dynamics, unlike in China, there are stigmatizing attitudes towards obesity in Japanese society (Iwabu et al., 2021). The discrimination of obesity and depression in Japan may have a substantial overlap and an interaction, resulting in the "jolly fat" hypothesis is not as significant in Japan as it is in China (Luck-Sikorski et al., 2018). These findings indicate that gendered behaviours and health outcomes are deeply rooted in socio-cultural environment, which should be considered in design and implement targeted interventions.

4.3. Strengths and limitation

The present study has several strengths. First, leveraging community-based survey data from large, national cohorts of older adults in China and Japan bolstered the generalizability of the results. Second, the study undertook gender-specific analyses and employed the CLPM model to provide valuable evidence for the temporal associations in different directions for the two key variables (i.e. depression and HRB clustering). However, notwithstanding these strengths, several limitations warrant consideration. First, the reliance on self-report measures for health risk behaviours and depression introduced the potential for response bias, and respondents may have been more inclined to respond in a socially desirable manner to the extent that underestimated the results (Ferrari et al., 2021). Second, depression in the current study was defined by the CES—D, which cannot be used to diagnose depression, and which may lead to underestimation of the relationship between depression and HRBs. Third, the present study was limited by the availability and comparability of harmonized variables in both cohorts, we used BMI instead of diet, and we could not cover all HRBs (e.g. sleep). However, the "SNAP" risk factors cover common and key health-related modifiable factors (The Royal Australian College of General Practitioners, 2004). And other potential confounders (e.g., use of antidepressants) were not considered. Fourth, the differences in survey time, sample size and urban-rural coverage all limit the comparison between the two study cohorts.

4.4. Conclusion

In conclusion, our findings highlight a unidirectional negative association of the risky cluster on depression in Chinese females, with notable variations observed across different countries and genders. Consequently, in crafting public health interventions in East Asia, it may be beneficial to encourage female middle-aged and older adults to maintain mental well-being by surpassing normal weight levels. Furthermore, it is imperative to comprehensively account for national and socio-demographic distinctions to formulate tailored preventive strategies.

CRediT authorship contribution statement

Min Wu: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Yu'an Zhang:** Writing – original draft, Visualization, Software, Methodology, Formal analysis. **Claire Mawditt:** Writing – review & editing, Visualization, Supervision, Software, Resources, Methodology, Formal analysis, Data curation, Conceptualization. **Jing Liao:** Writing – review & editing, Resources, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization.

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Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2024.12.112.

Data availability

The present study used publicly available data and the harmonized datasets are available through the Gateway to Global Ageing Data website [https://g2aging.org/].

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