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Research paper

Contribution of multiple pathways to the relationship between visual impairment and depression: Explaining mental health inequalities among older Chinese adults

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ABSTRACT

Background: Though visual impairment is a strong predictor for late-life depression, the underlying mechanisms remain unclear. This paper investigated the contribution of material, psychosocial and behavioural pathways in mediating a vision-depression association.

Methods: The study used cross-sectional data from the WHO Study on Global AGEing and Adult Health (SAGE), including 11,531 older Chinese adults. Depression was assessed based on an adaptation of the ICD-10 diagnostic criteria. Causal mediation analyses using inverse odds ratio weighting (IORW) approach were conducted to assess the mediating roles of material (wealth quintiles and perceived income inadequacy), behavioural (leisure activity, BMI and sleep) and psychosocial factors (social participation, trust and sense of safety).

Results: The participants with visual impairment had a 43% higher odds of depression than those with normal vision. In the mediation analysis, the material pathway contributed the most to the total effect, accounting for 31.7% of it. The proportion of the total effect which was mediated by psychosocial and behavioural factors was 24.2% and 22.5% respectively. When these three mediators were considered together in the full model, they accounted for 43.5% of the total effect of visual impairment on depression.

Limitations: There still existed unexamined mediating factors. The cross-sectional study design might restrict temporal sequence.

Conclusion: Visually-impaired population as high-risk group should be provided better access to screening, diagnosis and treatment of depression. Material, behavioural and psychosocial factors may serve as relevant points of entry for developing intervention programmes to improve the mental health conditions of visually-impaired people.

1. Introduction

Visual impairment has been found strongly linked to the aging process. A variety of geriatric eye diseases such as cataracts, age-related macular degeneration and diabetic retinopathy tend to trigger different levels of visual impairment (Resnikoff et al., 2004). In China, approximately 5.8% of the older population suffer from visual impairment or even blindness (Cheng et al., 2013). Visual impairment may exert a detrimental impact on the quality of life and psychological well-being (Bookwala and Lawson, 2011; Horowitz, 1994). Recent studies found a relatively consistent association between late-life visual impairment and geriatric mental health among different populations (Cosh et al., 2018; Park et al., 2018). However, the underlying mechanisms by which visual impairment leads to the deterioration of an older person's psychological well-being remain unclear.

There is abundant literature on the explanation of income-related health inequalities, which proposed a well-established set of pathways incorporating material, behavioural or psychosocial factors (Bartley, 2016; Lynch et al., 2000). The material pathway argues that economically disadvantaged group tend to have worse living conditions and less access to healthcare, leading to inequalities in health outcomes (Bartley, 2016). The behavioural pathway indicates that differential distribution of health-related preventive behaviours (e.g. physical activity) and health-risk behaviours (e.g. smoking and drinking alcohol) contribute to health inequalities (Pocock et al., 1987). The psychosocial pathway emphasizes buffering functions of social support when

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encountering disadvantaged environment. The unequal distribution of social networks and sense of security may serve as potential explanation of health inequalities (Wilkinson, 1997).

Supported by compelling evidence, depression has been found to exhibit socioeconomic inequalities despite the heterogeneity of measurements (Lorant et al., 2003). There is considerable interest in examining the mechanisms underlying the inequalities between visually-impaired and normally-sighted people based on the theoretical model of multiple pathways (Bartley, 2016; Lynch et al., 2000). What we can hypothesise based on this theoretical model is that visual compromise may trigger changes in material, behavioural and psychosocial factors, further leading to psychological deterioration. Previous work merely investigated the role of social networks or social support in this vision-depression association (Kempen et al., 2014; Van Nispen et al., 2016), which might be insufficient to accommodate the complexity of mechanisms.

Of different explanatory factors, psychosocial pathway usually incorporates stress-related components such as social support, self-control, work demands, and effort-reward imbalance (Bartley, 2016). But traditional psychosocial factors may neglect multiple dimensions of social relations. Of note, the concept of social capital has been recently proposed as an indicator of the psychosocial pathway to explain socioeconomic inequalities in health (Uphoff et al., 2013). Social capital is usually defined as the quality and quantity of social ties and connectedness when it is applied in the domain of health research (Harpham et al., 2002). Some research demonstrated the link between various measures of social capital and health, as well as the mediating role of social capital in the explanation of socioeconomic-related health inequalities (Kawachi et al., 1997). However, we have no prior evidence as to whether social capital serving as psychosocial factors could independently and integratedly contribute to the inequalities in mental health between visually-compromised and normally-sighted people.

Some research compared the two visual measures in relation to mental health, reporting that self-reported visual function loss was a better predictor for depression compared with the indicator of objective visual acuity (VA) (Zhang et al., 2013). Self-reported vision is widely used as a substitute for objective VA due to the low cost (Centers for Disease Control Prevention, 2010). Thus, it is of great interest to assess the discrepancies in the mediation effects between clinically-assessed VA and self-reported measures leading to geriatric depression.

In this study, we aimed to assess the mediation of the visual impairment to depression relationship by material, behavioural and psychosocial mechanistic pathways. Moreover, we examined the discrepancies of the mediation effects when different measures of visual impairment (i.e. objective VA and self-reported visual status) are used.

2. Methods

2.1. Study population

The World Health Organisation (WHO) Study on Global AGEing and Adult Health (SAGE) is a longitudinal study conducted in six countries including China, India, Ghana, South Africa, Mexico and the Russian Federation (Kowal et al., 2012). Nationally representative samples in every country were collected using a probabilistic, multi-stage sampling method. Within the SAGE study, participants were invited to complete a questionnaire consisting of questions on their socioeconomic conditions, lifestyles, psychosocial conditions, self-rated health, personal health history and other health-related information. The present study is a cross-sectional analysis of the Chinese sample in wave 1 of the SAGE (2007–2010). The participants aged 18–49 (n = 1642), individuals without complete interviews (n = 231), and participants with missing data in any of the variables included in this study (n = 1646) were excluded. The final sample size for complete case analysis was 11,531. The SAGE was approved by the World Health Organisation's (WHO) and country-specific Ethics Committee. All subjects provided written informed consent.

2.2. Depression

Based on the diagnostic criteria for research in the International Classification of Diseases, Tenth Revision (ICD-10) (World Health Organization, 1993), depression was diagnosed using an algorithm assessing self-reported depression symptoms in the last 12 months (Ayuso-Mateos et al., 2010). The items of depressive symptoms have been used in the World Mental Health Survey version of the Composite International Diagnostic Interview (WMH-CIDI) (Kessler and Üstün, 2004). In the WHO SAGE survey, a total of 18 items were included, which could be divided into two groups of symptoms (Arokiasamy et al., 2015).

The first group of symptoms involve: depressive mood; loss of interest or pleasure, including decreased libido; and tiredness or decreased energy. There were two items indicating the duration (more than two weeks) and intensity (most of the day, nearly every day). The second group of symptoms include: loss of appetite; changes in sleep patterns (initial insomnia or terminal insomnia); physical slowness; slow thinking process or loss of concentration; low self-esteem, unworthiness or hopelessness; anxiety or psychomotor agitation; and suicidal ideation or attempts. A diagnosis of depression was established with at least two of the first group symptoms and four of the second group symptoms (Arokiasamy et al., 2015).

2.3. Visual impairment

In this study, we defined visual impairment based on an objective measurement of VA and self-reported vision status. The objective 'visual impairment' assessment was based on distance and near VA in both eyes. Four-metre distance vision and 40-cm near vision Tumbling "E" Logmar Charts were used in distance and near vision tests respectively (World Health Organization, 2006). Based on the definition of visual impairment from the International Council of Ophthalmology (2002) (Colenbrander and De Laey, 2002), we dichotomised distance and near vision into two categories: visual impairment (decimal VA values less than 0.3) and normal vision (decimal VA values between 0.3 and 2.0). Participants were categorised as visually-impaired if they had either near visual impairment or distance visual impairment in both eyes (Arokiasamy et al., 2015).

In sensitivity analyses, self-reported vision was assessed using questionnaires by asking difficulties in recognising objects. Participants were assigned to the impaired vision category if they rated their vision as moderate or poor in either near or distance vision. The comparability between self-reported vision status and VA measurements were reported by other studies (Coyle et al., 2017; Uchino et al., 2017).

2.4. Mediators

Mediating variables incorporated material, behavioural and psychosocial factors. Wealth quintiles and perceived income adequacy were used as material variables. Wealth quintiles were estimated based on asset ownership using the random-effects probit model (Ferguson et al., 2003). Quintile one represented the lowest fifth of the population in terms of asset-based wealth, whereas quintile five represented the wealthiest fifth of the population. Perceived income adequacy was assessed by asking about the participants' subjective income satisfaction. Sleep status, leisure activity, and body mass index (BMI) were regarded as behavioural factors. Sleep was assessed through questions establishing whether participants had sleep disorders. We used moderate-intensity leisure activity which is defined as a recreational activity that increases breathing or heart rate for more than ten minutes every time and assessed using the Global Physical Activity Questionnaire. BMI was calculated based on measured height (cm) and weight (kg). We used social capital theory to construct psychosocial

factors (Ng and Eriksson, 2015). Questions used for the construction of mediator variables are presented in Appendix Table A1.

2.5. Covariates

Covariates included sex, age and chronic health conditions (no chronic disease, one disease and multiple diseases/ multimorbidity). To define chronic health conditions, seven chronic diseases (i.e. hypertension, diabetes, stroke, angina pectoris, chronic obstructive pulmonary disease/COPD, asthma, and arthritis) were included. Hypertension was assessed based on a blood pressure measurement performed at the time of interview. Its diagnosis criterion was based on WHO/ISH guidelines for the management of hypertension (Whitworth and Chalmers, 2004). Stroke and diabetes were assessed by asking whether the participants had ever had the diseases diagnosed by health professionals. Angina pectoris, COPD, asthma, and arthritis diagnoses were derived from self-reported symptoms using validated diagnostic algorithms.

2.6. Statistical analysis

In the first step, we used multivariable logistic regression to assess the association between the objective VA and depression, adjusted by covariates and various mediating factors. The association was adjusted for covariates including age, sex and multimorbidities in the basic model. In the material, behavioural and psychosocial model, the associations were adjusted for covariates and corresponding factors. The full model included all the variables simultaneously.

Then, we conducted a causal mediation analysis using the inverse odds ratio weighting (IORW) approach developed by Tchetgen (2013). This approach accommodates exposure-mediator interactions and allows for multiple continuous, dichotomous, or categorical mediators (Nguyen et al., 2015). The figure presented the mechanistic pathways between visual impairment and depression, indicating the indirect effects through material, behavioural and psychosocial factors (Fig. 1).

A weight was calculated through condensing the inverse odds ratio between visual impairment and multiple mediators given the covariates (Nguyen et al., 2015). The use of weights deactivates the interaction between visual impairment and mediators, rendering them independent of each other. The total effect was the coefficient for visual impairment in the unweighted generalised linear model. The natural direct effect (NDE) was estimated via weighted regression using the inverse exposure-mediator odds ratio weight. Then we estimated the natural indirect effect (NIE) by taking the difference between the total and the direct effects, obtaining the joint mediation of exposure effect by the set of mediators in the separate pathways. In sensitivity analyses, we repeated the analyses using the self-reported measure.

The distribution of key variables was compared between people with complete and incomplete observations (Appendix Table A2). People with missing data differ in some covariates including age, multimorbidity, wealth quintiles, vision problem and social participation from those with complete data. Given that the proportion of missing data is 12.5%, we deemed complete case analysis was satisfactory. This method is unbiased when missingness is independent of the outcome given the covariates (White and Carlin, 2010).

All statistical analyses were performed in Stata/SE 15. The 'svy' command was used to accommodate sampling weights in the SAGE study.

3. Results

3.1. Characteristics of respondents

The characteristics of participants in our study are presented in Table 1. Participants with visual impairment were found to be older and more likely to have multiple morbidities (20.5% vs. 16.3%) in comparison with those in the normal vision category. They were also found to be poorer, with 24.7% at the lowest wealth quintile compared with 16.5% of people with normal vision, and more likely to have lower perceived income adequacy (47.5% vs. 52.3% reported adequate). Visually compromised people were also less likely to engage in leisure activity (12.7% vs. 16.9% reported being active), had higher BMI (8.2% vs.7.7% reported being obese) and more sleep problems (3.2% vs. 2% reported low-quality sleep). With regard to social capital, participants with visual impairment had less access to different components of social capital including social participation (96.4 % vs. 98.8% reported having good social participation), trust (94.2% vs.94.4%) and sense of safety (83.7% vs.85.8%).

3.2. Multivariate logistic regression

In basic multivariate logistic regression model, the odds of depression among participants with visual impairment was 43% higher than those with normal vision (95% CI: 1.04–1.96) (Table 2). The odds ratios (ORs) were attenuated after including different sets of mediators. In the full model, the OR for the association between visual impairment and depression was 1.23 (95% CI: 0.89–1.69), losing its significance, after controlling for all confounders and mediators.

3.3. Mediation analysis

Adjusting for covariates, the coefficient for NIE mediated through

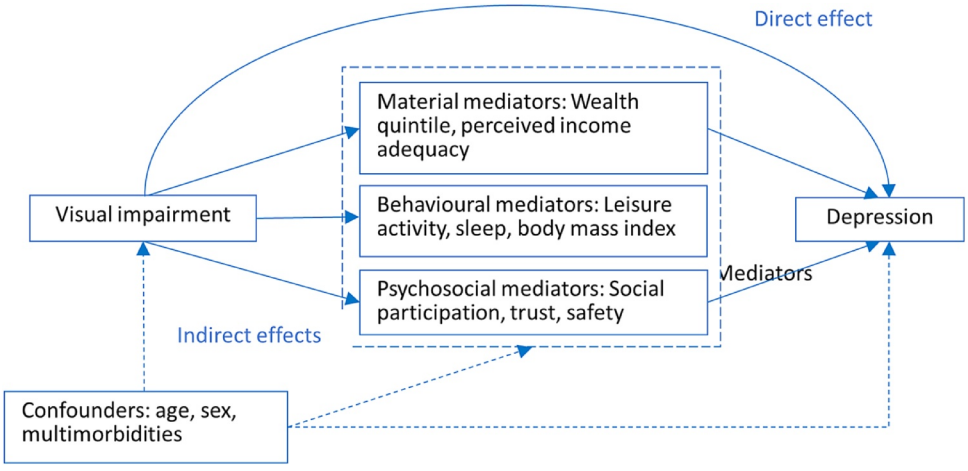

Fig. 1. Directed acyclic graph showing the hypothesised mediators in the association between visual impairment and depression.

Table 1
Characteristics of participants with visual impairment and normal vision.

	Visual impairment[a] N = 4487		Normal vision N = 7044	
	N	%	N	%
Age group				
50–59 year	1440	32.1	3709	52.7
60–69 year	1394	31.1	2047	29.1
70–74 year	1256	28.0	1117	15.9
80+ year	397	8.8	171	2.4
Sex				
Male	1854	41.3	3518	49.9
Female	2633	58.7	3526	50.1
Number of diseases[b]				
0	2147	47.8	3839	54.5
1	1419	31.6	2056	29.2
2+ (multimorbidities)	921	20.5	1149	16.3
Wealth quintiles				
1 (poorest)	1109	24.7	1161	16.5
2	916	20.4	1402	19.9
3	870	19.4	1464	20.8
4	761	17.0	1629	23.1
5 (richest)	831	18.5	1388	19.7
Perceived income adequacy				
Adequate	2131	47.5	3687	52.3
Moderate	1339	29.8	1998	28.4
Inadequate	1017	22.7	1359	19.3
Leisure activity				
Active	570	12.7	1192	16.9
Inactive	3917	87.3	5852	83.1
Body mass index				
Non-obese	4117	91.8	6499	92.3
Obese	370	8.2	545	7.7
Sleep				
Good	3774	84.1	6275	89.1
Moderate	568	12.7	626	8.9
Poor	145	3.2	143	2.0
Social participation				
Good	4326	96.4	6960	98.8
Moderate	130	2.9	70	1.0
Poor	31	0.7	14	0.2
Trust				
Have trust	4228	94.2	6648	94.4
Not have trust	259	5.8	396	5.6
Safety				
Feel safe	3756	83.7	6044	85.8
Not feel safe	731	16.3	1000	14.2

[a] Distance and near vision were classified into two categories including visual impairment (<0.3) and normal vision (0.3–2.0). Participants were categorized as visual impairment if they had either near visual impairment or distance visual impairment in both eyes.

[b] Chronic health conditions including hypertension, diabetes, stroke, angina pectoris, chronic obstructive pulmonary disease (COPD), asthma, and arthritis were included in the analysis.

material factors was 0.11 (95% CI: 0.03, 0.20) (Table 3). Psychosocial and behavioural factors had a coefficient for NIE of 0.09 (95% CI: 0.00, 0.17) and 0.08 (95% CI: −0.01, 0.17), respectively. The proportion of the total effect when mediated by material factors was 31.7%, the largest among the three sets of mediators. The proportion of the total effect mediated by psychosocial factors was 24.2% and by behavioural factors it was 22.5%. In the full model, the proportion of the total effect mediated jointly by material, behavioural and psychosocial factors was 43.5%.

3.4. Sensitivity analyses

In sensitivity analyses, replacing vision acuity with self-reported vision conditions yielded stronger association. The effect estimate for self-reported vision in the sensitivity analysis (model 0) was relatively greater ($OR_{self\text{-}reported}$ = 1.71, 95% CI: 1.10–2.66) (Appendix Table A3). The results of self-reported vision in mediation analysis slightly varied (Appendix Table A4). The magnitude of indirect effect mediated by all factors was considerably larger (β = 0.38, 95% CI: 0.19–0.57). The proportion of the total effect that was mediated by all factors, including covariates, material, behavioural and psychosocial factors, was 78.5%.

4. Discussion

The results suggested there is an association between visual impairment and depression controlling for age, sex and chronic health conditions. This association attenuated and become insignificant when the sets of mediators were added to the regression, indicating the presence of significant mediating effect of the mediators. A substantial proportion (43.5%) of the effects of visual impairment on depression were mediated by the three sets of explanatory factors. In the mediation analysis, material factors contributed the most to the vision-depression association, with an indirect effect of 31.7%, followed by psychosocial (24.2%) and behavioural factors (22.5%). The vision-depression association was found stronger when replacing clinically-assessed VA with self-reported visual status. Three pathways appeared to mediate higher proportion (78.5%) of total effect in sensitivity analyses.

Our findings have shown that visual impairment is strongly associated with depression, which are consistent with other research in different regions. A Tromsø cohort of Norwegian adults reported that distance visual acuity assessed with Snellen charts predicted depression scores at the 6-year follow up (Cosh et al., 2018). It has been found that perceived visual impairment was associated with depressive symptoms among Korean population (Park et al., 2018). In our study, self-reported visual status was also found a stronger predictor for late-life depression. However, the mental health of disabled population groups, especially people with visual impairment, is often neglected. A study showed that just 40% of eye health professionals were aware of the need to care for the mental health of visually compromised patients (Rees et al., 2009).

In the primary analysis, material pathway contributed the most to the vision-depression relationship when comparing relative contribution of three pathways. The material pathway is considered a more direct pathway to explain socioeconomic inequalities in health compared with the behavioural and psychosocial pathways (Aitken et al., 2018). But three explanatory pathways are deemed interrelated rather than mutually exclusive (Schrijvers et al., 1999). Any of three pathways may be either direct or indirect via an interplay with the other pathway (Skalická et al., 2009), thereby playing a mediating role on the vision-depression association. The discrepancies in the proportions of the two types of visual measures in our research might be due to misclassification bias (Ogburn and VanderWeele, 2012).

In addition, we found that when these three sets of mediators were taken together in the full model, they could account for 43.5% of the total effect of visual impairment on depression. While using the self-reported visual status, a higher proportion of mediation (78.5%) was yielded. This revealed that the direct effect for subjective visual status was relatively minor, with a larger proportion of indirect effects that can be attributed to material, behavioural and psychosocial factors. The total indirect effect in the full model was found much smaller compared with the sum of respective indirect effects in different pathways.

One of behavioural factors, BMI, was found inversely associated with depression in our study. There is controversy on the impact of obesity on depressive symptoms (Oh et al., 2018). We deemed that the disparity of association could be due to the age of study population. The “fat and jolly” hypothesis proposed that obesity is a protective factor of depressive symptoms among middle-aged and older adults (Crisp and McGuiness, 1976; Palinkas et al., 1996). Of note, several studies based on Chinese cohorts reported an inverse association between BMI and depression among older population (Ho et al., 2008; Qian et al., 2017), confirming what we observed in our study.

Some traditional psychosocial factors proposed in the literature were not applicable to our study. For instance, information regarding the home-work life balance was not applicable in our study, as many of

Table 2
Associations between objective measurement of visual acuity and depression, adjusting for material, behavioural and psychosocial factors.

	Basic model[a] OR (95%CI)	Material model[a] OR (95%CI)	Behavioural model[a] OR (95%CI)	Psychosocial model[a] OR (95%CI)	Full model[a] OR (95%CI)
Vision[b]					
Normal vision	Ref.	Ref.	Ref.	Ref.	Ref.
Visual impairment[a]	1.43 (1.04, 1.96)	1.29 (0.94, 1.78)	1.32 (0.96, 1.82)	1.37 (1.00, 1.88)	1.23 (0.89, 1.69)
Material factors					
Wealth quintiles					
1 (poorest)		Ref.			Ref.
2		1.32 (0.92, 1.91)			1.40 (1.00, 1.96)
3		0.80 (0.50, 1.26)			0.83 (0.51, 1.35)
4		0.58 (0.33, 1.02)			0.60 (0.34, 1.05)
5 (richest)		0.49 (0.26, 0.94)			0.55 (0.29, 1.01)
Perceived income adequacy					
Adequate		Ref.			Ref.
Moderate		1.33 (0.86, 2.07)			1.25 (0.80, 1.97)
Inadequate		2.85 (1.61, 5.05)			2.23 (1.19, 4.16)
Behavioural factors					
Leisure activity					
Active			Ref.		Ref.
Inactive			1.23 (0.64, 2.34)		0.98 (0.52, 1.86)
Body mass index					
Non-obese			Ref.		Ref.
Obese			0.52 (0.30, 0.91)		0.55 (0.32, 0.95)
Sleep					
Good			Ref.		Ref.
Moderate			3.61 (2.52, 5.17)		2.99 (1.99, 4.50)
Poor			6.54 (4.40, 9.70)		4.66 (3.19, 6.82)
Psychosocial factors					
Social participation					
Good				Ref.	Ref.
Moderate				3.37 (2.10, 5.42)	1.46 (0.89, 2.38)
Poor				12.33 (4.67, 32.56)	6.47 (2.62, 15.93)
Trust					
Have trust				Ref.	Ref.
Not have trust				1.33 (0.76, 2.34)	1.07 (0.67, 1.73)
Safety					
Feel safe				Ref.	Ref.
Not feel safe				1.72 (1.08, 2.74)	1.62 (1.01, 2.61)

Notes: Multivariate logistic regression were weighted using stratification and sampling weights from the SAGE study.
[a] All models are controlled for covariates including age, sex and multimorbidities.
[b] Distance and near vision were classified into two categories including visual impairment (< 0.3) and normal vision (0.3–2.0). Participants were categorized as visual impairment if they had either near visual impairment or distance visual impairment in both eyes.

Table 3
Total, natural direct and natural indirect effects of objective visual acuity on depression, with mediation though material, behavioural and psychosocial pathway.

	Material model β (95% CI)	Behavioural model β (95% CI)	Psychosocial model β (95% CI)	Full model β (95% CI)
Total effect	0.35 (0.10, 0.61)	0.35 (0.10, 0.61)	0.35 (0.10, 0.61)	0.35 (0.10, 0.61)
Natural direct effect	0.24 (−0.03, 0.52)	0.27 (0.00, 0.55)	0.27 (−0.01, 0.55)	0.20 (−0.10, 0.50)
Natural indirect effect	0.11 (0.03, 0.20)	0.08 (−0.01, 0.17)	0.09 (0.00, 0.17)	0.15 (0.04, 0.26)
Proportion mediated	31.7%	22.5%	24.2%	43.5%

Notes: All models adjusted for covariates including age, sex and multimorbidities. The 95% confidence intervals were obtained using nonparametric bootstrap with 500 replications.

the older participants were retired or not employed. Hence, theory-based social capital components were utilised as indicators of the psychosocial pathway to explain inequalities in mental health. The reasonability of social capital components in the explanation of health inequalities is reflected in the fact that social capital may influence health-related social norms and the diffusion of health-related information (Kawachi et al., 2008).

In our study, we constructed the components of psychosocial factors utilising a "social network approach" which consists of structural and cognitive social capital (Harpham et al., 2002). Structural social capital is referred to as the degree of social engagement to strengthen social ties whereas cognitive social capital refers to reciprocity and feelings within social networks. Cognitive social capital is considered as less tangible than structural social capital (Ng and Eriksson, 2015). Many research only used some more tangible variables that are similar to structural social capital, but neglected reciprocity or any feelings derived from social activities. The components of cognitive social capital (i.e. trust and sense of safety) selected in our study can provide the subjective aspects of psychosocial factors in the explanation of mental health inequalities.

Previous studies mainly examined a single mediating factor (Kempen et al., 2014; Van Nispen et al., 2016), but our study advances the literature regarding this relationship through utilising a comprehensive theoretical framework. The explanatory factors in our study are literature-derived and relatively balance-selected between the three pathways, providing a strong theoretical argument for mediation analysis. The mediation method used in the study, IORW, can accommodate multiple mediators and exposure-mediator interaction (Nguyen et al., 2015). It is more flexible than conventional Baron and Kenny approach (Baron and Kenny, 1986), allowing for different types

of models.

5. Limitations

Some limitations of this study have been identified. Although we used a comprehensive framework incorporating three pathways, there still existed unexamined mediating factors which may mediate the association between visual impairment and mental health. The mediating variables we selected are partly based on data availability. Some hypothesized mediators such as diet quality, working conditions and life satisfaction were not included in our study due to lack of data. In addition, we could not infer further causal conclusions with the cross-sectional nature of the study design despite the involvement of counterfactual approach to causal inference. A temporal sequence between the exposure, mediators and outcomes might not be ensured. Moreover, misclassification bias with regard to exposure and mediators might influence the results when relevant variables are dichotomous.

6. Conclusion

Findings of the study show that visual impairment in old age is a significant predictor for late-life depression. Visually-impaired population as high-risk group should be provided better access to mental health care, which can promote early detection of mental disorder and provide prompt treatment for low-vision patients with depressive symptoms. A substantial proportion of the effects of visual impairment on depression are mediated by the three sets of explanatory factors, making them a point of entry to intervention to promote mental health among visually impaired older population.

Authors' contribution

Xiaowei Dong: designed the study, performed statistical analyses and wrote the initial draft. **Nawi Ng:** contributed additional writing to the first draft, critical review and revisions.

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Supplementary materials

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