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Review

Chronic diseases and risk for depression in old age: A meta-analysis of published literature

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ABSTRACT

Objective: We assessed the relationship between chronic diseases and risk for depression in old age.
Method: MEDLINE, EMBASE, The Cochrane Library database were used to identify potential studies. All of the clinical studies that obtained data on the association between chronic diseases and risk of depression among individuals aged 55 years or older were identified and included in this review. The studies were classified into cross-sectional and longitudinal subsets. The quantitative meta-analysis of cross-sectional studies and that of longitudinal studies were preformed, respectively. For prevalence and incidence rates of depression, odds risk (OR) and relative risk (RR) were calculated, respectively.
Results: Since all but one study found in the search was for individuals 60 years of age or over, we assessed and report on results for this larger group only. 24 cross-sectional and 7 prospective longitudinal studies were included in this review. The quantitative meta-analysis showed that, among chronic diseases, stroke, loss of hearing, loss of vision, cardiac disease or chronic lung disease had both a significant OR and RR for increased depression in old age; arthritis, hypertension or diabetes had a significant OR but an un-significant RR for increased depression in old age; and gastrointestinal disease had neither a significant OR nor a significant RR for increased depression in old age.
Conclusions: We concluded here that in old age, the associations of depression with some chronic diseases were definite; among these chronic diseases, stroke, loss of hearing, loss of vision, cardiac disease and chronic lung disease were risk factors for increased depression, but it should be further investigated whether arthritis, hypertension and diabetes were risk factors for increased depression or not.

1. Introduction

The prevalence of clinical depression and presence of elevated depressive symptoms are higher among persons with some chronic diseases, such as diabetes, stroke, cardiac disease, chronic lung disease, and hypertension and so on, compared with the general population (Talbot and Nouwen, 2000; Anderson et al., 2001; Hackett and Anderson, 2005; Nicholson et al., 2006; Scalco et al., 2005; Norwood, 2007). These associations may be related to increased risk of depressive symptoms in individuals with these chronic diseases, increased risk of these chronic diseases in individuals with depressive symptoms, or both. Several factors associated with depressive symptoms, including obesity-promoting health, behaviors (e.g., physical inactivity, hypercaloric diets) and activation of the neuroendocrine and inflammatory responses (resulting in increased cortisol, catecholamines, and cytokines), can induce the development of these chronic diseases (Carnethon et al., 2007; Golden, 2007; Winokur et al., 1988; Lake et al., 1982; Roy et al., 1988; Maes et al., 1990; Kiecolt-Glaser and Glaser, 2002; Ford and Erlinger, 2004).

Depression is a major contributor to healthcare costs associated with older populations, and is projected to be the leading cause of disease burden in older populations by the year 2020 (Goodwin, 2003; Katon et al., 2003). The prevalence of depression in patients aged 65 and older may be as high as 40% in hospitalized and 30% in nursing home patients, and 8–15% in community settings (Leon et al., 2003; Birrer and Vemuri, 2004). The prognosis of these depressive states is poor. A meta-analysis of outcomes at 24 months estimates that only 33% of subjects are well, 33% are depressed, and 21% have died (Cole et al., 1999). Moreover, studies of depressed adults indicate that those with depressive symptoms, with or without depressive disorder, have poorer functioning, comparable to or worse than that of people with chronic medical conditions such as heart and lung disease, arthritis, hypertension, and diabetes (Gurland et al., 1988; von Korff et al., 1992; Wells and Burman, 1991). In addition to poor functioning, depression can induce the development of these chronic diseases and increase the perception of poor health, the utilization of medical services, and

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health care costs (Wells and Burman, 1991; Katon et al., 1992; Unutzer et al., 1997).

A diagnosis of some chronic diseases may also lead to symptoms of depression (Talbot and Nouwen, 2000), which has been shown in many longitudinal and cross-sectional studies (Al-Shammari and Al-Subaie, 1999; Blay et al., 2007; Carvakhais et al., 2008; Chen et al., 2005; Giltay et al., 2006; Harris et al., 2006; Kennedy et al., 1990). However, converse conclusion has been also conducted by some studies (de Beurs et al., 2001; Friedman et al., 2007; McDougall et al., 2007). Moreover, a recent systematic review and meta-analysis showed that odds ratio (OR) of poor health status as a function of increased depression in the elderly was un-significant (OR = 1.8, 95% confidence intervals (95% CI) = 0.5–12.8) (Cole and Dendukuri, 2003). This systematic review did not assess the association between chronic diseases and risk of depression in the elderly. Therefore, it has still been unknown whether chronic diseases are risk factors for depression in the old age or not.

Depression is a critically important issue for the old age and those working with the old age. The population of the old and the oldest-old person increases, the number of depression the old individuals can be expected to rise (Harpole et al., 2005; Koenig et al., 1988). In old age, both depression and chronic diseases have high prevalence and depression and chronic diseases may induce the development each other. Therefore, it is important to investigate the relationship between chronic diseases and risk for depression in old age. So we decided to conduct a meta-analysis in order to measure the magnitude and shape of the association between chronic diseases and risk for depression in old age. In this meta-analysis, depression included depressive symptoms, minor and major depression.

2. Methods

2.1. Search method

This was one part of a best-evidence research on depression in older people. In the research, we collected literature through searching MEDLINE (from the beginning of 1966), EMBASE (from the beginning of 1980) and The Cochrane Library (1990 to August 2007). The search terms (provided by Cochrane Center) included depression, older and clinical trials. Four researchers selected literature which involved clinical trials, depression (diagnostic criteria in formal depression scale) and old patients (55 years and above). The literatures, which were not clinical trials, unrelated with depression, or not including old people, were rejected. The literature selection included three stages: (1) reviewed title to reject the articles and remained those which would be potentially included; (2) reviewed title and abstract of the articles, which were remained in the first stage, rejected the articles and remained those which would be potentially included; (3) reading the full text of the articles, which were remained in the second stage, rejected the literature and remained those which would be included. Finally, 6420 articles were remained in the third stage and were classified into four subgroups according to the objective of the research program: etiology or epidemiology related, diagnostics related, therapeutics related and prognosis related. The search terms, search results and classification of literature were reported previously (Dong et al., 2008; Huang et al., 2009). The selection and classification of literature were preformed by the four researchers, and each article was selected and classified by two researchers independently, discrepancies were addressed by discussing. In this meta-analysis, we measured the magnitude and shape of the association between chronic diseases and depression in the old age, so only etiology or epidemiology related might be potentially included. The inclusion criteria and exclusion criteria were listed as follows.

2.2. Inclusion criteria

(1) Cross-sectional and longitudinal studies where all participants were 55 years and over; (2) original research reported in English; (3) with the complete information on the prevalence or incidence of depression in different chronic disease group; (4) and use of a diagnostic criteria in formal depression scale. We accepted the diagnostic category of depression as applied by the authors of each study, which included the following: (1) the presence of depressive disorder or depressive symptoms, as defined by scores above a cut point for abnormality on a standard mood scale; (2) severity of depressive disorder or depressive symptoms, as defined by scores on a standard mood scale; (3) the presence of major depression or minor depression (or dysthymia) according to Diagnostic and Statistical Manual of Mental Disorders (DSM)-IIIR, DSM-IV, or other standard psychiatric diagnostic criteria.

2.3. Exclusion criteria

Studies were excluded if they had any of the following: limited to specific patient characteristics, such as convenience sampling; retrospective recruitment; or if there was only unstructured assessment of mood.

2.4. Data extraction and checking

For longitudinal study, information about the country of study, group size at baseline and follow-up, age, proportion of men relative to women, depression criteria, exclusion criteria at baseline, length of follow-up, number of incident cases of depression in each group was abstracted from each report. For cross-sectional study, information about the country of study, group size, age, proportion of men relative to women, depression criteria, exclusion criteria, number of cases of depression in each group was abstracted from each report. Every paper included in the meta-analysis was read and the data were extracted and cross-checked independently by two authors; discrepancies were addressed by discussing.

2.5. Statistical analysis

Data were entered into the RevMan 4.2 meta-analysis program (Cochrane Collaboration, Oxford, UK; see http://www.cc-ims.net/RevMan/current.htm). Since the meta-analysis of cross-sectional studies had advantages of huge sample size and easily showing the association between chronic disease and prevalence of depression, and the meta-analysis of longitude studies had the advantage of easily conducting a causality conclusion. We conducted the meta-analysis of cross-sectional and that of longitudinal studies respectively. In the meta-analysis of cross-sectional studies, for prevalence rates of depression, odds risk (OR) and 95% confidence intervals (95%CIs) were calculated. Results had been summarized using conventional Forest plots and ORs, stratified by features of the studies included. In the meta-analysis of longitudinal studies, for incidence rates of depression, relative risk (RRs) and 95% CIs were calculated. Results had been summarized using conventional Forest plots and RRs, stratified by features of the studies included. Summary ORs and RRs were estimated using a random-effects model.

3. Results

3.1. The search

Our search found 1027 potential etiology or epidemiology related literature. 901 of the 1027 articles were rejected as obviously unsuitable (unrelated with chronic diseases) and 126

Table 1
Characteristics of 24 cross-section studies included the meta-analysis.

Study	Country	Participants (*N*)	From population	Age (years)	Gender (male %)	Criteria for depression	Exclusion criteria	Cases of depression
Al-Shammari and Al-Subaie (1999)	Saudi Arabia	7,970	Community	>60	62	30-GDS ≧ 20	–	670
Bergdahl et al. (2005)	Sweden	242	Community	≧85	25	DSM-IV	–	65
Blay et al. (2007)	Brazil	6,961	Community	>60	34	Short psychiatric evaluation schedule (six-item version) ≧20	–	2722
Bourdel-Marchasson et al. (1997)	France	2,792	Community	≧65	40.2	20-CES-D ≧ 16	–	358
Bruce et al. (2002)	USA	539	Community	65–102	34.9	DSM-IV	–	73
Brody et al. (2001)	USA	151	Community	≧60	32.4	SCID-IV	–	49
Chen et al. (2005)	China	1,600	Community	≧60	47.1	AGECAT	–	95
Chi et al. (2005)	China	917	Community	≧60	47.5	15-GDS ≧ 8	Cognitive impairment	113
Chow et al. (2004)	China	245	Nursing home	≧65	37.1	15-GDS ≧ 8	Cognitive impairment	71
Evans et al. (2007)	UK	13,900	Community	≧75	32.3	15-GDS ≧ 6	–	1105
Gallo et al. (2005)	USA	1,226	Primary care	≧60	30.1	CES-D> ≧20	Cognitive impairment	599
Gudmundsson et al. (2006)	Sweden	416	COPD patients being discharged after hospitalization	≧60	46.2	HAD	–	110
Ho and Jones (1999)	USA	2,818	Community	≧65	39.4	GLAMORGAN	–	307
Jones et al. (1984)	UK	657	A general practice	≥70	38.1	7-CES-D ≧ 6	–	85
Kulaksizoglu et al. (2005)	Turkey	1,018	Community	≥70	39	30-GDS > 14	–	163
Lindesay (1990)	UK	890	Community	≥65	40.1	CATEGO/ID ≧ 8	–	120
Steffens et al. (1999)	USA	3,660	Community	≥65	44.2	CES-D scores, quartiles for comparisons. The highest vs. the others	–	880
Stek et al. (2004)	Netherlands	599	Community	≥65	37	15-GDS > 5	–	77
Sun et al. (2007)	USA	2,194	Community	69–97	41.6	10-item CES-D > 9	–	368
Teresi et al. (2001)	USA	319	Nursing home	60–102	–	DSM-III-R	–	31
Tsai et al. (2005)	China (Taiwan)	1,200	Nursing homes	≧65	55.8	15-GDS > 5	Cognitive impairment	330
Tsai (2007)	China (Taiwan)	200	Care homes	≧65	65.5	15-GDS > 8	Cognitive impairment	98
Wang et al. (1999)	China	1,421	Community	≧65	44.2	GDS-S score ≧ 8	Dementia, chronic psychosis	191
Yohannes et al. (2000)	USA	137	Outpatients (COPD)	≧65	50.4	MADRS ≧ 3	–	62

CES-D Scale: Center for Epidemiologic Studies Depression Scale. DSM: Diagnostic and Statistical Manual of Mental Disorders. GMS-AGECAT: Geriatric Mental State Schedule Automated Geriatric Examination for Computer Assisted Taxonomy. Short CARE: shortened Comprehensive Assessment and Referral Evaluation. GDS-15: Geriatric Depression Scale. SADS: Schedule for Affective Disorders and Schizophrenia. HAD: Hospital anxiety Depression Scale.

remained. 94 of these 126 articles were rejected for a variety of reasons, including (a) no usable data; (b) no recognized instrument used for diagnosis. 32 studies were remained. Since the subjects in these studies except one were aged 60 years or more (Sonnenberg et al., 2000; Steunenberg et al., 2006), we excluded this study and conduct a meta-analysis in order to assess the association between chronic diseases and risk for depression in old age (≧60 years). 31 studies were included in the review (Al-Shammari and Al-Subaie, 1999; Blay et al., 2007; Chen et al., 2005; Giltay et al., 2006; Harris et al., 2006; Bourdel-Marchasson et al., 1997; Bergdahl et al., 2005; Brody et al., 2001; Bruce et al., 2002; Chi et al., 2005; Chow et al., 2004; Evans et al., 2007; Gallo et al., 2005; Gudmundsson et al., 2006; Ho and Jones, 1999; Jones et al., 1984; Kulaksizoglu et al., 2005; Lindesay, 1990; Steffens et al., 1999; Stek et al., 2004; Sun et al., 2007; Teresi et al., 2001; Tsai et al., 2005; Tsai, 2007; Wang et al., 1999; Yohannes et al., 2000; Forsell, 2000; Kim et al., 2006; Maraldi et al., 2007; Prince et al., 1998; Whyte et al., 2004).

3.2. Included studies

Characteristics of the 31 studies (including 24 cross-sectional studies (Al-Shammari and Al-Subaie, 1999; Blay et al., 2007; Chen et al., 2005; Bourdel-Marchasson et al., 1997; Bergdahl et al., 2005; Brody et al., 2001; Bruce et al., 2002; Chi et al., 2005; Chow et al., 2004; Evans et al., 2007; Gallo et al., 2005; Gudmundsson et al., 2006; Ho and Jones, 1999; Jones et al., 1984; Kulaksizoglu et al., 2005; Lindesay, 1990; Steffens et al., 1999; Stek et al., 2004; Sun et al., 2007; Teresi et al., 2001; Tsai et al., 2005; Tsai, 2007; Wang et al., 1999; Yohannes et al., 2000) and seven longitudinal (Giltay et al., 2006; Harris et al., 2006; Forsell, 2000; Kim et al., 2006; Maraldi et al., 2007; Prince et al., 1998; Whyte et al., 2004) available for meta-analysis) were summarized in Tables 1 and 2.

3.3. Data synthesis

3.3.1. Publication bias

We assessed publication bias using funnel plot (showed in Fig. 1). The funnel plot of ORs (under a fixed-effects model) was from the 31 studies in Tables 1 and 2. In the absence of publication bias the points should be symmetrical about the vertical line at the pooled ORs. The reasonably symmetrical did suggest the absence of publication bias.

3.3.2. Stroke and risk for depression in old age

Nine of included studies compared the prevalence of depression in old age between individuals with and without stroke (Bergdahl et al., 2005; Bruce et al., 2002; Gallo et al., 2005; Kulaksizoglu et al., 2005; Stek et al., 2004; Teresi et al., 2001; Tsai et al., 2005; Tsai, 2007; Wang et al., 1999). In the nine studies, there were 646 and 5283 individuals with and without stroke, respectively. There were 264 and 1422 cases of depression in the groups with and without stroke, respectively. After pooling these nine studies, there was

Table 2
Characteristics of seven prospective longitudinal studies included the meta-analysis.

Study	Number of subjects		Age (years)	Gender (male %)	Criteria for depression	Exclusion criteria at baseline	Length of follow-up (months)	Cases of incident depression *N* (%)	Country
	Baseline	Follow-up							
Forsell (2000)	1777	903	≥75	23	DSM-IV criteria	Depression, anxiety, psychosis	36	29 (3.2%)	Sweden
Giltay et al. (2006)	229	229	64–84	1	Zung SDS ≥ 50	Depression	60	75 (32.7%)	Netherlands
Harris et al. (2006)	–	945	≥65	41	GDS ≥ 5	GDS ≥ 5 dementia	24	79 (8.4%)	UK
Kim et al. (2006)	661	521	≥65	45	GMS B3	Depression.	24	63 (12%)	Korean
Maraldi et al. (2007)	597	597	70–79	52	10-item CES-D > 10	Depression	12	53 (9.6%)	USA
Prince et al. (1998)	538	383	≥65	39	Short CARE (clinical depression criteria)	Depression	12	46 (12%)	UK
Whyte et al. (2004)	1165	930	≥70	36.6	mCES-D score > 5	–	36	61 (6.6%)	USA

CES-D Scale: Center for Epidemiologic Studies Depression Scale. DSM: Diagnostic and Statistical Manual of Mental Disorders. Short CARE: shortened Comprehensive Assessment and Referral Evaluation. GDS: Geriatric Depression.

association between stroke and depression in old age (OR: 1.87, 95% CI: 1.33–2.62) (Fig. 2). Two of included studies compared incidence rates of depression in old age between individuals with and without stroke (Kim et al., 2006; Whyte et al., 2004). After pooling these studies, there were 56 and 1395 subjects with and without stroke respectively, and those with stroke had significantly higher risk for depression (RR: 3.19, 95% CI: 1.12–9.08) (Fig. 2). The significant OR and RR showed that stroke was an important risk factor for depression in old age.

3.3.3. Poor hearing and risk for depression in old age

Seven of included studies compared the prevalence of depression in old age between individuals with poor and good hearing (Al-Shammari and Al-Subaie, 1999; Blay et al., 2007; Bergdahl et al., 2005; Chi et al., 2005; Jones et al., 1984; Lindesay, 1990; Yohannes et al., 2000). In the seven studies, there were 4448 and 13,319 subjects with poor and good hearing, respectively. There were 1395 and 2386 cases of depression in the groups with poor and good hearing, respectively. After pooling these seven studies, there was association between depression in old age and poor hearing (OR: 1.71, 95% CI: 1.28–2.27) (Fig. 3). Two of included studies compared incidence rates of depression in old age between individuals with and without poor hearing (Forsell, 2000; Prince et al., 1998). After pooling these studies, there were 172 and 1114 subjects with poor and good hearing respectively, and those with poor hearing had significantly higher risk for depression (RR: 1.92, 95% CI: 1.12–3.29) (Fig. 3). The significant OR and RR showed that poor hearing was an important risk factor for depression in old age.

3.3.4. Poor vision and risk for depression in old age

Twelve of included studies compared the prevalence of depression in old age between individuals with poor and good vision (Al-Shammari and Al-Subaie, 1999; Blay et al., 2007; Bergdahl et al., 2005; Brody et al., 2001; Chi et al., 2005; Chow et al., 2004; Evans et al., 2007; Lindesay, 1990; Stek et al., 2004; Tsai et al., 2005; Tsai, 2007; Yohannes et al., 2000). In the 12 studies, there were 11,066 and 20,976 subjects with poor and good vision, respectively. There were 3022 and 2416 cases of depression in the groups with poor and good vision, respectively. After pooling these 12 studies, there was association between depression in old age and poor vision (OR: 1.94, 95% CI: 1.68–2.25) (Fig. 4). Three of included studies compared incidence rates of depression in old age between individuals with and without poor vision (Harris et al., 2006; Forsell, 2000; Prince et al., 1998). After pooling these studies, there were 255 and 1950 subjects with poor and good vision respectively, and those with poor vision had significantly higher risk for depression (RR: 2.38, 95% CI: 1.23–4.60) (Fig. 4). The significant OR and RR showed that poor vision was an important risk factor for depression in old age.

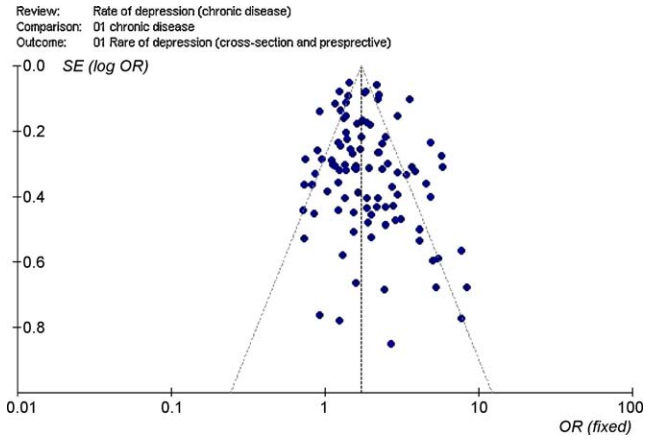

Fig. 1. Funnel plot of the 31 studies included in the meta-analysis.

3.3.5. Arthritis and risk for depression in old age

Six of included studies compared the prevalence of depression in old age between individuals with and without arthritis (Al-Shammari and Al-Subaie, 1999; Bergdahl et al., 2005; Lindesay, 1990; Stek et al., 2004; Tsai et al., 2005; Tsai, 2007). In the six studies, there were 2269 and 6491 subjects with and without arthritis, respectively. There were 417 and 714 cases of depression in the groups with and without arthritis, respectively. After pooling these six studies, there was association between depression in old age and arthritis (OR: 2.27, 95% CI: 1.35–3.82) (Fig. 5). One of included studies compared incidence rates of depression in old age between individuals with and without arthritis (Prince et al., 1998). This study, where subjects with and without arthritis were 146 and 237 included respectively, showed that subjects with arthritis had insignificantly higher risk for depression (RR: 1.49, 95% CI: 0.87–2.55) (Fig. 5).

3.3.6. Hypertension and risk for depression in old age

Six of included studies compared the prevalence of depression in old age between individuals with and without hypertension (Chen et al., 2005; Lindesay, 1990; Steffens et al., 1999; Sun et al., 2007; Tsai et al., 2005; Tsai, 2007). In the six studies, there were 3578 and 5833 subjects with and without hypertension, respectively. There were 824 and 1037 cases of depression in the groups with and without hypertension, respectively. After pooling these six studies, there was association between depression in old age and hypertension (OR: 1.25, 95% CI: 1.04–1.50) (Fig. 6). Two of included studies compared incidence rates of depression in old age between individuals with and without hypertension (Kim et al., 2006; Prince et al., 1998). After pooling these studies, there were 111 and 793 subjects with and without hypertension, respectively, subjects with hypertension had

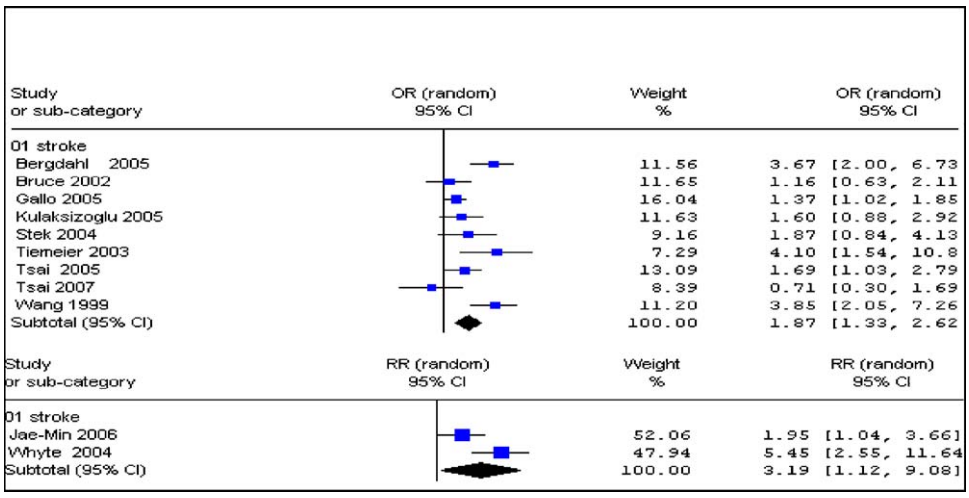

Fig. 2. Forest plot of ORs and RRs from 11 studies comparing the prevalence and incidence rates of depression in old age between subjects with and without stroke.

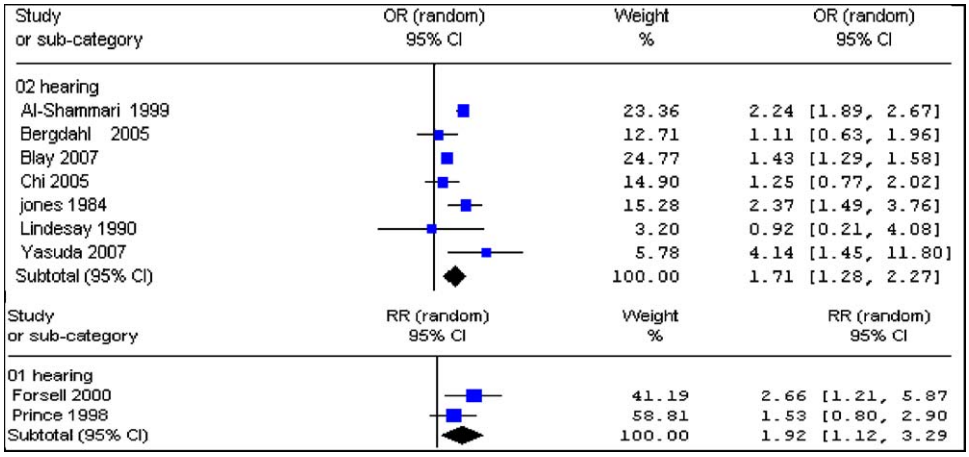

Fig. 3. Forest plot of ORs and RRs from nine studies comparing the prevalence and incidence rates of depression in old age between subjects with poor and good hearing.

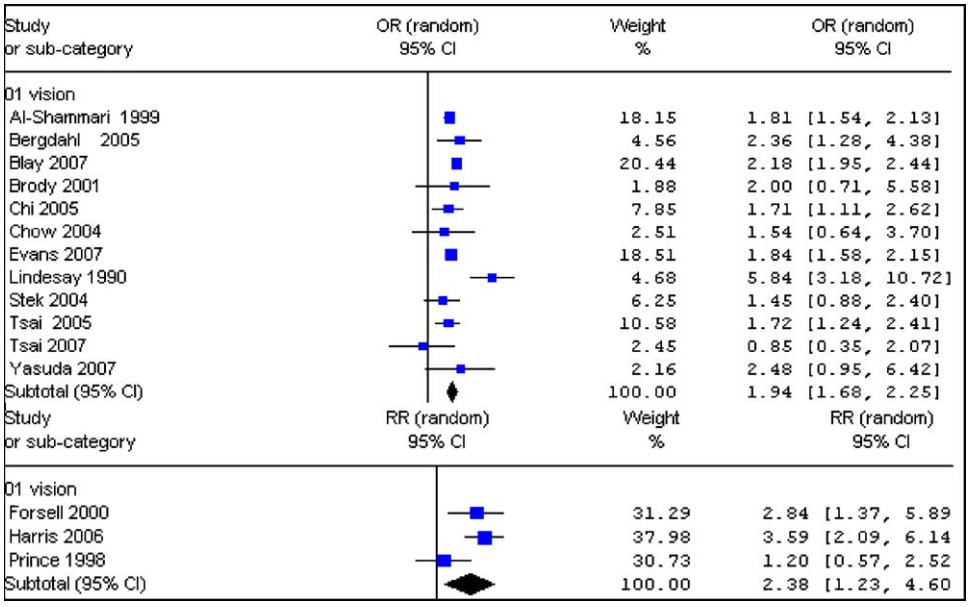

Fig. 4. Forest plot of ORs and RRs from 15 studies comparing the prevalence and incidence rates of depression in old age between subjects with poor and good vision.

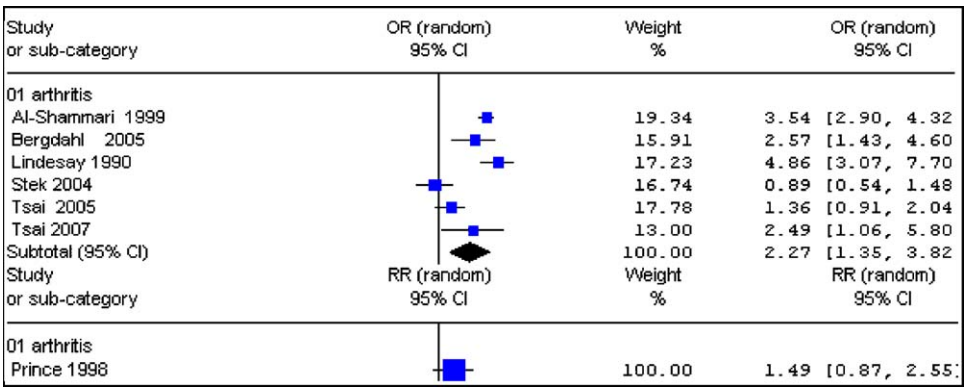

Fig. 5. Forest plot of ORs and RRs from seven studies comparing the prevalence and incidence rates of depression in old age between subjects with and without arthritis.

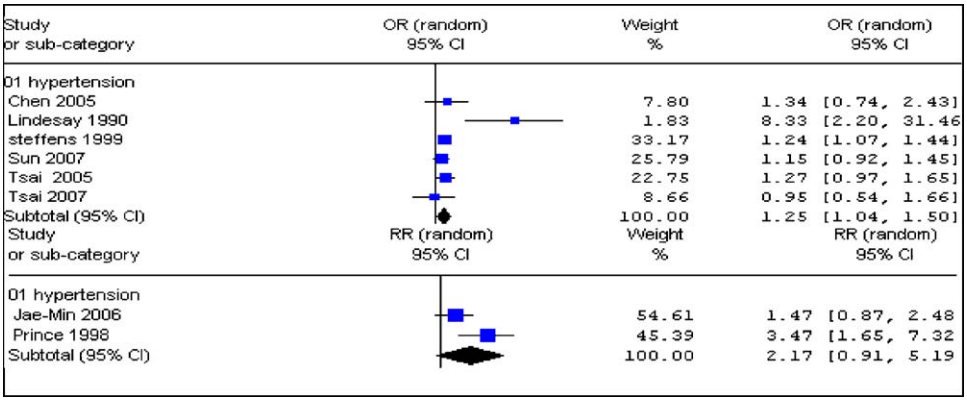

Fig. 6. Forest plot of ORs and RRs from eight studies comparing the prevalence and incidence rates of depression in old age between subjects with and without hypertension.

insignificantly higher risk for depression (RR: 2.17, 95% CI: 0.91–5.19) (Fig. 6).

3.3.7. *Cardiac disease and risk for depression in old age*

Eight of included studies compared the prevalence of depression in old age between individuals with and without cardiac disease (Al-Shammari and Al-Subaie, 1999; Bruce et al., 2002; Gallo et al., 2005; Gudmundsson et al., 2006; Lindesay, 1990; Steffens et al., 1999; Tsai et al., 2005; Tsai, 2007). In the eight studies, there were 2735 and 11,612 subjects with and without cardiac disease, respectively. There were 668 and 2023 cases of depression in the groups with and without cardiac disease, respectively. After pooling these 8 studies, there was association between depression in old age and cardiac disease (OR: 1.67, 95% CI: 1.37–2.04) (Fig. 7). Three of included studies compared incidence rates of depression in old age between individuals with and without cardiac disease (Giltay et al., 2006; Kim et al., 2006; Prince et al., 1998). After pooling these studies, subjects with cardiac disease had significantly higher risk for depression (RR: 1.37, 95% CI: 1.00–1.89) (Fig. 7). The significant OR and RR showed

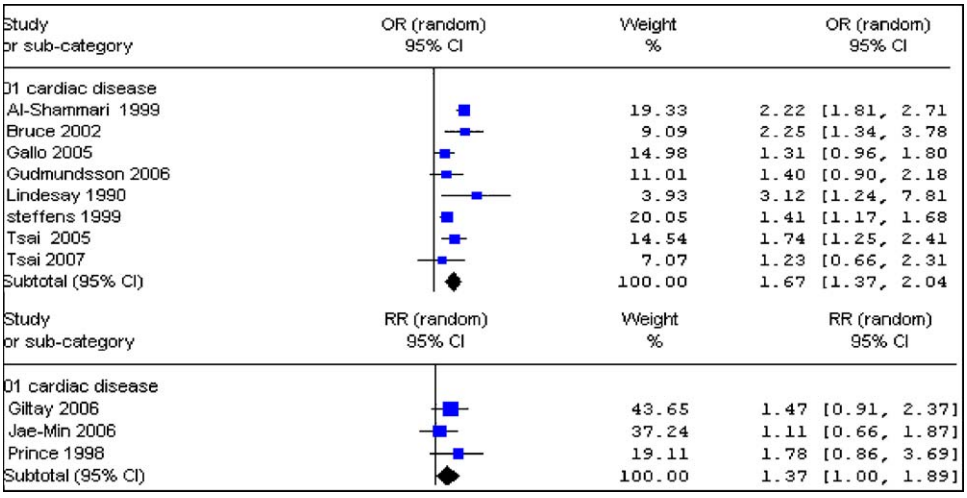

Fig. 7. Forest plot of ORs and RRs from 11 studies comparing the prevalence and incidence rates of depression in old age between subjects with and without cardiac disease.

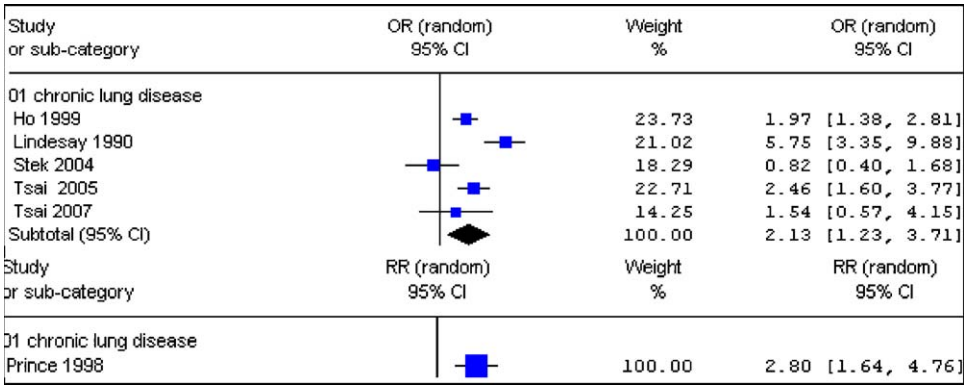

Fig. 8. Forest plot of ORs and RRs from six studies comparing the prevalence and incidence rates of depression in old age between subjects with and without chronic lung disease.

that cardiac disease was an important risk factor for depression in old age.

3.3.8. Chronic lung disease and risk for depression in old age

Five of included studies compared the prevalence of depression in old age between individuals with and without chronic lung disease (Ho and Jones, 1999; Lindesay, 1990; Stek et al., 2004; Tsai et al., 2005; Tsai, 2007). In the five studies, there were 481 and 5057 subjects with and without chronic lung disease, respectively. There were 134 and 797 cases of depression in the groups with and without chronic lung disease, respectively. After pooling these five studies, there was association between depression in old age and chronic lung disease (OR: 2.13, 95% CI: 1.23–3.71) (Fig. 8). One of included studies compared incidence rates of depression in old age between individuals with and without chronic lung disease (Prince et al., 1998). This study, where subjects with and without chronic lung disease were 77 and 306 included respectively, showed that subjects with chronic lung disease had significantly higher risk for depression (RR: 2.80, 95% CI: 1.64–4.76) (Fig. 8). The significant OR and RR showed that chronic lung disease was an important risk factor for depression in old age.

3.3.9. Diabetes and risk for depression in old age

Ten of included studies compared the prevalence of depression in old age between individuals with and without diabetes (Chen et al., 2005; Bourdel-Marchasson et al., 1997; Bergdahl et al., 2005; Bruce et al., 2002; Gallo et al., 2005; Gudmundsson et al., 2006; Stek et al., 2004; Sun et al., 2007; Tsai et al., 2005; Tsai, 2007). In the 10 studies, there were 1227 and 9053 subjects with and without diabetes, respectively. There were 403 and 1770 cases of depression in the groups with and without diabetes, respectively. After pooling these 10 studies, there was association between depression in old age and diabetes (OR: 1.81, 95% CI: 1.29–2.54) (Fig. 9). Three of included studies compared incidence rates of depression in old age between individuals with and without diabetes (Kim et al., 2006; Maraldi et al., 2007; Whyte et al., 2004). After pooling these studies, subjects with diabetes had insignificantly higher risk for depression in old age (RR: 1.50, 95% CI: 0.92–2.44) (Fig. 9).

3.3.10. Gastrointestinal disease and risk for depression in old age

Four of included studies compared the prevalence of depression in old age between individuals with and without gastrointestinal disease (Bruce et al., 2002; Lindesay, 1990; Tsai et al., 2005; Tsai, 2007). In the four studies, there were 166 and 2653 subjects with and without gastrointestinal disease, respectively. There were 57 and 637 cases of depression in the groups with and without gastrointestinal disease, respectively. After pooling these four studies, there was no significant association between depression in old age and gastrointestinal disease (OR: 1.95, 95% CI: 0.80–4.70) (Fig. 10). One of included studies compared incidence rates of depression in old age between individuals with and without gastrointestinal disease (Prince et al., 1998). This study, where

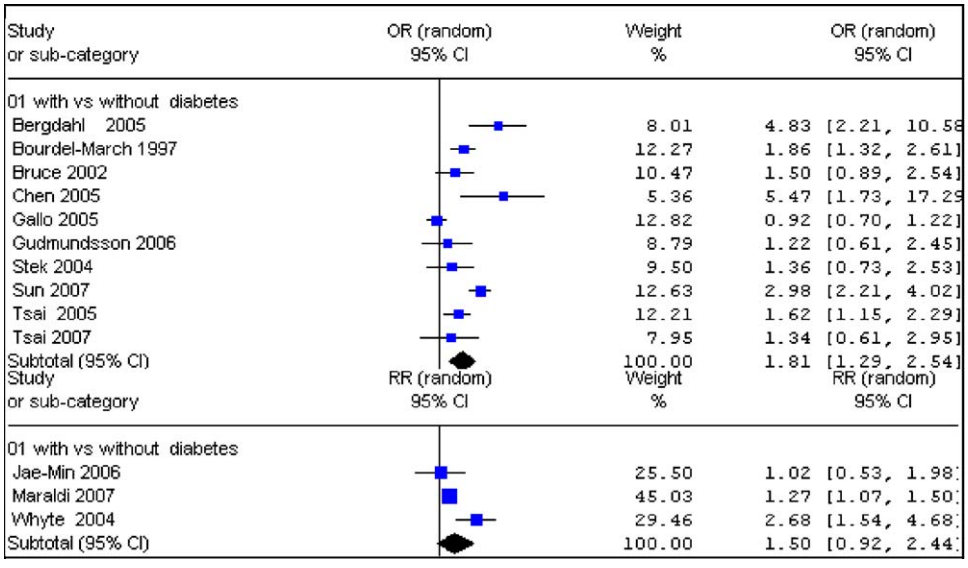

Fig. 9. Forest plot of ORs and RRs from 13 studies comparing the prevalence and incidence rates of depression in old age between subjects with and without diabetes.

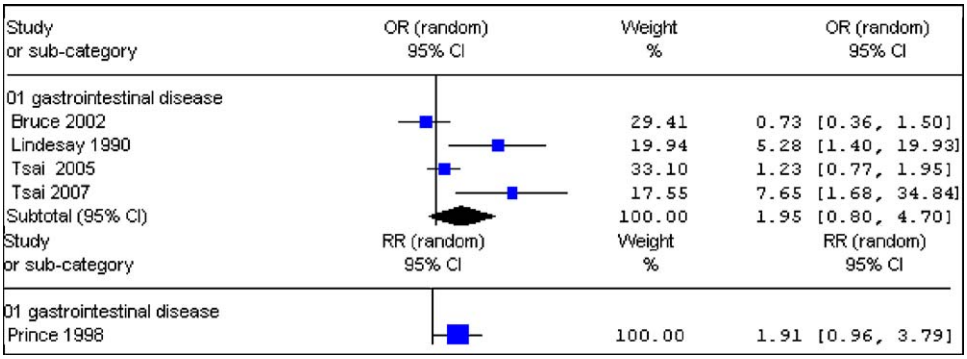

Fig. 10. Forest plot of ORs and RRs from five studies comparing the prevalence and incidence rates of depression in old age between subjects with and without gastrointestinal disease.

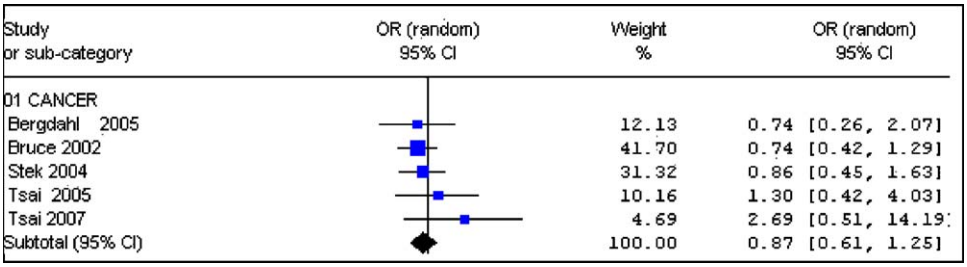

Fig. 11. Forest plot of ORs from five studies comparing the prevalence of depression in old age between survivors of cancer and not.

subjects with and without gastrointestinal disease were 38 and 345 included respectively, showed that subjects with gastrointestinal disease had insignificantly higher risk for depression (RR: 1.91, 95% CI: 0.96–3.79) (Fig. 10).

3.3.11. Survivors of cancer and risk for depression in old age

Five of included studies compared the prevalence of depression in old age between survivors of cancer and not (Bergdahl et al., 2005; Bruce et al., 2002; Stek et al., 2004; Tsai et al., 2005; Tsai, 2007). In the five studies, there were 310 and 2371 survivors of cancer and not, respectively. There were 46 and 497 cases of depression in the groups of survivors of cancer and not, respectively. After pooling these 5 studies, there was no significant association of depression in old age with survivors of cancer (OR: 0.87, 95% CI: 0.61–1.25) (Fig. 11). There was no study comparing the incidence rates of depression in old age between survivors of cancer and not.

3.3.12. Skin disease and risk for depression in old age

One of included studies compared the prevalence of depression in old age between individuals with and without skin disease

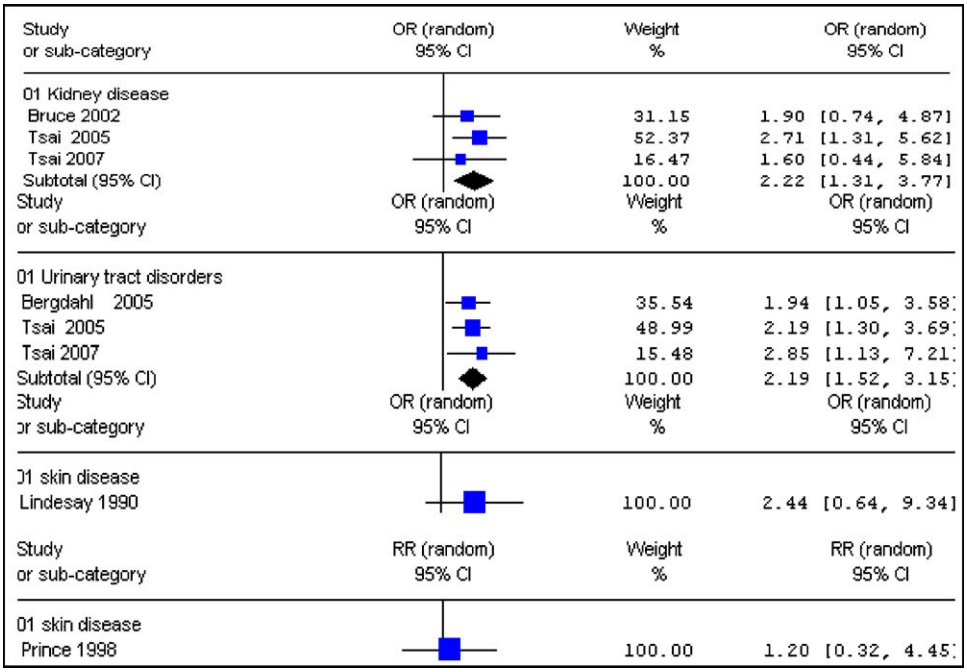

Fig. 12. Forest plot of ORs and RRs from seven studies comparing the prevalence and incidence rates of depression in old age between subjects with and without skin disease, kidney disease, urologic problems.

(Lindesay, 1990). This study, where subjects with and without skin disease were 11 and 879 included respectively, showed that there was no significant association between depression in old age and skin disease (OR: 2.44, 95% CI: 0.64–9.34) (Fig. 12). One of included studies compared incidence rates of depression in old age between individuals with and without skin disease (Prince et al., 1998). This study, where subjects with and without skin disease were 14 and 369 included respectively, showed that subjects with skin disease had insignificantly higher risk for depression (RR: 1.20, 95% CI: 0.32–4.45) (Fig. 12).

3.3.13. Kidney disease and risk for depression in old age

Three of included studies compared the prevalence of depression in old age between individuals with and without kidney disease (Bruce et al., 2002; Tsai et al., 2005; Tsai, 2007). In the three studies, there were 67 and 1872 subjects with and without kidney disease, respectively. There were 27 and 474 cases of depression in the groups with and without kidney disease, respectively. After pooling these three studies, there was significant association between depression in old age and kidney disease (OR: 2.22, 95% CI: 1.31–3.77) (Fig. 12). In the included studies, there was no study comparing the incidence rates of depression in old age between subjects with and without kidney disease.

3.3.14. Urologic problems and risk for depression in old age

Three of included studies compared the prevalence of depression in old age between individuals with and without urologic problems (Bourdel-Marchasson et al., 1997; Tsai et al., 2005; Tsai, 2007). In the three studies, there were 150 and 1492 subjects with and without urologic problems, respectively. There were 68 and 425 cases of depression in the groups with and without urologic problems, respectively. After pooling these three studies, there was association between depression in old age and urologic problems (OR: 2.19, 95% CI: 1.52–3.15) (Fig. 12). In the included studies, there was no study comparing the incidence rates of depression in old age between subjects with and without urologic problems.

4. Discussion

We conducted the meta-analysis of cross-sectional studies and that of prospective longitudinal studies respectively. The results were clear: some chronic diseases were risk factors for depression in old age such as stroke, poor hearing, poor vision, cardiac disease and chronic lung disease; there were associations of depression in old age with arthritis, hypertension, diabetes, urologic problems and kidney, but it had still unknown whether these disease were risk factors for depression in old age or not; there were no significant association of depression in old age with survivors of cancer and gastrointestinal disease; and it still has been unknown whether there was the association of depression in old age with skin disease. These were robust findings about relationship between chronic diseases and risk for depression among the old age.

Although depression was recognized as an important complication of stroke, the relevant systematic review concluded that depression was associated with more severe strokes, but evidence did not allow for ready identification of patients most at risk of developing this important complication of stroke (Hackett and Anderson, 2005). This review published in 2005 and there was no age limitation in it. In our meta-analysis, in old age, stroke was not only association with depression, but also an important risk factor for depression. Our meta-analysis and the previous systematic review showed that there was significant association between depression and stroke in both general and old population, stroke was a definite risk factor for depression in old age, but indefinite in general population. There might be difference in risk for depression of stroke between general and old population, or stroke was also a definite risk factor for depression in general population, which had not been confirmed.

Poor hearing and vision had high prevalence rates in old age and were recognized age-related degenerations. Our meta-analysis showed that in old age, both poor hearing and vision were associated with depression and also were risk factors for depression. Individuals with poor hearing or vision were more likely to experience disability, limitation in Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) and poor social support; all of these were confirmed risk factors for depression in old age (Cole and Dendukuri, 2003; Schillerstrom et al., 2008). This might be a reason for the higher risk of depression in individuals with poor hearing or vision. The higher risk could explain the association of depression with poor hearing or vision, however, old individuals with depression were more likely to feel poor in hearing or vision, and this might be also another reason for this association.

In our meta-analysis, in old age, cardiac disease and chronic lung disease were not only association with depression, but also important risk factors for depression. The association between cardiac disease and depression and depression as a cardiac risk factor were confirmed by previous systematic review, and cardiac disease as a risk factor for depression in old age was confirmed by our meta-analysis (Nicholson et al., 2006). Therefore, cardiac disease and depression were risk factors for each other. To best our knowledge, this was the only meta-analysis or systematic review focused no association between chronic lung disease and depression, and our meta-analysis showed that in old age, chronic lung disease was not only association with depression, but also important risk factor for depression. We did not assess the risk for chronic lung disease in individuals with depression, so whether depression was risk factor for chronic lung disease should be further investigated.

The bidirectional association between diabetes and depression had been confirmed by a systematic review and a longitudinal, large sample size, cohort study (Anderson et al., 2001; Sherita et al., 2008). Our meta-analysis showed in old age, there was definite association between diabetes and depression. Although, in our meta-analysis, diabetes had an un-significant RR for depression in old age; all the studies, included the review, showed that subjects with diabetes had higher (not statistically significant) risk for depression, diabetes was risk factor for depression in general people and there was definite association between diabetes and depression in old age. We concluded here diabetes might be a risk factor for depression in old age. This should be further confirmed by using a longitudinal, large sample size, cohort study.

Despite the high prevalence of depression, hypertension and arthritis in old age, the associations of depression with hypertension and arthritis had received little attention. Our meta-analysis showed in old age, there were definite associations of depression with the two diseases. Although, in our meta-analysis, each of the two diseases had an un-significant RR for depression in old age; all the studies, included the review, showed subjects with the two diseases had higher (not statistically significant) risk for depression and there were definite association of depression in old age with the two diseases. We concluded here hypertension and arthritis might be both risk factors for depression in old age. This should be further confirmed by using longitudinal, large sample size, cohort studies.

In our meta-analysis, survivors of cancer in old age had an un-significant lower prevalence of depression than general old persons. None of the five included studies, comparing the prevalence of depression in old age between survivors of cancer and not, had significant OR. We could conclude here there was no difference in prevalence of depression in old age between survivors

of cancer and not. Both urologic problems and kidney disease had significant ORs, there was no relevant longitudinal study on the risk for depression in old age with the two diseases. There might be associations of depression with the two diseases, but it should be explored whether the two diseases were risk factors for depression in old age. Gastrointestinal disease had neither significant OR nor RR for depression in old age, and there might be no association between depression and gastrointestinal disease in old age.

Although we attempted to adhere to the guidelines for reporting meta-analyses of observational studies, this review did have four limitations (Stroup et al., 2000). First, we did not hand search journals and made no attempt to identify unpublished studies. Despite our extensive literature search, we only included MEDLINE, EMBSAE and The Cochrane Library in our search and other databases such as CINAHL, PsycINFO were not included. Moreover, the search was limited to articles published in English. Therefore, some studies had been missed. Secondly, risk factors for depression might be differently related to the onset, chronicity and recurrence, but we did not differentiate them. In fact, in most of the studies, included in the review, onset, chronicity and recurrence of depression had not been differentiated. So it was impossible for us to differentiate them in our meta-analysis. Thirdly, medical illness might be recent life event, which was a confirmed risk for depression. However, the association of recent life event with medical illness might be significant in subjects with new medical illness, but insignificant in those with chronic status. In our meta-analysis, we assessed the relationship between chronic diseases and risk for depression in old age. Therefore, we did not take notice recent life event. Finally, there was heterogeneity in the results, perhaps related to different definitions of depression in different studies and small study groups in some studies. Therefore, random-effects model, which had less precision than the fixed-effects model, was used in the review. Consequently, the results of the meta-analysis for these risk factors must be interpreted cautiously.

Conflicts of interest

None.

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