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Perceived criticism and depressive symptoms among adults aged 50 years and older: a 17-year population-based cohort study

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The longitudinal association between perceived criticism and depressive symptoms has not been fully elucidated in older adults. We aimed to explore the above association and the modifying role of sex in older adults. Data were from the English Longitudinal Study of Ageing (waves 1–9; 2002–2019). Depressive symptoms were assessed with the 8-item version of the Center for Epidemiologic Studies–Depression Scale, and a cut-off value of ≥ 4 was used to define clinically significant depressive symptoms. We included participants aged ≥ 50 years and without depressive symptoms at baseline, and established four dynamic prospective cohorts to explore the associations of perceived criticism from spouses ($n = 8155$), children ($n = 9049$), other immediate family members (OIFM, $n = 9370$), and friends ($n = 9736$) with depressive symptoms, respectively. In the full-adjusted model, compared with perceived no spouse criticism, perceived some (hazard ratio [HR], 1.36; 95% confidence interval [CI], 1.18–1.55) and a lot (HR, 2.24; 95% CI, 1.85–2.72) were associated with higher risks of depressive symptoms, but perceived a little was not (HR, 1.05; 95% CI, 0.92–1.20). Compared with perceived no child criticism, perceived a little (HR, 1.24; 95% CI, 1.12–1.36), some (HR, 1.50; 95% CI, 1.33–1.68), and a lot (HR, 2.02; 95% CI, 1.62–2.52) were associated with higher risks of depressive symptoms, and perceived criticism from OIFM and friends showed similar results. Sex significantly modified the above associations, and females were more susceptible to four types of perceived criticism than males. Our findings emphasize the benefits of reducing criticism of older adults in preventing their depressive symptoms.

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INTRODUCTION

The latest data from the Global Burden of Disease Study shows that major depressive disorder affects over 332 million individuals and is the second largest contributor of years lived with disability worldwide [1]. Major depressive disorder is a risk factor for some adverse outcomes, such as suicidal behavior [2, 3], hypertension [4], diabetes [5], heart disease [6], and stroke [7]. The data from 30 European countries shows that the prevalence of depressive symptoms in adults aged 60 years and older is higher than in other age groups [8]. With the aging of the population [9], depressive symptoms among older adults have become a major public health issue [10]. Due to the lack of sufficiently effective treatments and high recurrence rates [11, 12], it is critical to identify risk factors for depressive symptoms to prevent their occurrence.

Expressed emotion in the surrounding environment is of great concern, and it usually refers to how family members or other closely related individuals express themselves to a person. High-expressed emotion (e.g., hostile and aggressive tones) in the surrounding environment might cause the reduction of functional connectivity in some brain regions, and might be associated with some adverse events [13]. For example, one meta-analysis has shown that the high-expressed emotion of caregivers is associated

with a higher risk of relapse in patients with MDD [14]. Being criticized is an important part of expressed emotion in the surrounding environment [14], and is defined as negative evaluative feedback received from others in social interactions [15]. As social roles change, being criticized is a pervasive common phenomenon in daily life among older adults [16–19], and the criticisms faced by them usually come from their spouses, children, other immediate family members (OIFM), friends, and so on. Several cross-sectional studies have shown that perceived criticism from families and friends is associated with more severe depressive symptoms among older adults [16–19], but reverse causality might exist due to a cross-sectional design. Additionally, most previous studies did not distinguish specific types of family criticism (e.g., spouse criticism, child criticism, and OIFM criticism) among older adults [16–19]. Hence, one longitudinal study is needed to determine whether specific types of perceived criticism precede depressive symptoms, a necessary condition for identifying risk factors. Moreover, previous studies indicate that there might exist differences in the susceptibility of females and males to negative experiences [20–24], but the sex differences in the association between perceived criticism and depressive symptoms has not been fully clarified among older adults.

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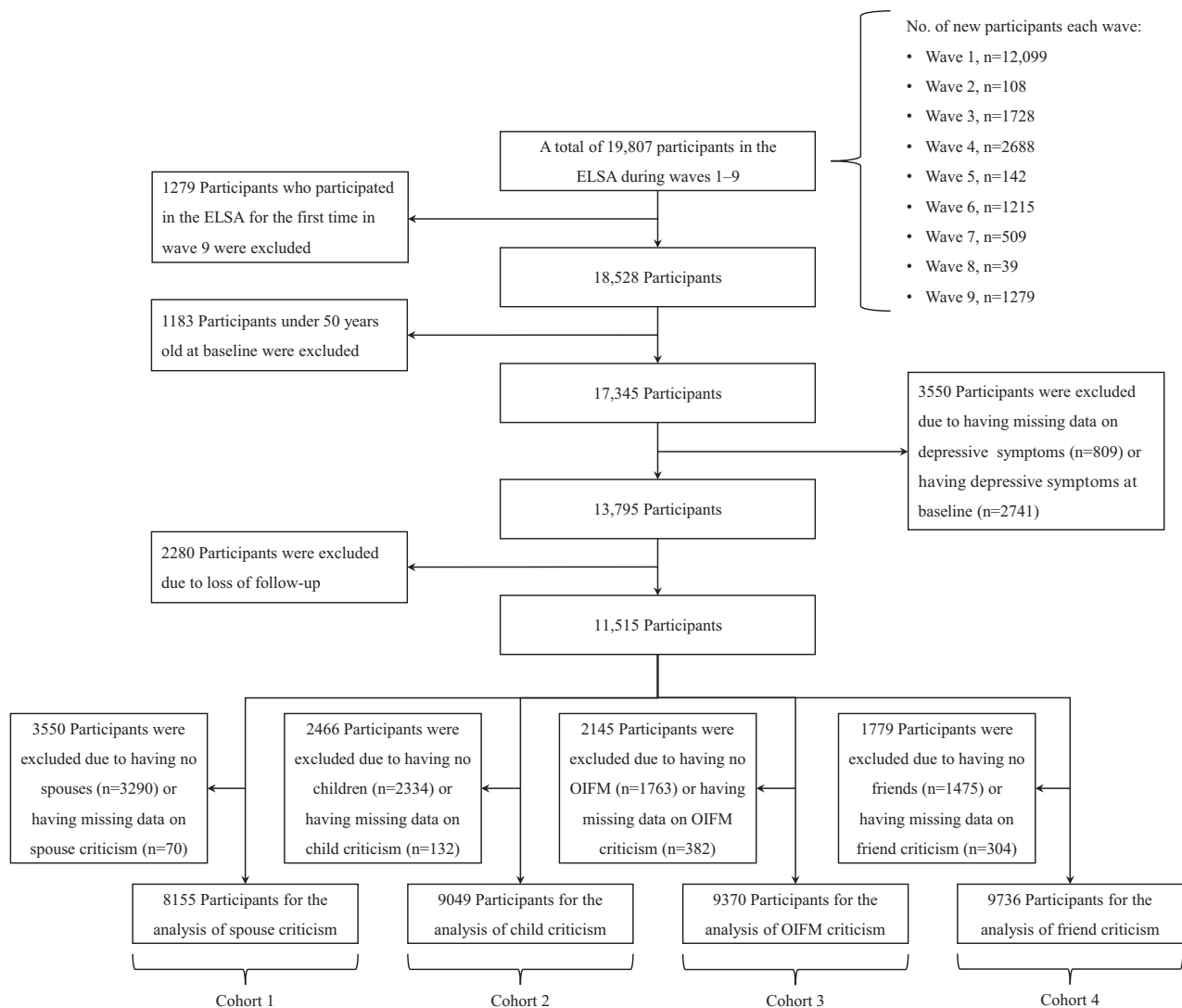


Fig. 1 Flow chart of inclusion and exclusion of participants. ELSA english longitudinal study of ageing, OIFM other immediate family members.

Using the data of a 17-year nationally representative cohort among adults aged 50 years and older, we aimed to explore the associations of perceived spouse criticism, child criticism, OIFM criticism, and friend criticism with depressive symptoms, respectively, and to examine the modifying role of sex in the above associations. Our findings will provide clues for preventing depressive symptoms in older adults.

METHODS

Study design and participants

The England Longitudinal Study of Ageing (ELSA) is an ongoing, dynamic, prospective, and nationally representative cohort of community-dwelling adults aged 50 years and older in the UK, which has been previously described in detail [25]. In short, the ELSA was initiated in 2002–2003 (wave 1) and was biennially followed up until 2018–2019 (wave 9). The sample of the ELSA was compared with national census data and was deemed representative of the non-institutionalized general population in the UK aged 50 years and older [25]. The ELSA received ethical approval from the London Multicenter Research Ethics Committee (MREC/01/2/91). All participants signed the informed consent document. All procedures complied with the Helsinki Declaration of 1975, as revised in 2008.

In the ELSA, the information on perceived spouse criticism, children criticism, OIFM criticism, and friend criticism was investigated among the participants who reported having spouses, children, OIFM, and friends,

respectively. Since some older adults did not have spouses, children, OIFM, and friends at the same time, establishing a cohort would lose a large sample. Thus, we established four cohorts to explore the associations of perceived criticism from spouses, children, OIFM, and friends with depressive symptoms, respectively. Fig. 1 shows the flow chart of inclusion and exclusion of participants. The ELSA is a dynamic cohort, and 12,099, 108, 1728, 2688, 142, 1215, 509, 39, and 1279 new participants entered the cohort at waves 1–9, respectively. We used the time when participants first participated in the ELSA as their baseline. After excluding ineligible participants, 8155, 9049, 9370, and 9736 participants were included in the analyses of perceived criticism from spouses, children, OIFM, and friends, respectively.

Assessment of depressive symptoms

In waves 1–9, depressive symptoms were assessed with the 8-item version of the Center for Epidemiologic Studies-Depression Scale (CES-D) [26]. Participants were asked whether they felt depressed, felt that everything was an effort, slept restlessly, were happy, felt lonely, enjoyed life, felt sad, and could not get going in the past week. Each item had a score of 1 (yes) or 0 (no), and two items (i.e., “were happy” and “enjoyed life”) were scored in reverse. The total score ranged from 0 to 8. A higher score indicates more severe depressive symptoms. Referring to previous studies [27–29], a cut-off value of ≥ 4 was used to define clinically significant depressive symptoms. McDonald’s omega coefficients were 0.810, 0.805, 0.824, 0.975, 0.819, 0.820, 0.815, 0.801, and 0.804 in waves 1–9, respectively, suggesting

that the CES-D had a high reliability in the ELSA. In addition, the assessment date of depressive symptoms in each wave was recorded.

Assessment of perceived criticism

At baseline, participants were surveyed for four types of perceived criticism (i.e., spouse criticism, child criticism, OIFM criticism, and friend criticism). First, participants were asked, “Do you have a husband, wife, or partner with whom you live?”. Those answering “yes” were asked, “How much do they criticize you?”. The options included “not at all”, “a little”, “some”, and “a lot”. Second, participants were asked, “Do you have any children?”. Those answering “yes” were asked the same question as that of spouse criticism. Third, participants were asked, “Do you have any OIFM, for example, any brothers or sisters, parents, cousins or grandchildren?”. Those answering “yes” were asked the same question as that of spouse criticism. Finally, participants were asked, “Do you have any friends?”. Those answering “yes” were asked the same question as that of spouse criticism.

Assessment of potential covariates

At baseline, potential covariates were assessed using the self-report questionnaire, including age, sex (male and female), race/ethnicity (White race and others [i.e., Asian, Asian British, Black, Black British, mixed ethnic group, and other]), education level (high [university degree or equivalent]; middle [A-level/higher education below degree]; and low [no qualifications/O-level or equivalent]), employment status (employed; unemployed; and retired), wealth, the wave of entering the ELSA (waves 1–8), smoking status (current smokers and non-current smokers), drinking status, physical activity, self-reported hypertension (yes and no), self-reported diabetes (yes and no), and self-reported cardiovascular disease (yes and no) [30]. Wealth was based on a comprehensive assessment of economic resources (e.g., financial, housing, and physical wealth) excluding pension wealth, and was divided into quintiles (1 = poorest; 5 = richest) [31]. According to the frequency of drinking in the past year, drinking status was categorized into less than weekly, 1–4 days a week, and 5–7 days a week [28]. Physical activity was assessed by asking participants how often they participated in vigorous, moderate, and light physical activities. Referring to previous studies [32], physical activity was classified into vigorous, moderate, and light physical activities.

Statistical analyses

Baseline characteristics were summarized according to perceived spouse criticism. Categorical variables were shown as frequency (percentage) and were compared using Pearson Chi-squared tests or Fisher's exact tests, as appropriate. Continuous variables were shown as mean (standard deviation [SD]) and were compared using one-way analyses of variance or Kruskal-Wallis tests, as appropriate.

Detailed information on the covariates with missing values is shown in Supplementary Table S1. The missing proportion of all covariates is less than 8%. To maximize the statistical power, we performed multiple imputations with chained equations with 10 data sets to impute covariates with missing values. Cox proportional hazard models were used to estimate the hazard ratio (HR) and 95% confidence interval (CI) to explore the associations of perceived criticism from spouses, children, OIFM, and friends with depressive symptoms, with “not at all” as the reference. Person-years were calculated from the baseline date to the assessment date of new-onset depressive symptoms or the end of follow-up, whichever occurred first. The proportional hazard assumption was examined by Schoenfeld tests, and no violation of this assumption was found. To assess the effect of covariates on the above associations, we sequentially incorporated them into the models. Model 1 was unadjusted for any covariates. Model 2 was adjusted for age and sex at baseline. Model 3 was further adjusted for race/ethnicity, education level, employment status, wealth, smoking status, drinking status, physical activity, diabetes, hypertension, and cardiovascular disease at baseline, as well as the wave of entering the ELSA.

To assess the modifying role of sex in the association between perceived criticism and depressive symptoms, we added an interaction term between perceived criticism and sex to model 3. Sex-stratified analyses were further conducted if the interaction term was statistically significant.

To test the robustness of the results, we conducted several sensitivity analyses. First, we excluded participants developing depressive symptoms during the first two years of follow-up to reduce the influence of reverse causation. Second, since participants might lose their spouses, children, OIFM, and friends during the follow-up, we excluded participants who

reported no spouses, children, OIFM, or friends at the last follow-up for the corresponding analysis. Third, in the main analysis, to ensure sufficient sample size, we established four cohorts to explore the associations between the four types of perceived criticism and depressive symptoms, respectively, and the four types of perceived criticism did not adjust to each other. The association between each type of perceived criticism and depressive symptoms might be confused by the other three types of perceived criticism, so we established a cohort that only included participants with complete data on four types of perceived criticism. In addition to adjusting for the covariates in model 3 in the main analysis, four types of perceived criticism were simultaneously included in the model. Fourth, based on the data of the third sensitivity analysis, each criticism was categorized into yes (i.e., “a lot”, “some”, and “a little”) and no (i.e., “not at all”). Cumulative perceived criticism was calculated and ranges from 0 to 4, with a higher number meaning more types of perceived criticism. We explored the association between cumulative perceived criticism and depressive symptoms. Finally, we excluded participants with missing values for the covariates to test the effect of missing values on the results.

All statistical analyses were conducted using Stata version 17.0 (StataCorp LLC). Statistical significance was defined as a two-tailed *P*-value < 0.05.

RESULTS

Baseline characteristics

For the analysis of perceived spouse criticism, this study included 8155 participants with a mean age of 60.8 (SD, 8.5) years, among whom 52.3% were male (Table 1). Compared with participants perceiving no spouse criticism, those perceiving a lot were more likely to be male, have a low educational level, be employed, be current smokers, and have diabetes. Moreover, they were poorer and took more vigorous physical activity. The baseline characteristics of participants in the analyses of perceived criticism from children, OIFM, and friends were shown in Supplementary Tables S2–S4, respectively.

Association between perceived criticism and depressive symptoms

The follow-up time and number of incident cases are shown in Supplementary Table S5. During a follow-up of 17.3 years, 1878 (23.0%), 2233 (24.7%), 2302 (24.6%), and 2389 (24.5%) developed depressive symptoms for analyses of criticism from spouses, children, OIFM, and friends, respectively. In the full-adjusted model (Fig. 2, model 3), compared with perceived no spouse criticism, perceived some (HR, 1.36; 95% CI, 1.18–1.55) and a lot (HR, 2.24; 95% CI, 1.85–2.72) were associated with higher risks of depressive symptoms, but perceived a little was not (HR, 1.05; 95% CI, 0.92–1.20). Compared with perceived no child criticism, perceived a little (HR, 1.24; 95% CI, 1.12–1.36), some (HR, 1.50; 95% CI, 1.33–1.68), and a lot (HR, 2.02; 95% CI, 1.62–2.52) were related to higher risks of depressive symptoms. Compared with perceived no OIFM criticism, perceived a little (HR, 1.22; 95% CI, 1.11–1.33), some (HR, 1.51; 95% CI, 1.34–1.70), and a lot (HR, 2.29; 95% CI, 1.86–2.81) were correlated with higher risks of depressive symptoms. Similarly, compared with perceived no friend criticism, perceived a little (HR, 1.27; 95% CI, 1.16–1.38), some (HR, 1.36; 95% CI, 1.19–1.55), and a lot (HR, 2.04; 95% CI, 1.37–3.04) were associated with higher risks of depressive symptoms.

Modifying role of sex and sex-stratified analyses

We found that sex modified the associations of perceived criticism from spouses (*P*-value for interaction = 0.020 for a little), children (*P*-value for interaction = 0.049 for a little), OIFM (*P*-value for interaction = 0.032 for a little), and friends (*P*-value for interaction < 0.001 for a little) with depressive symptoms (Table 2). After adjusting for all covariates (Fig. 3), compared with those not perceiving spouse criticism, only males perceiving a lot had a higher risk of depressive symptoms (HR, 1.85; 95% CI, 1.36–2.51), but females perceiving some (HR, 1.43; 95% CI, 1.21–1.69) and a lot (HR, 2.46; 95% CI, 1.90–3.17) both had higher risks of depressive symptoms. Compared with those

Table 1. Characteristics of participants by perceived spouse criticism at baseline.

Characteristic ^a	Total (n = 8155)	Perceived spouse criticism				P-value ^b
		Not at all (n = 1558)	A little (n = 3611)	Some (n = 2570)	A lot (n = 416)	
Age, mean (SD), years	60.8 (8.5)	60.6 (8.7)	60.8 (8.4)	61.0 (8.4)	61.2 (8.7)	0.416
Male	4263 (52.3)	568 (36.5)	1898 (52.6)	1547 (60.2)	250 (60.1)	<0.001
White race	7974 (97.8)	1520 (97.6)	3543 (98.1)	2510 (97.7)	401 (96.4)	0.108
Educational level						<0.001
High	2606 (32.4)	420 (27.4)	1196 (33.5)	872 (34.4)	118 (28.6)	
Middle	648 (8.0)	115 (7.5)	310 (8.7)	191 (7.5)	32 (7.8)	
Low	4801 (59.6)	999 (65.1)	2070 (57.9)	1469 (58.0)	263 (63.7)	
Employment status						0.016
Employed	4002 (49.1)	733 (47.0)	1782 (49.4)	1260 (49.0)	227 (54.6)	
Unemployed	1060 (13.0)	236 (15.2)	466 (12.9)	306 (11.9)	52 (12.5)	
Retired	3093 (37.9)	589 (37.8)	1363 (37.8)	1004 (39.1)	137 (32.9)	
Wealth quintiles						<0.001
1 (Poorest)	671 (8.9)	149 (10.4)	259 (7.7)	209 (8.9)	54 (13.9)	
2	1318 (17.5)	281 (19.6)	571 (17.0)	387 (16.5)	79 (20.4)	
3	1553 (20.6)	311 (21.7)	669 (19.9)	495 (21.1)	78 (20.1)	
4	1846 (24.5)	320 (22.3)	876 (26.0)	573 (24.4)	77 (19.9)	
5 (Richest)	2149 (28.5)	375 (26.1)	991 (29.4)	683 (29.1)	100 (25.8)	
The wave of entering the ELSA						<0.001
Wave 1	5444 (66.8)	1045 (67.1)	2458 (68.1)	1676 (65.2)	265 (63.7)	
Wave 2	34 (0.4)	8 (0.5)	11 (0.3)	14 (0.5)	1 (0.2)	
Wave 3	656 (8.0)	117 (7.5)	278 (7.7)	230 (8.9)	31 (7.5)	
Wave 4	1307 (16.0)	228 (14.6)	580 (16.1)	428 (16.6)	71 (17.1)	
Wave 5	38 (0.5)	2 (0.1)	19 (0.5)	16 (0.6)	1 (0.2)	
Wave 6	486 (6.0)	105 (6.7)	196 (5.4)	144 (5.6)	41 (9.9)	
Wave 7	180 (2.2)	50 (3.2)	62 (1.7)	62 (2.4)	6 (1.4)	
Wave 8	10 (0.1)	3 (0.2)	7 (0.2)	0 (0.0)	0 (0.0)	
Current smoking	1160 (14.2)	215 (13.8)	492 (13.6)	375 (14.6)	78 (18.8)	0.036
Alcohol consumption						<0.001
Less than weekly	2030 (24.9)	447 (28.7)	867 (24.0)	593 (23.1)	123 (29.6)	
1–4 day/week	3696 (45.3)	687 (44.1)	1659 (46.0)	1175 (45.7)	175 (42.2)	
5–7 day/week	2427 (29.8)	424 (27.2)	1084 (30.0)	802 (31.2)	117 (28.2)	
Physical activity						0.035
Light	1975 (24.2)	369 (23.7)	885 (24.5)	615 (23.9)	106 (25.5)	
Moderate	3738 (45.8)	700 (44.9)	1644 (45.5)	1229 (47.8)	165 (39.7)	
Vigorous	2442 (29.9)	489 (31.4)	1082 (30.0)	726 (28.3)	145 (34.9)	
Hypertension	2610 (32.0)	474 (30.4)	1142 (31.6)	852 (33.1)	142 (34.1)	0.217
Diabetes	487 (6.0)	81 (5.2)	192 (5.3)	186 (7.2)	28 (6.7)	0.007
Cardiovascular disease	1300 (15.9)	252 (16.2)	568 (15.7)	415 (16.1)	65 (15.6)	0.961

SD standard deviation.

^aUnless otherwise indicated, data are expressed as No. (%) of participants.^bOne-way analyses of variance were used to compare the means of continuous variables. Pearson Chi-squared tests were performed to compare the distribution of categorical variables.

not perceiving child criticism, males perceiving some (HR, 1.38; 95% CI, 1.14–1.68) and a lot (HR, 2.04; 95% CI, 1.46–2.84) had higher risks of depressive symptoms, but females perceiving a little (HR, 1.30; 95% CI, 1.15–1.47), some (HR, 1.55; 95% CI, 1.34–1.79), and a lot (HR, 1.97; 95% CI, 1.45–2.66) all had higher risks of depressive symptoms. Compared with those not perceiving OIFM criticism, males perceiving some (HR, 1.48; 95% CI, 1.21–1.80) and a lot (HR, 2.79; 95% CI, 2.03–3.84) had higher risks of depressive symptoms, but females

perceiving a little (HR, 1.29; 1.15–1.45), some (HR, 1.50; 95% CI, 1.29–1.75), and a lot (HR, 1.99; 95% CI, 1.52–2.61) all had higher risks of depressive symptoms. Compared with those not perceiving friend criticism, males perceiving a lot had a higher risk of depressive symptoms (HR, 1.80; 95% CI, 1.11–2.91), but females perceiving a little (HR, 1.45; 95% CI, 1.30–1.62), some (HR, 1.47; 95% CI, 1.24–1.74), and a lot (2.09; 95% CI, 1.00–4.40) all had higher risks of depressive symptoms.

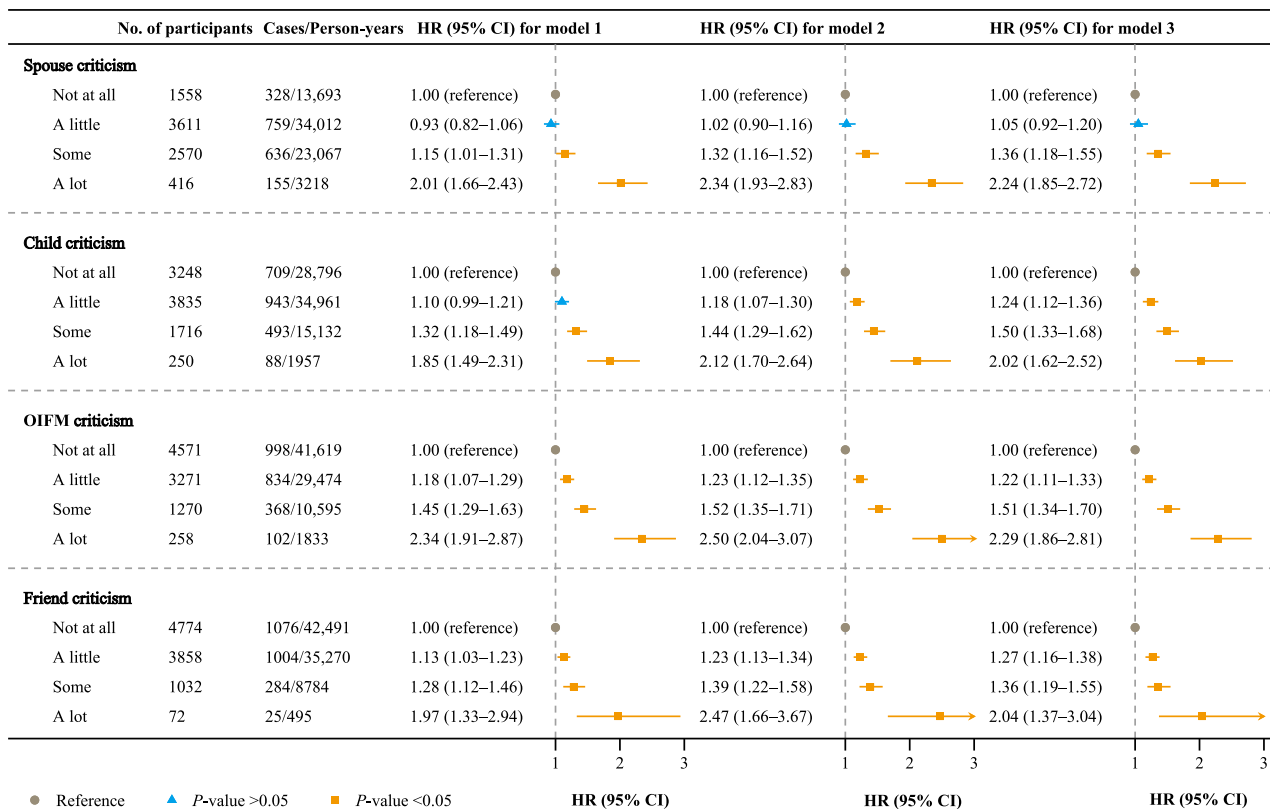


Fig. 2 Association of perceived criticism with depressive symptoms. Model 1: unadjusted for any covariates. Model 2: adjusted for age and sex at baseline. Model 3: adjusted for age, sex, race/ethnicity, education level, employment status, wealth, smoking status, drinking status, physical activity, hypertension, diabetes, and cardiovascular disease at baseline, as well as the wave of entering the England Longitudinal Study of Ageing. CI confidence interval, HR hazards ratio, OIFM other immediate family members.

Table 2. Modifying role of sex in the association of perceived criticism with depressive symptoms.

Interaction item	HR (95% CI)	P-value for interaction
Spouse criticism × sex ^a		
A little × females	1.39 (1.05–1.84)	0.020
Some × females	1.26 (0.95–1.68)	0.108
A lot × females	1.33 (0.89–1.97)	0.161
Child criticism × sex ^a		
A little × females	1.21 (1.00–1.49)	0.049
Some × females	1.14 (0.90–1.45)	0.288
A lot × females	0.98 (0.63–1.54)	0.937
OIFM criticism × sex ^a		
A little × females	1.25 (1.02–1.52)	0.032
Some × females	1.03 (0.80–1.33)	0.834
A lot × females	0.76 (0.49–1.18)	0.226
Friend criticism × sex ^a		
A little × females	1.49 (1.25–1.79)	<0.001
Some × females	1.24 (0.95–1.62)	0.115
A lot × females	1.11 (0.46–2.69)	0.819

Models included perceived criticism, sex, perceived criticism × sex, age, race/ethnicity, education level, employment status, wealth, the wave of entering the English Longitudinal Study of Ageing, smoking status, drinking status, physical activity, hypertension, diabetes, and cardiovascular disease at baseline.

CI confidence interval, HR hazards ratio, OIFM other immediate family members.

^aThe reference group for perceived criticism was “not at all”, and the reference group for sex was males.

Sensitivity analyses

First, after excluding participants developing depressive symptoms within two years (Supplementary Table S6), the results did not change significantly. Second, after excluding participants having no spouses, children, OIFM, or friends at the last follow-up (Supplementary Table S7), perceived a lot of friend criticism became unrelated to depressive symptoms in females (HR, 2.37; 95% CI, 0.88–6.37), possibly due to small sample size ($n = 10$). Third, we established one cohort, only including participants with complete data on spouse criticism, child criticism, OIFM criticism, and friend criticism. In addition to adjusting for the covariates in model 3 in the main analysis, four types of perceived criticism were simultaneously included in the model (Supplementary Table S8). Perceived a lot of friend criticism became unrelated to depressive symptoms in females (HR, 1.97; 95% CI, 0.68–6.87), possibly due to the small sample size ($n = 5$). Fourth, in the analysis of the association between cumulative perceived criticism and depressive symptoms (Supplementary Table S9), each increase type of criticism was a higher risk of depressive symptoms in total participants (HR, 1.16; 95% CI, 1.11–1.21), males (HR, 1.09; 95% CI, 1.02–1.16), and females (HR, 1.20; 95% CI, 1.13–1.26), and sex modified the above association (P -value for interaction = 0.032). Finally, after excluding participants with missing values for the covariates (Supplementary Table S10), the results did not change significantly.

DISCUSSION

Up to the present, limited longitudinal evidence is available on the association of perceived criticism with depressive symptoms in older adults. Using data from the ELSA, this 17-year prospective cohort study of older adults found that perceived some and a lot

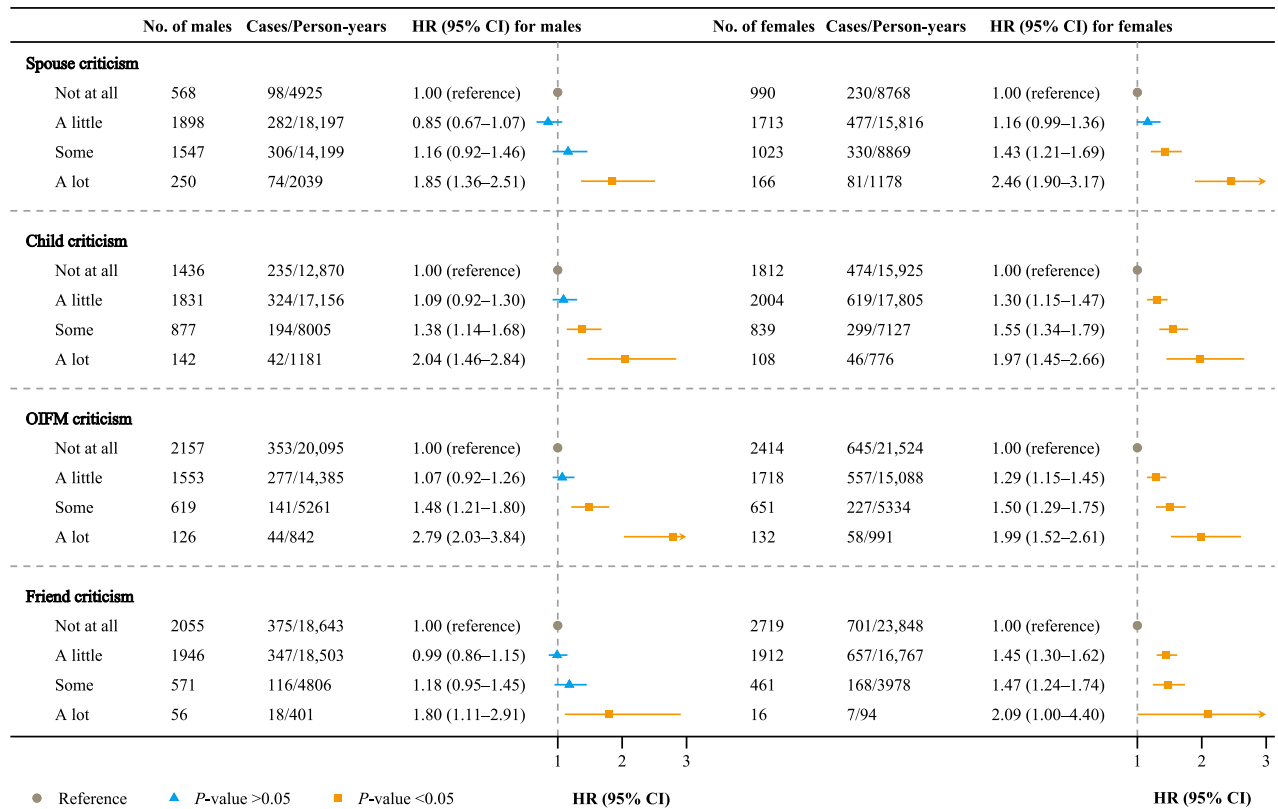


Fig. 3 Association of perceived criticism with depressive symptoms stratified by sex. The results were adjusted for age, sex, race/ethnicity, education level, employment status, wealth, smoking status, drinking status, physical activity, hypertension, diabetes, and cardiovascular disease at baseline, as well as the wave of entering the England Longitudinal Study of Ageing. CI confidence interval, HR hazards ratio, OIFM other immediate family members.

of spouse criticism was associated with higher risks of depressive symptoms, but perceived a little spouse criticism was not, and perceived criticism from children, OIFM, and friends was related to higher risks of depressive symptoms, even a little criticism. In addition, sex significantly modified the above associations, and females were more susceptible to four types of criticism than males. Our findings provide new insights into the prevention of depressive symptoms in older adults.

We found that perceived criticism from spouses, children, and OIFM is a risk factor for depressive symptoms among older adults. Although not distinguishing specific types of family criticism, previous cross-sectional studies have found that perceived family criticism is associated with more severe depressive symptoms in older adults [16–19], which to some extent supports our findings. In addition, several studies have explored the association between perceived spousal criticism and depressive symptoms in young adults or patients with major depressive disorder [24, 33, 34]. For example, similar to our findings, a longitudinal study has shown that perceived spousal criticism was associated with more severe depressive symptoms both 5 and 10 years later in adults with a mean age of 28 who had been married for one year [24]. However, another longitudinal study has found that perceived spousal criticism is not related to the recurrence of depressive symptoms among patients with major depressive disorder [33]. Additionally, one cross-sectional study has reported that perceived spousal criticism is correlated with milder depressive symptoms in patients with major depressive disorder [34]. The reason why our findings are inconsistent with those of the last two studies might be that their participants are patients with major depressive disorder [33, 34], while the participants in our study are the general population.

Currently, relatively few studies have explored the association between perceived friend criticism and depressive symptoms. Only one cross-sectional study has shown that perceived friend criticism is correlated with more severe depressive symptoms among older adults [16]. Our cohort study showed that perceived friend criticism was associated with a higher risk of depressive symptoms, further confirming the results of the previous cross-sectional study [16]. Furthermore, our data showed that older adults with friends outnumber those with spouses, those with children, and those with OIFM. Therefore, criticism from friends among older adults should not be ignored, and more studies are needed in the future to confirm our findings.

We observed that sex significantly modified the associations between perceived criticism and depressive symptoms, and the sex-stratified analysis showed that perceived some and a lot of spouse criticism was associated with the increased risk of depressive symptoms in females, but only perceived a lot of spouse criticism was associated with the increased risk of depressive symptoms in males. For perceived criticism from children, OIFM, and friends, the results were similar to that of perceived spouse criticism. These findings suggest that females are more susceptible to four types of criticism, which is reasonable based on the findings of previous studies [20–23]. A study of dizygotic twins has found that females show greater sensitivity to interpersonal relationships, whereas males show greater sensitivity to external career and goal-oriented factors [20]. Discrimination and psychological intimate partner violence are similar stressors to criticism. One study of immigrant groups has shown that females are more vulnerable to discrimination than males [21]. Previous studies have reported that psychological intimate partner violence is more strongly correlated with mental health problems in

females than in males [22, 23]. However, one small-sample cohort study ($n = 249$) has shown that perceived spousal criticism was associated with more severe depressive symptoms one year later in males, but not in females [24], which is contradictory to our results. Participants in the above study were young adults (average age, 28 years), had been married for about a year, and had received premarital education intervention [24]. These characteristics of participants might be the reason for inconsistent results.

The mechanism linking perceived criticism and depressive symptoms has not been fully clarified. A neuroimaging study indicates that the relevant mechanisms might involve the activation of the amygdala, dorsolateral prefrontal cortex, and anterior cingulate cortex [35]. In addition, a recent study has combined high-expressed emotion stimulation, including criticism, with a neuroimaging tool (i.e., functional near-infrared spectroscopy), and has found that when patients with schizophrenia are exposed to high-expressed emotion stimulation, the functional connections of some brain regions are reduced [13]. The study is very enlightening, and it is worth noting that the study pointed out that functional near-infrared spectroscopy is a portable, lightweight, and cost-effective tool [13]. Thus, the combination of high-expressed emotion stimulation with neuroimaging tools (especially functional near-infrared spectroscopy) to explore the functional connectivity of brain regions that might be involved in perceived criticism affecting depressive symptoms is a potentially valuable direction for future studies.

This study has several important strengths. First, we used a large sample representative of older adults living in the UK [25], so the results are representative. Second, the 17-year prospective cohort study design allowed for the identification of temporality between perceived criticism and depressive symptoms, making up for the shortcomings of previous cross-sectional studies. Third, most previous studies did not distinguish specific types of family criticism. In contrast, we assessed the associations of perceived criticism from spouses, children, and OIFM with depressive symptoms, so our findings provide more specific scientific evidence. Finally, sex-stratified analyses allowed for the identification of differences in susceptibility to criticism between males and females. Nevertheless, several potential limitations should also be considered. First, perceived criticism was self-reported, which might lead to reporting bias. Second, although the population in this study extensively represents adults aged 50 years or older in the UK, our findings should be cautiously generalized to other populations. Finally, due to the nature of observational studies, the impact of unmeasured confounding factors (e.g., genotype) on the results cannot be eliminated, hindering the determination of the causal association.

In conclusion, in this 17-year prospective cohort study among adults aged 50 years and older, perceived some and a lot of spouse criticism was associated with an increased risk of depressive symptoms, but perceived a little spouse criticism was not, and perceived criticism from children, OIFM, and friends was correlated with an increased risk of depressive symptoms, even a little criticism. Moreover, females were more susceptible to perceived criticism than males. From a public health perspective, our findings emphasize the benefits of reducing criticism of older adults in preventing their depressive symptoms.

DATA AVAILABILITY

Data are openly available to researchers via the UK Data Service.

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AUTHOR CONTRIBUTIONS

Ciyong Lu and Yanzhi Li designed this study. Yanzhi Li, Yang Yang, and Jingman Shi managed the literature searches and summaries of previous related work. Yanzhi Li, Liwan Zhu, Caiyun Zhang, Hao Zhao, and Wenjian Lai did the statistical analysis. Yanzhi Li wrote the first draft of the manuscript. All authors reviewed the manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The English Longitudinal Study of Ageing received ethical approval from the London Multicenter Research Ethics Committee (MREC/01/2/91). All participants signed the informed consent document. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

ADDITIONAL INFORMATION

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