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Association between social support, smartphone usage and loneliness among the migrant elderly following children in Jinan, China: a cross-sectional study

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ABSTRACT

Objectives As the fast population ageing in the past few decades, China has also witnessed an increase in the number of migrant elderly following children (MEFC). This study aims to examine the relationship between MEFC's social support, smartphone usage and loneliness in Jinan, China.

Design Cross-sectional survey.

Setting Shandong Province, China.

Participants The participants were 656 MEFC aged 60 years or above.

Primary and secondary outcome measures Loneliness was measured by an eight-item version of the University of California Los Angeles Loneliness Scale (ULS-8). A t-test and one-way Analysis of Variance (ANOVA) were conducted to compare the level of loneliness across different sociodemographic variables, social support indicators and smartphone usage indicators. Structural equation modelling was used to validate the association between the above variables.

Results The MEFC's mean score on the ULS-8 was 12.82±4.05, indicating a relatively lower level of loneliness. It was found that social support and smartphone usage exerted negative effects on loneliness of the MEFC, and the standardised direct effects were −0.165 (95% CI −0.257 to −0.070) and −0.094 (95% CI −0.180 to −0.003), respectively. Social support was found to be positively associated with smartphone usage of the MEFC, and the standardised direct effect was 0.147 (95% CI 0.052 to 0.246).

Conclusions The loneliness of the MEFC was relatively low and was clarified to be negatively associated with social support and smartphone usage. Effective intervention measures on social support and smartphone usage to alleviate loneliness among the MEFC in China were recommended based on this study.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Structural equation modelling analysis was conducted to examine the association between social support, smartphone usage and loneliness.
⇒ The level of loneliness among the migrant elderly following children (MEFC) was evaluated using the Chinese version of the eight-item University of California Los Angeles Loneliness Scale.
⇒ The cross-sectional data were not able to prove causal relationship between the three variables mentioned earlier.
⇒ More potential variables relevant to the relationship between social support and loneliness among the MEFC needed to be explored in future studies.

BACKGROUND

The world's population is ageing rapidly as a result of declining fertility and mortality rates during the past few decades. As of 2020 the world's population was 7.8 billion people, of which 9.3% were 65 years old or older,[1] while in 1960 the proportion was merely 5.0%.[2] This trend will continue into the next 40 years because it is estimated that by 2060, the world's population will be 10.2 billion, and 17.8% of these people will be 65 and older.[2] The tendency is more severe in the low-imcome and middle-income countries such as China. Statistics from Seventh National Census in 2020 showed that 264 million Chinese, or 18.7% of the country's population, were 60 years old or older.[3] It is a large increase compared with the Sixth National Census in 2010, which showed that the proportion of the elderly aged over 60 years old was merely 13.26%.[4] Estimation on future Chinese ageing population reveals a total of 487 million elderly by 2050, with the percentage of 34.9% of the whole population.[5]

China is also defined by massive population migrations. It has the largest migrant population in the world—375 million people in 2020—and this population has grown almost 70% in the past decade.[6] Although the growth rate of migrant population has slowed due to urbanisation and the upgrading of industrial structure since 2016, there has been a relatively rapid increase in the number of migrant elderly in this period.[7] Furthermore, some studies have indicated that there are large differences between the migration patterns

of older adults in China and western countries. One of the powerful examples was that family factors, such as the need to care for grandchildren, were central motivations for elderly Chinese migration.[8–10] These elderly were referred as the migrant elderly following children (MEFC). They moved across districts, cities or provinces in China as opposed to foreign immigrants. Therefore, this difference and the rapid increase in population ageing and elderly migrant populations has made MEFC a significant issue in current China.

Previous studies have examined the myriad adverse effects that migration could have on the health of elderly people. For example, migrant elderly cannot enjoy the same social welfare and medical insurance as their local counterparts because China's registration system restricts their access to local health services.[11 12] Furthermore, elderly migrants usually lose social relationships and have to change their lifestyles and living environments, which could make them vulnerable to depression symptoms and loneliness.[13] These studies have suggested that improving the physical and mental health of migrant elderly should be a focus of public health programmes.

Loneliness could be defined as 'an aversive emotional response to a perceived discrepancy between one's desired and actual social relationships'.[14] Ageing was an accepted risk factor for loneliness.[15 16] Factors to loneliness in older individuals included sociodemographic characteristics, physical and psychological factors and social resources factors.[17 18] Loneliness among migrant elderly might be more severe for the deteriorated mental health with age and migration-related narrowing of social circles and separation of old fellows.[19 20] Hence, social predictors should be attached great importance when exploring MEFC's loneliness.

Social support was defined as 'an exchange of resources between at least two individuals perceived by the provider or the recipient to be intended to enhance the well-being of the recipient'.[21] Studies have found that higher levels of social support helps improve elderly individuals' physical and mental health-related quality of life[22] and life satisfaction,[23] and that such support can reduce depressive symptoms[24] and lower their perceived loneliness.[25] Furthermore, studies have shown that inadequate social support increases the risk of mortality from various diseases.[26] When it comes to migrant elderly, a qualitative study revealed that they might perceive lower social support because of the lack of accompany from grown-up children and the difficulty to take good care of grandchildren compared with local counterparts.[27] Therefore, these studies have suggested that policy interventions should aim to increase the quality of social support for elderly migrants to maintain and improve their mental and physical well-being.

Various researchers have examined the interaction between social support and loneliness among the elderly.[28–30] A Spanish study found that a larger social network protected the elderly from the worst effects of loneliness.[31] A Nepalese study suggested that there is a negative relationship between social support and loneliness, especially when the elderly receive this support from their spouses.[32] However, few researchers have examined the relationship between these two variables among the migrant elderly, especially China's peculiar MEFC population.

The rise of the internet has led many people to seek out social interactions online using smartphones. According to the International Data Corporation, 1.3 billion smartphones were shipped worldwide in 2014 alone.[33] According to China's Ministry of Industry and Information Technology, about 134 million elderly use smartphones to access the internet.[34] The rise of smartphones in China has seen an accompanying boom in chatting and communication apps such as WeChat (a chatting app in China which also allows users to send money to each other) and Alipay (an electronic payment app in China). Most studies on the relationship between smartphones and adverse health outcomes have emphasised that young students and workers are at risk of smartphone addiction and thus experience adverse mental consequences.[35 36] Although some studies have also examined smartphones' role in elderly peoples' loneliness,[37 38] they have only examined online communications' mitigating effects on loneliness during the COVID-19 pandemic and the relationship between incoming calls, outgoing calls and loneliness. Several studies have explored the association between internet use and loneliness among the elderly as well.[39 40] However, there was difference between internet use and smartphone use. The former was mainly based on computers, which was not as portable as smartphones and could not pay bills as conveniently as smartphones did. Therefore, the association between the smartphone usage and loneliness among the migrant elderly is still understudied.

Fewer studies have examined the relationships between social support, smartphone usage and loneliness among the elderly. One study proved the association between social media communication (including WeChat), social support, social contact and older persons' loneliness.[41] Another provided similar empirical evidence for this relationship.[42] However, what they failed to consider was that smartphones could not only be used to socialise but serve as tools to solve problems in daily life (such as electronic payment by smartphones). In other words, they did not take instrumental smartphone usage (payment by WeChat or Alipay in our research) into consideration.

In sum, although several studies have examined the relationships between social support and elderly loneliness, as well as smartphone usage and elderly loneliness respectively, none had explored the association between social support, smartphone usage and loneliness simultaneously, and certainly not in China's MEFC populations. This study aimed to examine the empirical relationship between social support, smartphone usage and loneliness using structural equation modelling (SEM) among the MEFC in Jinan, China. The hypotheses were as follows. First, it was hypothesised that there was a negative

relationship between social support and loneliness, as well as smartphone usage and loneliness; moreover, it was hypothesised that there was a positive relationship between social support and smartphone usage.

METHODS

Data collection and the research subjects

The data was collected in Jinan City, Shandong Province, China on August, 2020. Shandong Province lies in the east of China. Jinan City is the capital city of Shandong Province and its Gross Domestic of Products in 2020 was 1.01 trillion Chinese Yuan (≈US$157 285.51 million).[43] As of 1 July 2020, Jinan has 10 districts and 2 counties (132 subdistricts and 29 towns) under its jurisdiction.[44] According to the Seventh National Census of China, the local resident population of Jinan City was 9.20 million by the end of November 2020,[45] an increase of 13.44% over the past ten years.[46] There were 1.8 million migrants in Jinan City by the end of November 2020,[45] of whom those were older than 60 years, following their children to Jinan City became the research subjects of this study. Multistage cluster random sampling was used to select the participants of the study. In the first stage, three districts were chosen from the 10 districts as the primary sampling units (PSUs) in consideration of the economic development and the geographic location. In the second stage, a total of three subdistricts were selected from each PSU as the secondary sampling units (SSUs), which means one subdistrict was chosen from each of the previously selected districts. In the third stage, three communities were selected from the SSUs, which means one community was chosen from each of the previously selected subdistricts. All the migrant elderly who aged more than 60 years and follow their children to Jinan City in these three communities constituted the total sample of this study.

Thirty-two university students became the investigators after the training about the background information about the whole study, contents of the questionnaire, and technique on social survey. Twenty-minute around face-to-face interviews were conducted between the investigators and subjects to collect the data. Before every interview, the oral consent to participate was obtained by asking the respondents whether they had time and were willing to join the survey after the introduction of the background and the purpose of the research. A total of 670 migrant elderly who follow their children were initially chosen and interviewed. However, 14 of them were excluded from the sample due to obvious logical errors in the questionnaire or uncompleted questionnaires. A total of 656 elderly individuals were eventually included in the database.

Measurements

Sociodemographic variables

Children's gender, and the gender, age, marital status, employment status, educational level and monthly income of the elderly were included as sociodemographic variables (see online supplemental file 1). The study participants were grouped into 60–69 years old, 70–75 years old or over 75 years old; marital status was first coded as currently married, unmarried, divorced, widowed or other and then recoded into the following two groups: currently married and single (including unmarried, divorced, widowed or other) for the convenience of statistical analysis; employment status was coded as employed, retired or unemployed; educational level was coded as illiterate, primary school graduate, junior middle school graduate and high school and above graduate.; and monthly income was coded as either less than 100 RMB (≈US$15.49), 101–600 RMB (≈US$92.94), 601–2000 RMB (≈US$309.81) and over 2000 RMB (≈US$309.81). We also included additional, migrant-specific characteristics to account for our unique MEFC population. These included the duration of migration, spatial type of migration, number of migrants, temporary residential permits and willingness to migrate (see online supplemental file 1). Migration duration was coded as less than 1 year, 1–2 years, 2–5 years, 5–10 years and over 10 years; spatial type of migration was coded as across districts or counties, prefecture-level cities, or the province; number of migrants was coded as alone, with spouse, with other kin, and over two members; temporary residential permits were coded as yes or no; and willingness to migrate was assessed using a 5-point scale ranging from 1 ('totally reluctant') to 5 ('totally willing').

Dependent variable

Loneliness was evaluated by an eight-item version of University of California Los Angeles Loneliness Scale (ULS-8) designed by Hays and DiMatteo.[47] They selected eight items from the revised UCLA Loneliness Scale including two reversed items.[14] Some scholars have also translated the ULS-8 into Chinese and verified the reliability and validity of the scale.[48] Each item was scored on a 4-point scale ranging from 1 ('never') to 4 ('always') (see online supplemental file 1). Total score of the ULS-8 ranges from 8 to 32—the higher the score, the lonelier the elderly are. The Cronbach's α value for the scale was 0.83.

Independent variables

Social support

Social support was measured by three questions: (a) 'what is the way of talking when you are in trouble?', (b) 'what is the way of seeking help when you are in trouble?' and (c) 'how often did you attend organised activities for groups (such as party and youth league organisations, religious organisation, trade union and so on)?'. Responses to the first question were 'never talk to anyone', 'only talk to one or two persons', 'will talk to the friend who takes the initiative to inquiry' and 'take the initiative to talk about my own troubles'. Responses to the second question were 'just rely on myself', 'rarely ask someone for help', 'sometimes ask someone for help' and 'often ask family, friends or organisations for help'. Responses to the last question were

'never attend', 'occasionally attend', 'often attend' and 'take the initiative to attend' (see online supplemental file 1). The Cronbach's α value of the above variables was 0.67.

Smartphone usage

Smartphone usage of the participants in our study was measured via their responses to two questions: (a) 'how often did you pay by WeChat or Alipay?' and (b) 'how often did you communicate with friends or relatives by WeChat?'. Respondents answered these questions on a 4-point scale ranging from 1 ('never') to 4 ('everyday') (see online supplemental file 1). The Cronbach's α value of the above variables was 0.76.

Statistical analysis

Descriptive statistics (mean and standard deviation for continuous variables and percentage for categorical variables) were used to describe the sociodemographic characteristics of the elderly. T-test or one-way Analysis of Variance (ANOVA) were used to compare the difference in loneliness among different sociodemographic variables, social support indicators and the smartphone usage indicators. Statistical significance was set at $p \leq 0.05$ and the CI was calculated at 95% level. All the analyses were conducted using SPSS V.22.0 (IBM Corp).

SEM was used to verify the statistical association between social support, smartphone usage and loneliness among the MEFC. The model established in the current study encompassed three latent variables: social support, smartphone usage and loneliness, and 13 manifest variables. The maximum likelihood estimation was conducted to obtain the parameters over the arrows. Using a bootstrap method, a 95% CI of the estimated standardised effects was calculated. The total effect, direct effect and indirect effect were deemed to be significant when zero was not included in the 95% CI.[49] Whether our proposed model was in line with the empirical data was assessed by following model fit indices, which have been employed by many previous researchers[50 51]: χ^2/df, comparative fit index (CFI), goodness fit index (GFI), adjusted goodness fit index (AGFI) and root mean square error of approximation (RMSEA). The hypothetical model would be considered as a well fitted model when χ^2/df<5, CFI>0.90, GFI>0.90, AGFI>0.90 and RMSEA<0.08 in this study. All the SEM analyses was performed using AMOS V.22.0 (IBM Corp, Armonk, New York, USA). All methods were performed in accordance with relevant guidelines and regulations.

Patient and public involvement

This study involved no patients or public in the process of design, planning and conduct of this study. The results would not be disseminated to study participants or any other individuals or communities.

RESULTS

Sociodemographic characteristics of the sample

Table 1 presents the basic demographic and loneliness information of the MEFC in this study. A total of 656 participants with the average age of 66.19±4.53 years old were included in this research. The mean score of ULS-8 among the migrant elderly was 12.82±4.05. Of all the participants, 36.3% were male, 79.4% followed their sons to Jinan City, 84.12% belonged to the 60–69 age group, 88.9% were currently married, 74.4% were unemployed and 29.9% were illiterate. Regarding monthly income, 33.7% made 0–100 RMB monthly, 23.6% made 101–600 RMB, 27% made 601–2000 RMB and 15.7% made over 2000 RMB. Table 1 also displays our study participants' migration characteristics. It showed that 35.7% elderly migrated to Jinan City for 5–10 years, 67.2% elderly migrated across the prefecture-level city, 60.1% migrated with their spouses, 64.8% did not get a temporary residential permit and 67.7% were totally willing to migrate. According to the results of t-test or one-way ANOVA, statistical differences were found among the age, monthly income, migration duration, temporary residential permit and willingness of migration groups with respect to loneliness among the MEFC in Jinan, China.

Association between independent variables and loneliness

Independent variables were measured by using five exogenous manifest variables—ways of talking in trouble, ways of seeking help in trouble, attending organised activities for groups (as shown in table 2), communication by WeChat, and payment by WeChat or Alipay (as shown in table 3). A total of 235 (35.8%) study participants chose to take the initiative to talk about their own troubles, while 174 (26.5%) subjects only talk to one or two persons when they were in trouble. Regarding the way of seeking help when in trouble, 41.6% often asked family, friends or organisations for help. Nevertheless, most of our study participants (474 elderly, 72.3%) never attended organised activities for groups and only 118 (18.0%) of them occasionally attended these activities. The common frequency of communication by WeChat was never (418 individuals, 63.7%), followed by usually (108 individuals, 16.5%) and everyday (85 individuals, 13.0%). For the frequency of payment by WeChat or Alipay, 74% of the participants answered 'never'. Moreover, the MEFC who adopted different ways to talk and seek help when in trouble, and who attended organised activities and used smartphone-based apps with different frequencies reported different levels of loneliness. Specifically, the MEFC who got higher scores on the ULS-8 shared following features. They never talk to anyone when in trouble, rarely asked someone for help when in trouble, occasionally attended organised activities for groups, and seldom communicated with others by WeChat.

Structural equation modelling analysis

Model fit indices

Figure 1 shows the result of the SEM analysis of the default model proposed in this study. This model included three latent variables: social support, smartphone usage and loneliness. Table 4 shows the indices of model fitness in this study and their cut-off criteria. Using maximum

Table 1 Demographic characteristics and the loneliness among the migrant elderly following children in Jinan, China

Variables	N (%)	Mean score of ULS-8 (SD)	T/F value	P value
Total	656 (100)	12.82 (4.05)		
Gender of the elderly				
Male	238 (36.3)	12.66 (4.14)	0.608*	0.436
Female	418 (63.7)	12.92 (4.00)		
Gender of the children				
Male	521 (79.4)	12.80 (4.09)	0.055*	0.814
Female	135 (20.6)	12.90 (3.91)		
Age				
60–69	552 (84.1)	12.82 (4.03)	3.354†	0.036
70–75	73 (11.1)	12.18 (3.92)		
Over 75	31 (4.7)	14.42 (4.40)		
Marital status				
Currently married	583 (88.9)	12.73 (4.03)	1.592*	0.112
Single‡	73 (11.1)	13.53 (4.16)		
Employment status				
Employed	37 (5.6)	12.62 (4.29)	2.416†	0.090
Retired	131 (20.0)	12.15 (3.88)		
Unemployed	488 (74.4)	13.02 (4.07)		
Educational level				
Illiterate	196 (29.9)	13.36 (4.18)	1.765†	0.152
Primary school	144 (22.0)	12.75 (3.94)		
Junior middle school	192 (29.3)	12.55 (4.04)		
High school and above	124 (18.9)	12.48 (3.97)		
Monthly income (RMB)				
Less than 100	221 (33.7)	12.66 (4.18)	9.028†	<0.001
101–600	155 (23.6)	14.23 (4.30)		
601–2000	177 (27.0)	12.21 (3.51)		
More than 2000	103 (15.7)	12.12 (3.78)		
Migration duration				
Under 1 year	69 (10.5)	13.16 (4.05)	5.247†	<0.001
1–2 years	60 (9.1)	14.02 (3.93)		
2–5 years	199 (30.3)	13.42 (4.13)		
5–10 years	234 (35.7)	12.37 (4.03)		
Over 10 years	94 (14.3)	11.68 (3.64)		
Spatial type of migration				
Across district/county	146 (22.3)	12.32 (3.66)	1.650†	0.193
Across prefecture-level city	441 (67.2)	12.92 (4.16)		
Across the province	69 (10.5)	13.26 (4.08)		
Number of migrants				
Alone	233 (35.5)	12.82 (4.06)	0.938†	0.422
Two (with spouse)	394 (60.1)	12.78 (4.05)		
Two (with other kin)	3 (0.5)	16.67 (7.64)		
Over two	26 (4.0)	13.04 (3.66)		
Temporary residential permit				

Continued

Table 1 Continued

Variables	N (%)	Mean score of ULS-8 (SD)	T/F value	P value
Yes	231 (35.2)	11.95 (3.79)	4.107*	<0.001
No	425 (64.8)	13.30 (4.12)		
Willingness of migration				
Totally reluctant	14 (2.1)	14.21 (4.89)	5.957†	<0.001
Partially reluctant	12 (1.8)	12.08 (3.45)		
Normally	34 (5.2)	14.41 (4.04)		
Partially willing	152 (23.2)	13.83 (4.16)		
Totally willing	444 (67.7)	12.33 (3.92)		

*T value.
†F value.
‡Single included those who were unmarried (1, 0.2%), divorced (5, 0.8%), widowed (58, 8.8%) and under other circumstances (9, 1.4%).
SD, Standard deviation; ULS-8, eight-item version of University of California Los Angeles Loneliness Scale.

likelihood estimation, the proposed model had a χ^2/df of 2.861, a CFI of 0.956, a GFI of 0.963, an AGFI of 0.943 and an RMSEA of 0.053, indicating that the model established in this study fitted the empirical data well.

Relationship between social support, smartphone usage and loneliness

Figure 1 and table 5 display the empirical relationship between social support, smartphone usage and loneliness. The 95% CI of the estimated standardised effects were calculated by bias-corrected percentile bootstrap method in AMOS (a bootstrap sample of 1500 was specified),[49] showing that the direct, indirect and total effects were statistically significant. Considering the relationship between social support and loneliness, social support exerted both the direct and indirect effects on loneliness and the indirect effect existed on the basis of the smartphone usage. As shown in table 5, the total effect of social support on loneliness was negative (standardised total effect was −0.165), indicating that lower levels of social support received by the MEFC were related to higher levels of loneliness. Furthermore, a negative direct and a negative indirect effect (through smartphone usage) of the social support on loneliness were observed (standardised direct effect was −0.151 and standardised indirect effect was −0.014). Regarding the relationship between smartphone usage and loneliness, a negative association was founded between them (standardised

Table 2 Social support and the loneliness of the MEFC in Jinan, China

Variables	N (%)	Mean score of ULS-8 (SD)	F value	P value
Total	656 (100)	12.82 (4.05)		
Ways of talking in trouble				
Never talk to anyone	127 (19.4)	13.61 (4.63)	5.927	0.001
Only talk to one or two persons	174 (26.5)	12.92 (4.09)		
Will talk to the friend who takes the initiative to inquiry	120 (18.3)	13.46 (4.11)		
Take the initiative to talk about my own troubles	235 (35.8)	12.00 (3.51)		
Ways of seeking help in trouble				
Just rely on myself	128 (19.5)	12.52 (4.15)	13.881	<0.001
Rarely ask someone for help	132 (20.1)	14.44 (4.21)		
Sometimes ask someone for help	123 (18.8)	13.47 (4.08)		
Often ask family, friends or organisations for help	273 (41.6)	11.89 (3.62)		
Attending organised activities for groups				
Never attend	474 (72.3)	12.75 (4.11)	6.989	<0.001
Occasionally attend	118 (18.0)	13.94 (3.96)		
Often attend	34 (5.2)	12.09 (3.47)		
Take the initiative to attend	30 (4.6)	10.47 (2.69)		

SD, Standard deviation; ULS-8, eight-item version of University of California Los Angeles Loneliness Scale.

Table 3 Smartphone usage and the loneliness among the migrant elderly following children in Jinan, China

Variables	N (%)	Mean score of ULS-8 (SD)	F value	P value
Total	656 (100)	12.82 (4.05)		
Communication by WeChat				
Never	418 (63.7)	13.02 (4.16)	5.098	0.002
Seldom	45 (6.9)	13.33 (4.27)		
Usually	108 (16.5)	13.07 (3.70)		
Everyday	85 (13.0)	11.25 (3.52)		
Payment by WeChat/Alipay				
Never	490 (74.7)	12.89 (4.12)	4.358	0.005
Seldom	35 (5.3)	13.74 (4.35)		
Usually	35 (5.3)	14.11 (4.19)		
Everyday	96 (14.6)	11.70 (3.23)		

SD, Standard deviation; ULS-8, eight-item version of University of California Los Angeles Loneliness Scale.

direct effect was −0.094), suggesting the MEFC who used their smartphones less frequently were much lonelier. As for the relationship between social support and the smartphone usage, higher levels of social support of the elderly was associated with more frequent usage of smartphones (standardised direct effect was 0.147).

DISCUSSION

This study provided evidence of the empirical relationship between social support, smartphone usage and loneliness among the MEFC in Jinan, China. Social support and smartphone usage were found to be negatively associated with loneliness. Meanwhile, social support was positively associated with smartphone usage. This means that our hypotheses were empirically supported.

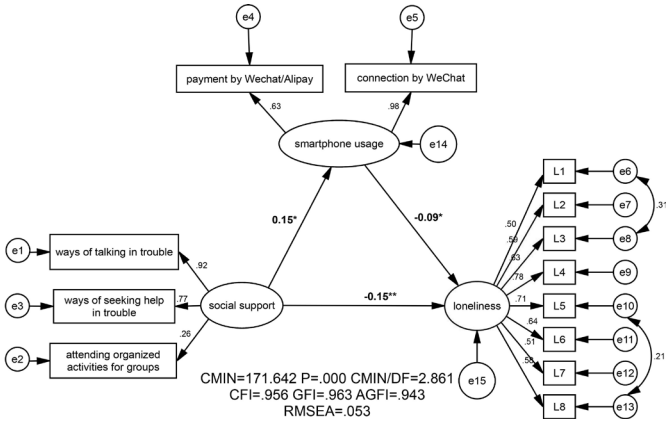

Figure 1 SEM analysis between social support, smartphone usage and loneliness among the migrant elderly following children in Jinan, China. *p≤0.05, **p≤0.01. AGFI, adjusted good-ness fit index; CFI, comparative fit index; CMIN, χ^2 value; df, degree of freedom; GFI, goodness fit index; L1-L8, the corresponding items of ULS-8, in which L3 and L6 were reversely coded; RMSEA, root mean square error of approximation.

Level of loneliness among the MEFC in Jinan, China

The average ULS-8 score was 12.82±4.05 in this study, which was much lower than the scores reported in a study of Chinese ordinary elderly who live with the spouse only (without the children).[52] One probable reason was that Confucianism culture, as the prevailing culture in China, particularly emphasises the importance of the mutual support of family members, family union and the social harmony.[53] Previous studies also showed that the Asian culture is characterised by collectivist,[54] which highlight the interdependence and mutual support between the individuals.[55] Thus, living with adult children and grandchildren to help the childcare makes the MEFC enjoy the happiness of a family union and would mitigate MEFC's loneliness to a large degree. The level of loneliness in the current study was much lower than that reported in studies of widowed elderly as well as the empty-nest elderly in China.[56 57] One possible reason was that widowhood and living alone indicated a lower level of support from family members, which usually predicts higher levels of

Table 4 The comparison of the model fit indices for the current model and the cut-off criteria

Model fit indices	Cut-off criteria	Indices for the current model	Decision
χ^2	–	171.642*	–
χ^2/df	<5	2.861	Good fitting
CFI	>0.90	0.956	Good fitting
GFI	>0.90	0.963	Good fitting
AGFI	>0.90	0.943	Good fitting
RMSEA	<0.08	0.053	Good fitting

*p≤0.001.
AGFI, adjusted good-ness fit index; CFI, comparative fit index; GFI, goodness fit index; RMSEA, root mean square error of approximation.

Table 5 The coefficient between the social support, smartphone usage and loneliness by using SEM

Model pathways	Estimated effect	95% CI	
		Lower bounds	Upper bounds
Total effect			
Social support→loneliness	−0.165	−0.257	−0.070
Direct effect			
Social support→loneliness	−0.151	−0.244	−0.053
Smartphone usage→loneliness	−0.094	−0.180	−0.003
Social support→smartphone usage	0.147	0.052	0.246
Indirect effect			
Social support→smartphone usage→loneliness	−0.014	−0.036	−0.001

CI, Confidence interval.

loneliness. Furthermore, studies have showed that decline in physical health and functional status predicted higher levels of loneliness[18] while good physical health and little limitation to the activities of daily living underlies the act of migration in our sample.

Association between social support and loneliness

Negative relationship between social support and loneliness among the MEFC in the present study was consistent with several other studies. Previous studies have revealed a significant negative association between social support and emotional loneliness among the Chinese elderly,[58] and suggested that there is a closer relationship between loneliness and subjective support than loneliness and objective support,[59] and that the number of close relatives and friends and frequent contact with them were negatively related to loneliness among the Canadian elderly.[60] The mechanism behind might lie in that social support would make a compensation for the adverse effect of stress on mental health status, facilitate alleviating negative emotions and promoting health seeking behaviours regarding loneliness.[22] However, it is probable that the MEFC faced more barriers to use the previous social support from the original residence than the local elderly did,[13] and therefore, they are forced to regain social support using smartphones or other smart electronic devices instead.

Association between smartphone usage and loneliness

Smartphone usage was found to be negatively correlated with loneliness, implying that smartphone usage could help to reduce loneliness among the MEFC. Actually, previous studies have raised two different results on the association between smartphone usage and loneliness.[61] One hypothesis suggested that smartphone usage could be useful in reducing loneliness by enhancing existing relationships and offering opportunities to form new connections via facilitating non-face-to-face social interactions.[62 63] The other indicated that smartphone usage would increase the level of loneliness because it made people displace offline interactions and social activities with online ones and lower the frequency of communication with people around.[64] A study on 1318 Japanese midlife and older adults suggested that social smartphone usage was negatively associated with loneliness while smartphone usage for entertainment was positively associated with it.[65] One explanation might lie in that the former stimulates the face-to-face interaction while the latter displaces offline social contacts, thus leading to different levels of loneliness.[66] Moreover, smartphone usage could exacerbate the level of loneliness through phone dependency as Wan *et al* found among the elderly in community day care centres.[67] However, as for the relationship between instrumental smartphone usage (electronic payment by WeChat or Alipay) and loneliness, result in the current study was inconsistent with a previous Japanese study in which a non-significant association was found between them.[65] One possible explanation may exist in the higher popularity of Alipay and WeChat in China than Japan. Once the elderly were familiar with electronic payment, it would be easier for them to adapt to urban life, thus lowering their loneliness to a large degree.

Association between social support and smartphone usage

The positive relationship between social support and smartphone usage observed in this study was consistent with prior studies. One cohort study demonstrated that there was a positive correlation between social support received by homeless elderly individuals and their access to mobile phones and the internet.[68] Another study revealed that smart technologies have a significant effect on social connectedness among senior citizens living at home.[69] Other studies have confirmed the role of information communication technology in alleviating social isolation, thus enhancing social support among the elderly.[70]

Association between social support, smartphone usage and loneliness

Relationship between social support, smartphone usage and loneliness has been described in both empirical studies and a mini-review study. A longitudinal analysis using data from three waves of *Health and Retirement Study* found that internet use was correlated with lower perceived loneliness and more social contact.[71] Another study explored the relationship between internet use and well-being (including social support, loneliness, life satisfaction and psychological well-being) using path analysis, and concluded that there was a significant positive relationship between internet use and social support and

a negative association between social support and loneliness in the elderly.[72] The underlying reason might be that older adults use smartphones to make new friends online to acquire social support and reduce their loneliness as they age, become disabled or lose their spouses or siblings.[42] Nevertheless, as for the subjects in our study, MEFC previously enjoyed different levels of social support in their hometown. Geographical distance to kin and the time-consuming liability to take good care of their grandchildren served as a severe hindrance for them to socialising. For the MEFC who owned a higher level of social support in the past, they chatted with kinship and fellows online without any location or time barriers and then hardly felt lonely.[73] For those who had a lower level of social support before, both the functions of online communication and electronic payment on smartphones were less used and a subsequent higher level of loneliness would appear. Thus, the effects of smartphone usage depend somewhat on the strength of MEFCs' existed social support networks before their migration.

Finally, this study also revealed that some sociodemographic attributes could predict higher levels of loneliness among the MEFC. Contrary to previous studies,[74 75] we found no significant difference in MEFCs' loneliness by gender. It may result from the scale used to measure loneliness.[76] Elderly aged over 75 years old had higher levels of loneliness since more complications of chronic diseases, loss of intimate relatives or friends and consequent psychological distress could occur during this age.[77] We found that elderly with a monthly income of 101–600 RMB, not those with a monthly income of 0–100 RMB were lonelier, as opposed to a previous study.[75] This might because migrant elderly have a higher proportion of economic dependence on their family members compared with the local elderly,[78] thus, what we investigated could not reflect their actual income. Half of the elderly migrated to Jinan for more than 5 years and tended to be less lonely because of the adaption to the change on lifestyle and living environment. In addition, a temporary residential permit was found to be a crucial factor to relieving loneliness because this gave the MEFC more free access to various public services.[79]

Limitations

The study has several limitations. First, smartphone usage could not be measured comprehensively because only two questions were used to evaluate it. More uses of the smartphone would be included in future studies. Second, the cross-sectional data could merely reveal correlation between social support, smartphone usage and loneliness, but was not able to prove causal relationship between different variables. Third, other variables might exert an effect between social support and loneliness among the MEFC, which needs further study in the future. Fourth, the comparison in relation to loneliness between the MEFC and the local elderly could be explored in the future studies. Fifth, three questions used for measuring social support could not contain all kinds of social support, especially support from family members. More efforts should be made to understand the relationship between family support, smartphone usage and loneliness among the MEFC.

CONCLUSIONS

The present study provided a further understanding on the empirical association between social support, smartphone usage and loneliness. Social support and smartphone usage were found to be significantly associated with loneliness among the MEFC in Jinan, China. Moreover, a significant and positive relationship between social support and smartphone usage was also clarified. Therefore, interventions concentrated on promoting social support and solving the barriers to use smart devices were recommended. Policymakers in host cities should provide MEFC and their local counterparts with equal access to social support services. Likewise, policymakers and businesses could attempt to make more smartphones available for the elderly. This could be done by subsidising their purchase of smartphones and creating policies that encourage manufacturers to make existing smart technologies and applications more suitable for the MEFC.

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