

# Frailty, Quality of Life, and Loneliness of Aging in Native and Diasporic Chinese Adults

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## Abstract

**BACKGROUND:** Global migration has increased in the past century, and aging in a foreign country is relevant to the Chinese diaspora.

**OBJECTIVE:** With regard to migration, this study focuses on the places of aging as the context of older Chinese adults. This study aimed to describe the general health and wellbeing of this population with respect to their location.

**DESIGN:** This study has a cross sectional design.

**SETTING AND PARTICIPANTS:** Participants were recruited who were “aging in place” from Tianjin, China (199 participants), and “aging out of place” from the Netherlands (134 participants). Data from April to May 2019 in China and November 2018 to March 2019 in the Netherlands were aggregated.

**MEASUREMENTS:** frailty, QoL and loneliness were used in both samples.

**RESULTS:** T-tests and regression analyses demonstrated that social domains of frailty and QoL, as well as loneliness and frailty prevalence characterized the major differences between both places of aging. A correlation analysis and visual correlation network revealed that frailty, quality of life (QoL), and loneliness were more closely related in the aging out of place sample. Social domains of frailty and QoL, as well as the prevalence of loneliness and frailty, characterized the major differences between both places of aging.

**CONCLUSIONS:** The findings indicate that frailty, QoL, and loneliness have a complex relationship, confirming that loneliness is a major detriment to the general wellbeing of older Chinese adults aging out of place. This study examined the places of aging of the larger Chinese population and allows a comprehensive understanding of health and wellbeing. The social components, especially loneliness, among the aging out of place Chinese community should receive more attention practice and clinical wise. On the other hand, frailty as well as its prevention is of more importance for the Chinese community aging in place.

*Key words:* Chinese, migration, subjective well-being, correlation network.

## Introduction

One of the fastest and increasing groups of aging population in the world comprises the ethnic Chinese, including those located in their home country and the worldwide diaspora. It is expected that

the ethnic Chinese will make up one quarter of the elderly population of 60 years and older by 2025 (1). Moreover, with 10 million Chinese migrants worldwide, China is the fourth largest country of origin of all international migrants (2). Therefore, the large number of overseas and national Chinese populations underlines the international relevance of this ageing population.

In the context of emerging global migration, Sadarangani and Jun (3) have introduced the concepts of “aging in place” and “aging out of place”. Originally, the concept of “aging out of place” was used to refer to older adults who are unable to age in their residential home and therefore must age out of place in an institution. However, the concept of aging out of place can be extended and applied to aging immigrants in a foreign environment with the emphasis on the sociocultural aspects (3). These can refer to the social, political, and cultural environment as well as the emotional aspects of aging such as detachment or social isolation. Along the same line, older adults who are aging in their native country can be considered to be “aging in place”. This is generally preferred as it includes a sense of attachment to one’s nearer community and home which consequently improves the social connectedness and wellbeing (4).

Building upon this rationale, it can be conceived that aging immigrants who have been residing for a long term in their host country are “aging out of place” due to discrepancies between the older adults and their environment. The existing literature show how the aging Chinese immigrants have specific challenges while aging which result in stress and affect their wellbeing, despite residing many years “out of place”. These challenges are related to practical problems as language barriers, and limited accessibility of healthcare, but as well as related to a dissonance with their social environment, as loneliness and social isolation (5 – 7). Therefore, an explorative study of the older Chinese adults, who are “aging in place” and “aging out of place” could provide insights in the potential differences in health patterns in both contexts. As Lewis and Buffel (8) contend, the number of studies with a focus on the places of aging are insufficient, especially regarding the aging diaspora and their native counterparts in their country of origin (9).

Majority of the studies on the health of aging Chinese immigrants in Western societies have reported on various health related indicators such as mental health, depression,

anxiety, loneliness, physical health, and wellbeing. The mental health of the aging Chinese diaspora tends to be generally worse than the native local population and related to sociodemographic factors, physical health, and culturally specific factors such as relationships with families (10-13). This indicates that the Chinese diaspora are mentally and psychologically vulnerable. Moreover, mixed observations were made among the Chinese diaspora in Western countries where their physical health would be either better or worse than the native population in Western countries, such as obesity, hypertension, and diabetes (10, 14-17).

Usually, chronic diseases are considered to be a marker for defining current populations' health. However, when using these markers, the complexities of different health-related dynamics are not taken into account. A more comprehensive health assessment is provided for frailty for which the individual's adaptational processes are central (18). The frailty index measures on a continuous scale and can simultaneously indicate the clinical dichotomous condition "frail" and "not frail" (19). The multidimensionality of this concept includes physical, social, cognitive, and mental wellbeing elements and therefore captures different dynamics of importance to health (20).

Moreover, frailty has been shown to be related to a reduced quality of life (QoL) (21 - 24). In general, an increase of frailty is related with a lower QoL. However, inconsistent findings were ascertained among nursing home residents (25). To this date, insights into the influence of aging in or out of place within the larger ethnic Chinese population remains lacking and especially among the diaspora.

Further, loneliness is a relevant social indicator of the diasporic older adults as has been widely researched among previous studies. A Canadian study showed that elderly Chinese immigrants reported a higher prevalence of loneliness than the native Canadian elderly population (26). This pattern is echoed in comparison studies with immigrant Chinese in the UK (27). The Chinese immigrants in the Netherlands are also troubled by loneliness (28, 29). Furthermore, loneliness seemed to be explained by negative health outcomes (30). Therefore, social and general health indicators are relevant to the diasporic community and should be taken into account in addition to general measures assessing the health and wellbeing of the diaspora.

Although frailty and QoL and have been widely researched, recent literature on loneliness has established a negative relationship with QoL and insights regarding loneliness and frailty remains understudied (31 - 33). The study of Herrera-Badilla et al. (32) is the only previous study to have studied loneliness and frailty, which demonstrated an independent relationship between both concepts. However, more research is needed to gain insights into their relationships as frailty, QoL and loneliness are demonstrated to be relevant to health and wellbeing. Although loneliness has been widely studied with depression and other mental health outcomes, loneliness, frailty, and QoL have rarely been studied together, and therefore could provide additional insights into these three concepts. Moreover, as the concept of "aging in and out of place" by Sadarangani

and Jun (3) emphasizes the social (dis)connectedness to one's environment, the concepts frailty and QoL are suitable as it encompasses broad range of dimensions of the health and wellbeing, such as physical and social frailty and QoL, whereas loneliness regards the social isolation from the place of aging.

As demonstrated in various studies, the social and environmental characteristics are important factors to health status (34-36). More importantly, comparisons between the same ethnic groups in different countries could provide crucial insights in the dynamics of frailty and QoL in the aging population. However, the current body of literature lacks the cross-national comparisons within the same ethnic population regarding native and diasporic populations. General findings have led to the phenomenon of healthy immigrant effect for which immigrants have a better health status compared to the host country's native population (14). Given all of this, an exploration of older immigrants (aging out of place) and the native population of the country of origin (aging in place) could yield additional crucial insights in the health and aging processes.

Therefore, this study aimed to examine the general health and wellbeing of older Chinese adults. Specifically, by examining the latent constructs and patterns of frailty, QoL and loneliness, and to explore the relationships among frailty, QoL, and loneliness between the Chinese "aging in place" and "aging out of place" population. The following research questions guide this study:

1. Do the latent concepts of frailty, QoL and loneliness have equal structural constructs in both places of aging?
2. What are the differences between places of aging in terms of frailty, QoL and loneliness of older Chinese adults?
3. How are frailty, QoL and loneliness related to each other in the context of aging in and out of place?

## Methods

### *Participant recruitment and data collection*

Data was gathered from aging Chinese populations in China and the Netherlands and aggregated between April to May 2019 in China and between November 2018 to March 2019 in the Netherlands. The following inclusion criteria were held for the recruitment of participants: 60 years old of age and cognitive ability to understand the research questions in Chinese. Eligible participants were informed about the study and were requested to participate on a voluntary basis. They were informed about their right to withdraw at any time and the anonymous processing and reporting of their information. All of the participants were given the form to fill in the questionnaires by themselves or an informal acquaintance in case of illiteracy.

For the aging in place sample, older adults in China were approached in a local neighborhood in Tianjin where leisure activities were undertaken. All of the participants filled in the questionnaires by themselves. The recruitment for the aging out of place sample occurred in the Netherlands in six urban cities during local meetings of Chinese associations for older adults. As this population contained illiterate individuals, a minority

of the forms were filled in together with the researcher or an acquaintance or friend. This was the case for approximately 10% of the participants.

### **Contextual background**

Mainland China accounts for older Chinese adults with a population of 168 million. As reported by the WHO, life expectancy has almost been doubled since 1950 due to an epidemiological shift of communicable diseases to chronic diseases (61). Nearly a third of all disease burden in China are attributed to chronic diseases among the older population. Majority of the older population in China has attained education up to high school (62). Living arrangements among are mainly either with spouse (36.2%) or adult children (41.3%). Single person household are rare with only 9% (63).

The Chinese diaspora in the Netherlands comprises approximately of at least 110.000 persons, of which a third consist of the aging population. Majority of the older diasporic Chinese population originate from Hong Kong and mainland China, are concentrated in the urban areas, and have attained either no education, primary- or middle school. Multipleperson households are prevalent among this population with 48.7% (64).

### **Frailty**

The Frailty Index-35 (FI-35) is specifically developed for Chinese older adults and validated among older adults in China (38). The leading definition for frailty was “as an individual loss of body function caused by various types of factors, which will increase the risk of adverse health events” (37, 38). The FI-35 consists of four domains and 11 underlying dimensions: physical (nutrition, motion, muscle strength, energy, and sleep), cognitive (emotion and cognition), social (role and social contact) and environment (environment and adaptability). The FI-35 measures frailty from a deficit point of perspective (e.g., “can you lift 5kg with your arms?”, “has your sleeping time reduced in the past 6 months?”) with a dichotomous scale (yes, no) and is conceptualized as an accumulation of deficits. Affirmative answers to each item had a scoring of 1 point, and 0 points were given in non-affirmative answers. The frailty score ranged from 0 to 1; it was the sum of all of the items divided by 35.”? A higher score indicated an increase in frailty. The prevalence of frailty was indicated by a score of 0.23. Responses with more than 20% of missing answers were excluded.

### **Quality of life**

The leading definition of QoL by the WHO for the WHOQOL-BREF states “individuals’ perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns” (39). Therefore, the subjective individual perception of one’s life regarding four domains is central to the WHOQOL-BREF. The domains

are physical (pain and discomfort; energy and fatigue; sleep and rest), psychological (positive feelings; self-esteem; body image negative feelings; thinking, learning, memory, and concentration), social relationships (personal relationships; social support; sexual activity), and environment (physical safety and security, home environment, financial resources, services, information, leisure, environment, transportation). The WHOQOL-BREF is scored from 0 – 100 for QoL on the four domains. An increased score indicates a higher quality of life or health. This instrument is validated in China (40). All questions were scored on a 5-point scale. Item 3 and 4 were negatively phrased and reversed for further analysis. The calculation of domain scores was the average of each domain which was multiplied by 4. Responses with more than 20% of missing answers were excluded.

### **Loneliness**

Loneliness has been described as “situations where the number of existing relationships is smaller than desirable or acceptable, as well as situations where the intimacy wished for has not been realized” (41). The De Jong Gierveld Loneliness Scale (DJGLS) is theoretically based on the conceptualization of loneliness by Weiss (42) for which loneliness consists of social and emotional loneliness. The DJGLS measures social and emotional loneliness as a subjective experience that is independent of situational factors. Feelings of lacking personal intimacy (emotional loneliness) and social embeddedness (social loneliness) are scored in the DJGLS. The Chinese version of 6-item De Jong Gierveld loneliness scale (DJGLS) was used to measure loneliness (65). The scale consists of six items, and these are scored with “none” (1 point), “more or less” (2 points), and “yes” (3 points). The scale was validated among the native and diasporic older Chinese adults (29). The loneliness prevalence for each category (none, moderate, or severe social and emotional loneliness and overall loneliness) was calculated according to the original manual (43). For further analyses, the sum scores of the respective items were used to calculate the raw scores for each category; emotional and social loneliness as well as loneliness. The sum scores of emotional and social loneliness ranged from 3 to 9 points, and loneliness ranged from 6 to 18 points for which an increase of points indicates an exacerbation of loneliness.

### **Background variables**

Sociodemographic data included age, gender, education, marital status, years of residence in Tianjin or the Netherlands, city of birth (aging in place sample) or country of birth (aging out of place sample), and number of children. Lifestyle data included living situation and smoking habit. Health related data included selfcare ability and self-report of presence of common chronic diseases: Alzheimer’s disease, arthritis, cancer, diabetes, heart disease, heart attack, osteoporosis, Parkinson’s disease, pneumonia, stroke, and other diseases.

**Statistical Analysis**

To analyze if the used assessment constructs were measured equally in both samples, a multiple group confirmatory factor analysis (MGCFA) was applied with the “Lavaan” library in R. MGCFA investigates the associations (correlations, known as factor loadings) between the specific domains and between the overall constructs of frailty, QoL, and loneliness between both places of aging. The reliability of the used instruments was assessed with Cronbach’s alpha.

Comparisons of the aging in and out of place sample means were done using an independent-sample t-test (domain scores of frailty and QoL). Cohen’s d was calculated for the domain scores of both samples using the “Lsr” library (44). The effect size was considered small (0.2–0.5), medium (0.5–0.8), or large ( $d \geq 0.8$ ) (45). Dichotomous results of the prevalence of frailty and loneliness were expressed as percentages and compared using a proportion test. In addition to the calculated prevalence of frailty and loneliness, the raw summed score was used to calculate Cohen’s d. A multivariate backward regression was further applied with SPSS v24® to examine the differences between both samples regarding frailty and QoL domains, and loneliness sum scores while correcting for demographic factors (age, gender, marital status, education, number of children, years spent in Tianjin or the Netherlands, selfcare ability and number of reported chronic diseases). Aging in place was coded as 0 and aging out of place was coded as 1.

The four domains of FI-35 and QoL, as well as the summed scores of emotional and social loneliness, were used to calculate Pearson’s correlation coefficients using the “Hmisc” library for R (46). A correlation network was generated with “Qgraph” library to visualize and inspect the correlations (47). The network was based on the strength of the correlation, whereby thicker lines denoted stronger correlations and thinner lines denoted weaker correlations. Moreover, positive and negative correlations were expressed by the color of the line: red for negative correlations and green for positive correlations. Correlations were categorized as poor ( $r < 0.3$ ), fair ( $r = 0.3–0.6$ ), moderate ( $r = 0.6–0.8$ ), or very strong ( $r > 0.8$ ) (58).

The critical value of level of significance for all analyses was set at 0.05. Bonferroni correction for p-values was applied for the t-test and correlation analyses. The adjusted cut-off p-values for the 0.05 level were calculated using the following formula:  $0.05/(n \text{ tests})$ .

**Ethical procedures**

Ethical approval was granted by ethical approval board of the University Medical Center Groningen and the Tianjin University of Traditional Chinese Medicine to conduct this study. Participants were provided with an information leaflet and the option to withdraw from the study at any time. Informed consent was given prior to participation in this study.

**Results**

The study sample characteristics are presented in Table 1. The participants of the aging in place sample were born in China of which the majority was locally born in Tianjin (66.8%) and relatively highly educated, cohabiting (81.9%), and 70.3% had at least one chronic disease. The majority of the aging out of place sample was born either in China (42.5%) or Hong Kong (42.5%), relatively less educated, cohabiting (68.5%), and 53% had one or more chronic diseases.

**Table 1.** Study samples characteristics of aging in and out place

	Aging in place: China	Aging out of place: The Netherlands
Study sample (n)	199	134
Age (in years)		
Mean (SD)	70.3 (6.5)	70.8 (8.7)
Gender (female, %)	51.8	57.5
Years lived in Tianjin/ the Netherlands		
Mean (SD)	51 (26.7)	39.6 (9.2)
Country of birth (%)		
China	100.0	42.5
Hong Kong	0.0	42.5
Malaysia	0.0	6.0
Indonesia	0.0	1.5
Surinam	0.0	0.7
Singapore	0.0	3.7
Taiwan	0.0	1.5
Vietnam	0.0	0.7
Missing	0.0	0.7
City of birth (%)		
Tianjin	66.8	–
Outside Tianjin	33.2	–
Education level (%)		
No education	5.0	9.0
Elementary school	14.6	33.6
Middle school	37.7	39.6
High school	25.6	11.2
Bachelor’s or higher	17.1	4.5
Missing	0.0	2.2
Living situation (%)		
Alone	18.1	27.6
With partner	55.8	54.4
With children	12.6	2.2
With partner and children	11.6	11.9
Other	2.0	2.2
Missing	0.0	1.5
Children (n, sd)	1.75 (0.9)	2.9 (1.5)
Marital status (%)		
Unmarried	1.5	3.7
Married	82.9	67.2
Divorced	1.5	9.7

**Table 1 (continued).** Study samples characteristics of aging in and out place

	Aging in place: China	Aging out of place: The Netherlands
Widowed	14.1	17.9
Missing	0.0	1.5
Selfcare ability (%)		
No ability	0.0	0.7
Some ability	11.6	20.1
Complete ability	85.4	76.9
Missing	3.0	2.2
Presence of chronic diseases (%)		
0	29.6	47.0
1	42.2	31.8
2	24.6	15.9
>3	3.5	5.3
Missing	0	1.5
Smoking (%)	15.6	3.0
Missing	3	1.5

The most common diseases among the aging in place sample included heart disease (48.7%), diabetes (25.4%), osteoporosis (20.7%) and arthritis (19.1%). The reported chronic diseases among the aging out of place sample's included diabetes (23.1%), arthritis (22.4%), osteoporosis (15.7%) and heart disease (8.2%).

**Reliability and Multiple Group Confirmatory Factor Analysis of Frailty, QoL, and Loneliness**

The reliability of the frailty (FI-35) scale was 0.804 for the aging in place and 0.874 for the aging out of place samples. The QoL scale (WHOQOL-BREF) gave an alpha value of 0.913 for the aging in place and 0.862 for the aging out of place samples. Loneliness (DJGLS) produced an alpha value of 0.68 for the aging in place and 0.71 for the aging out of place samples.

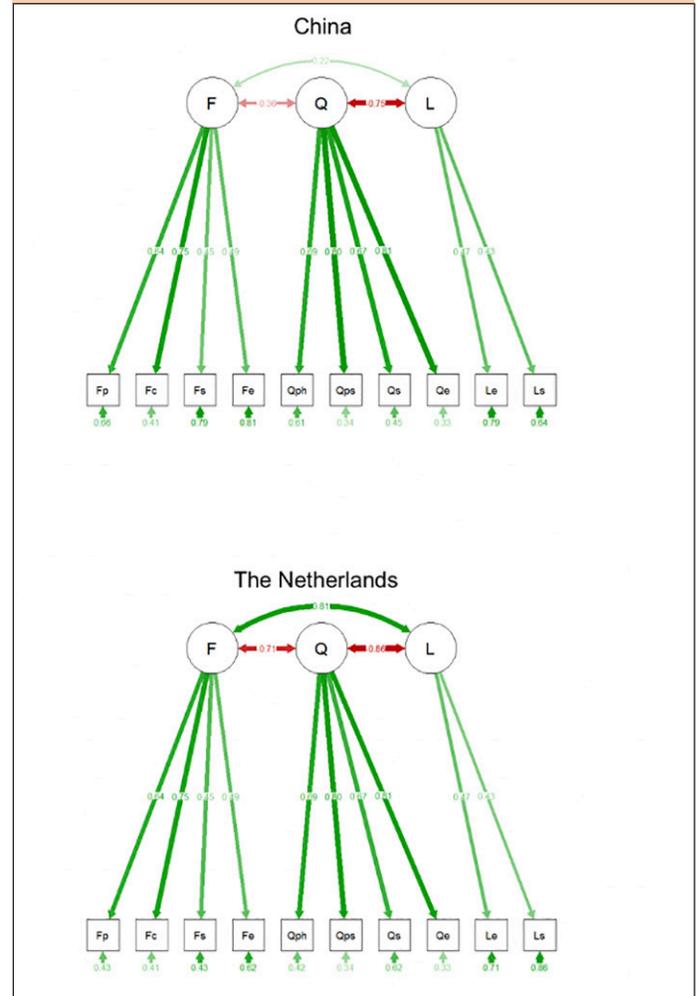
The factor loadings of frailty, QoL, and loneliness of both samples are significantly different from zero and are shown in Figure 1. The information indices as well as the testing results given in Table 2 demonstrate that the loadings can be taken equal between the aging in and out of place samples ( $p = 0.617$ ). This indicates that the meaning of the constructs in both samples is equal. The fit of equal loadings over the two models indicated a CFI of 0.896 and TLI of 0.874, which are close to reasonable fit (59 - 60). Moreover, the associations within the constructs were close to equal, as shown in Figure 1.

**Frailty, QoL and Loneliness between aging in and out of place samples**

The means of the frailty, QoL, and loneliness domains were calculated and compared between the aging in and out of place samples, as presented in Table 3. The aging in place sample showed a greater prevalence and a higher score of frailty (82.4%, mean of 0.39) than the aging out of place sample

(61.9%, mean of 0.30), with a fair effect size of  $d = 0.55$ . This was also reflected in all four frailty domains, where the scores of the aging in place sample were significantly higher than those of the aging out of place sample, especially social frailty, with a strong effect size of  $d = 0.84$ .

**Figure 1.** Confirmative factor loadings of the domains with the latent factors frailty (F), QoL (Q), and loneliness (L) as well as correlations between these among participants aging in (China) and out of place (the Netherlands)



Abbreviation of the domains: Fp= Frailty Physical domain; Fc= Frailty Cognitive domain; Fs= Frailty Social domain; Fe= Frailty environment domain; Qph= QoL Physical domain; Qps= QoL Psychological domain; Qs= QoL Social domain; Qe= QoL Environment domain; Le= Emotional loneliness; Ls= Social loneliness.

Three out of the four QoL domain scores were significantly higher in the aging in place sample, showing a higher QoL in this sample in comparison with the aging out of place sample. The social QoL domain had the largest effect size of  $d = 0.36$ .

The loneliness scores for all three loneliness categories were significantly lower in the aging in place sample, indicating a lower loneliness prevalence in comparison with the aging out of place sample. This was also reflected in the large effect size of  $d = -1.34$ .

Multivariate regression analysis confirmed that the same mean scores for frailty domains, QoL domains, and loneliness categories were significantly different in both samples, as presented in Table 4. When correcting for age, gender, marital

**Table 2.** Goodness-of-fit indices and likelihood ratio testing results of MGCFA with different and equal factor loadings

	AIC	BIC	CFI	TLI	RMSEA	$\chi^2$ (df)	$\Delta\chi^2$ ( $\Delta$ df)	p
Different factor loadings	8524	8775	0.893	0.850	0.093	173 (64)	-	-
Equal factor loadings	8512	8726	0.896	0.874	0.085	181 (74)	8 (10)	0.617

**Table 3.** Frailty domains, QoL domains, and loneliness categories expressed as percentages and means (standard error) between the older Chinese adults aging in place in China and aging out of place in the Netherlands, together with Cohen’s d effect size

	Aging in place: China (% or mean, SE)	Aging out of place: The Netherlands (% or mean, SE)	Effect size (d):
Frailty (total score > 0.23) (%)	82.4	61.9*	
Frailty domain scores			
Physical	0.39 (0.02)	0.32 (0.02)	0.29
Cognitive	0.38 (0.02)	0.30 (0.02) *	0.34
Social	0.40 (0.02)	0.20 (0.02) *	0.84
Environmental	0.40 (0.02)	0.31 (0.02) *	0.38
Total frailty score	0.39 (0.01)	0.30 (0.01) *	0.55
QoL domains scores			
Physical	62.92 (1.07)	63.00 (1.25)	0.01
Psychological	64.64 (1.05)	59.81 (1.25) *	0.33
Social	65.72 (0.94)	60.85 (1.25) *	0.36
Environment	64.31 (1.07)	60.67 (1.23)	0.25
Loneliness categories (%)			
Social loneliness	42.0	75.0*	-0.66
Emotional loneliness	56.5	71.0	-0.29
Loneliness	48.2	74.8*	-1.34

\* Bonferroni adjusted p < 0.05; Note. The cut-off p-value after Bonferroni correction was 0.05/13 = 0.004

**Table 4.** Multivariate regression of frailty domains, QoL domains, and loneliness categories when controlling for demographic and health factors and place of aging

	Frailty					QoL				Loneliness		
	Physical	Cognitive	Social	Environmental	Total frailty score	Physical	Psychological	Social	Environmental	Social Loneliness	Emotional loneliness	Loneliness
Age	.064	.012	.082	.077	.073	-.257*	-.013	-.074	-.038	-.040	-.040**	-.045*
Gender	-.073	-.087	-.055*	-.034	-.039*	4.896**	.089	-.006	.051	-.012	-.029	.020
Marital status	.053	.055	.046	.037+	.082	-.027	-.006	-.004	.019	.050	.162+	.063
Education	-.038	.067	-.043	-.020+	-.025	.006	.080	.060	.080	.215*	-.017	.026
Number children	-.036	-.020*	-.030	.062	-.037	1.347*	2.218**	1.163+	1.158+	-.043	.165*	.219+
Years in Tianjin/the Netherlands	.030	-.001*	-.059	-.024	-.038	.000	.062	.031	.144***	.032	-.069	-.023
Selfcare ability	-.133***	0.084	-.144***	-.096**	-.113***	10.457***	7.722***	5.290*	8.101***	-.067	-.723**	-.718+
Chronic diseases	.036**	.029*	.006	.002	.020*	.000	-.051	1.736*	.054	-.041	.053	.272+
Place of aging	-.073**	-.076**	-.201***	-.084*	-.102***	.025	-6.150***	-5.261**	-.081	1.233***	.077	2.788***
R <sup>2</sup>	.089***	.064***	.185***	.091***	.155***	.104***	.066***	.051**	.069***	.094***	.040**	.288***

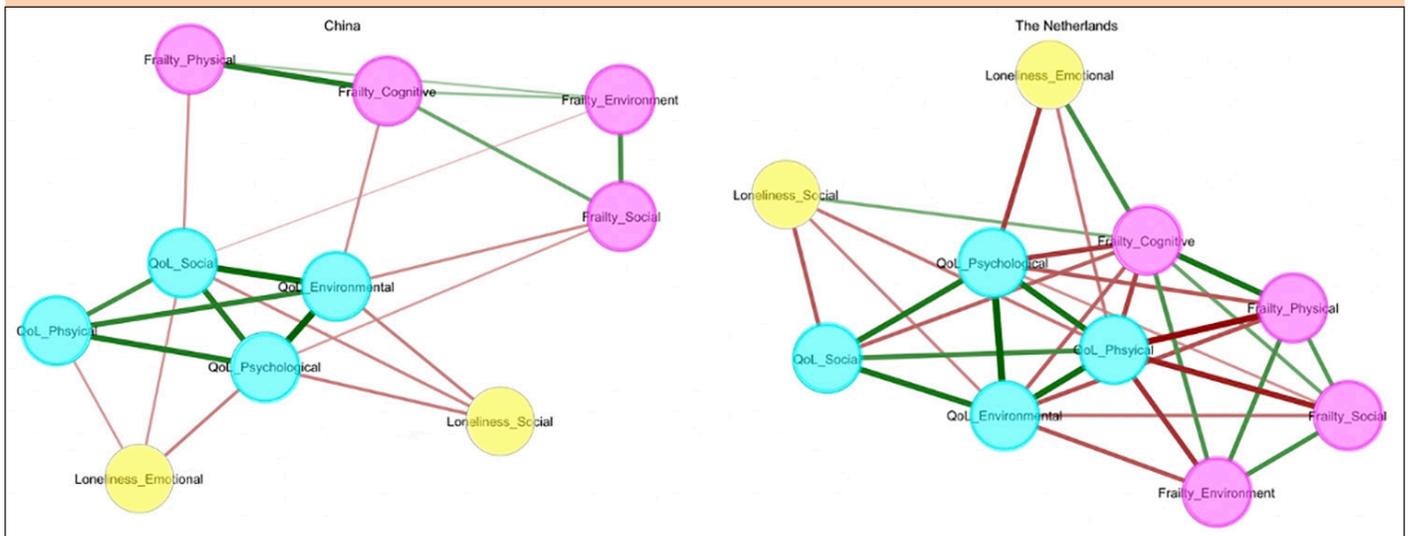
+p < .1, \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.

status, education level, number of children, and years spent in the Netherlands or Tianjin, selfcare ability, and number of chronic diseases, the independent variable “place of aging” predicted the difference in outcome scores between both countries.

The frailty domains scored lower for the aging out of place sample. On average, the aging out of place sample was significantly less frail ( $\beta = -.102$ ,  $p < 0.001$ ). Social frailty showed the largest mean difference of all frailty domains ( $\beta =$

$-0.201$  points,  $p < 0.001$ ). Psychological and social QoL scores were significantly lower for the aging out of place sample, with psychological QoL having a largest mean difference ( $\beta = -6.150$ ,  $p < 0.001$ ). Social loneliness and overall loneliness scores were significantly increased for the aging out of place sample, with overall loneliness having the highest mean difference ( $\beta = 2.788$ ,  $p < 0.001$ ). Loneliness explained the differences in both samples with the highest proportion of the samples with an R<sup>2</sup> of .288.

**Figure 2.** Correlation networks of the frailty, QoL, and loneliness domains of the older Chinese adults aging in place sample (China) and out of place (the Netherlands)



The thickness and the intensity of the color of the lines between the nodes (domains) are based on the strength and direction of the correlation coefficient, representing correlations significantly different from zero. Red lines represent negative correlations, and green lines represent positive correlations. The color of the nodes corresponds to the concepts where frailty is purple, QoL is blue, and loneliness is yellow.

### ***Correlations among the Frailty, QoL, and Loneliness Domains and Comparison between Aging in and out of Place Samples***

The domain scores of frailty, QoL, and loneliness were correlated within each sample, as presented in Table 3. The correlation coefficients and their levels of significance are presented for the aging in place sample in the upper diagonal and for the aging out of place sample in the lower diagonal. A correlation network based on the correlation data is presented in Figure 2.

In general, the significant associations among the domains within frailty, QoL, and loneliness were positively correlated. Correlations within the loneliness category were not significant in either sample.

The associations between frailty and QoL were negatively and more strongly correlated in the aging out of place sample. The aging in place sample had a smaller number of significant correlations, and the sample generally showed poor correlation between frailty and QoL. The thinner lines between the frailty and QoL nodes in Figure 1 and the significance of the correlation matrix in Table 4 suggests that the aging in place sample exhibited less significant and weaker correlations. On the other hand, the aging out of place sample exhibited mostly significant and fair correlations between frailty and QoL.

Moreover, in the aging out of place sample, the corresponding domains of physical QoL and physical frailty, of psychological QoL and cognitive frailty, and of environment QoL and environmental frailty exhibited significant and fair to moderate correlations, which were stronger in comparison with noncorresponding domains. However, this was not the case for social QoL and social frailty in the aging out of place sample. In the aging in place sample, the corresponding domains were all insignificant.

The correlations of social and emotional loneliness with the frailty domains were all insignificant in the aging in place sample. In contrast, the QoL domains were significantly and poorly to fairly correlated with loneliness. In the aging out of place sample, loneliness was generally similar in strength and significantly correlated with cognitive frailty and the QoL domains.

### **Discussion**

This study is the first to examine the relationships among frailty, QoL, and loneliness. The results reveal unique insights into the Chinese aging in and out of place samples. The main finding from this study is that frailty was more closely related to QoL and loneliness for the aging out of place than the aging in place sample. In the aging in place sample, QoL and loneliness were more strongly related to each other, whereas they were more weakly related to frailty. Major differences were observed in the social components of health, with loneliness being the largest contributor. The older adults aging out of place, in general, had lower social frailty, lower social QoL, and a profound prevalence of loneliness compared to those aging in place. Moreover, the findings from the MGCFA revealed that the health-related concepts of frailty, QoL, and loneliness could be considered as equal structural construct for both places of aging.

The systematic review and meta-synthesis of Crocker et al. (22) revealed that frail older adults exhibit the largest difference in the physical domain of the WHOQOL-BREF compared to non-frail older adults. This finding implies that frailty and physical QoL have a stronger relationship than other QoL domains. A similar observation was found in the aging out of place sample, whereby physical QoL and (the domains of) frailty generally showed a much stronger relationship than other domains of QoL. However, the opposite trend was observed

**Table 5.** Correlation matrix of frailty, QoL, and loneliness domains for China above and for the Netherlands below the main diagonal

China/ The Netherlands	Frailty physical	Frailty cognitive	Frailty social	Frailty social environment	QoL physical	QoL psychological	QoL social	QoL environment	Loneliness emotional	Loneliness social
Frailty physical	-	0.55*	0.11	0.22*	-0.10	-0.14	-0.25*	-0.14	0.14	0.11
Frailty cognitive	0.55*	-	0.36*	0.25*	-0.07	-0.18	-0.22	-0.26*	0.02	0.10
Frailty social	0.39*	0.34*	-	0.46*	-0.08	-0.23*	-0.20	-0.27*	-0.09	0.14
Frailty environment	0.43*	0.42*	0.43*	-	0.03	-0.09	-0.14*	-0.17	-0.03	0.11
QoL physical	-0.59*	-0.45*	-0.53*	-0.48*	-	0.56*	0.46*	0.52*	-0.24*	-0.18
QoL psychological	-0.39*	-0.47*	-0.25*	-0.24	0.56*	-	0.55*	0.67*	-0.31*	-0.31*
QoL social	-0.18	-0.36*	-0.19	-0.19	0.45*	0.53*	-	0.63*	-0.24*	-0.29*
QoL environment	-0.41*	-0.37*	-0.33*	-0.40*	0.57*	0.63*	0.54*	-	-0.22	-0.31*
Loneliness emotional	0.27	0.44*	0.15	0.25	-0.31*	-0.47*	-0.27	-0.32*	-	0.18
Loneliness social	0.09	0.30*	0.24	0.23	-0.31*	-0.25	-0.39*	-0.28	0.27	-

\* Bonferroni adjusted  $p < 0.05$ . Note. The cut-off value for Bonferroni correction was calculated as  $0.05/45 = 0.001$

for the aging in place sample, whereby there was no significant relationship between physical QoL and any of the frailty domains.

The low association between frailty and QoL for the aging in place sample is aligned with the findings of Fougère et al. (25). Frailty was not found to be associated with QoL among nursing home residents. This is possibly due to the extremely high prevalence of frailty in their study (95.1%), which created a ceiling effect. Moreover, frail older adults may resort to social components of life such as social support and social contacts, which function as protective of QoL despite a high frailty status (48; 49). As the aging in place sample in this study also reported a relatively high prevalence of frailty (82.4%), the lower correlation between QoL and loneliness than in the aging out of place sample (61.9%) is plausible. This could also explain the relatively low prevalence of loneliness in the aging in place sample (48.2%), as well as the absence of its relationship with frailty; loneliness in the aging out of place sample may be higher than expected due to the prevalence of frailty. The high prevalence of loneliness among immigrants may be due social vulnerabilities, such as lack of embeddedness in the host country and negative experiences such as racism, as described in various studies (50 - 53). Nonetheless, loneliness was moderately related to both frailty and QoL in the aging out of place sample. This pattern confirms that loneliness is important and highly relevant for the general wellbeing of the aging out of place sample.

Moreover, Wu et al. (54) suggested that health behavior and access to health care are important factors contributing to self-reported health status among the ethnic Chinese. It is also possible that these findings are reflective of the sociodemographic differences and the contrasting (accessibility to) healthcare systems in both countries. In addition, the healthy migrant hypothesis could be used to explain the lower scores of frailty in the “aging out of place” sample than the “aging in place” sample, whereby receiving countries have relative healthier migrant populations due to the return of less healthy immigrants to their home countries.

As this is the one of the first studies to investigate loneliness in combination with the general health indicators of frailty and QoL, the findings provide important support for the hypothesis

and previous findings that social components become more important in life as a function of the prevalence of frailty. Moreover, the results strengthen the assumption that lower scores for an objective health measure, such as frailty, do not necessarily entail a lower subjective experience in terms of QoL and loneliness. Therefore, health surveys aimed at encompassing multiple facets of life should treat subjective measures as equally important as objective physical health measures.

In any case, a comparison of the findings of this study with the literature is challenging, as there is no universal accepted characterization of frailty; the used metrics differ greatly, e.g., frailty phenotype versus Frailty Index. Additionally, the use of different existing QoL instruments hinders comparisons, although these are less diverse than those used for frailty, e.g., SF36 versus WHOQoL-BREF (55 - 57). Therefore, the interpretation of these findings should be considered in this light. Once an unequivocal conceptualization of frailty is established, these findings can become more clinically relevant.

This study demonstrated the important finding that the places of aging and social components characterize major differences in the aging Chinese samples. The correlation analysis provided insights into different components contributing to the general wellbeing of the aging Chinese samples. This is aligned with the general findings of studies among the diasporic Chinese showing that mental health and loneliness are major problems for older adults aging out of place. In this study, loneliness and social frailty were shown to be majorly increased among older adults aging out of place as a function of social components, whereas older adults aging in place were more challenged in terms of their frailty. Public health research should include comparisons of places of aging in the context of international migration, which can provide important insights into the specific aging processes of adults aging out of place. With the increased globalization and international migration over the last century, this has become an important aspect of public health. Moreover, the implication of this study also applies to the social policy making for older Chinese adults. The findings suggests that the population can be distinguished in terms of frailty and loneliness. A distinction based on these or similar measures could provide counteractions against loneliness among the

aging out of place older adults. This does not only entail the public policy making agencies, such as the local or national government bodies, but also local and social initiatives that concerns the wellbeing of the older adults. Regarding frailty, a multidisciplinary approach, such as medical-, social-, or psychological care, could provide improvement as frailty is relevant beyond the medical field. For example, older Chinese adults who are aging out of place may benefit from initiatives or projects that are culturally fit or tailored to this population.

Some limitations should be taken into account during the interpretation of these findings. Both samples were based on convenience sampling, whereby the aging in place sample was from a local neighborhood in one urban city, while the aging out of place sample was from a wider distribution of a smaller country. However, this study showed through MGCFA analysis that the used instruments may be taken equal in their latent constructs. Additionally, the study samples are similar to the population characteristics, as the aging out of place population mainly reside in urban areas, education profile and country of birth. Therefore, the findings are only limited to the urban populations. Moreover, moderate effects may not have been demonstrated in this study due to the limited sample size, with only strong effects being visible; thus, the findings remain limited to these samples.

Another possible explanation of the findings could be based upon healthy migrant theory. As the aging out of place sample have reported lower number of chronic diseases and lower frailty prevalence, it gives the impression that the migrant sample is a selection of the physical and medical healthier individuals than the aging in place sample, while a lower social wellbeing, such as loneliness and QoL characterizes this group. In line with literature of older migrants, cultural differences and language barriers may contribute to social isolation and wellbeing of older Chinese in the Netherlands (28).

## Conclusion

The cross-sectional design of this study on places of aging contributes to the literature on aging processes, yielding unique insights into the relationships among frailty, QoL, and loneliness and their domains for older Chinese adults aging in and out of place. Furthermore, the inclusion of the Chinese population in the Netherlands is unique, as it is a very closed community, and this study is one of the first to report details on their frailty, QoL, and loneliness.

This study provided novel and important insights into the health and wellbeing of the aging ethnic Chinese community. The explorative study design as a function of the places of aging allowed a more comprehensive understanding of their health and wellbeing. Moreover, frailty, QoL, and loneliness exhibited a complex relationship. Future research is recommended to investigate aging in and out of place populations as it may yield important insights in addition to the current body of knowledge. Specifically, additional comparative studies with larger study samples should be conducted. The social components, especially loneliness, among the aging out of place Chinese community should

receive more attention both policy and practice wise. On the other hand, frailty as well as its prevention is of more importance for the Chinese community aging in place.

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