RESEARCH

The mediating and moderating effects of psychological distress on the relationship between social media use with perceived social isolation and sleep quality of late middle-aged and older adults

Ramin Shiraly[1*], Farnaz Yaghooti[2] and Mark D. Griffiths[3]

Abstract

Objectives Older adults are more likely to have poor sleep quality and be socially isolated. The present study examined the potential benefits and disadvantages of social media use (SMU) with respect to sleep quality and perceived social isolation among Iranian late-middle-aged and older adults with focus a on both the mediating and moderating role of psychological distress.

Methods A population-based cross-sectional study was conducted among 900 older community-dwellers living in Shiraz using a structured questionnaire. Social media use was assessed by estimating the frequency of social networking site visits per week. Data concerning self-rated physical health, chronic medical and mental health conditions, perceived social isolation, sleep quality, and psychological distress were also collected. Multiple linear regression was used to identify independent variables associated with outcomes. Then, mediation and moderation models were used to examine the potential mediating and moderating effects of psychological distress and SMU on their relationships with the study variables.

Results Higher social media use was associated with better sleep quality and less perceived social isolation. Nevertheless, the relationships between SMU and participants' sleep quality and perceived social isolation were largely mediated by their level of psychological distress. Furthermore, SMU had a significant moderating effect in the relationship between the psychological distress and the levels of perceived social isolation, so that participants with higher frequency of SMU per week felt less loneliness.

Conclusions The study findings suggest that SMU has a positive buffering effect regarding late middle-aged and older adults' mental health mainly through moderation of their perceived social isolation. The mediating role of psychological distress in research examining the relationship between SMU and older adults' mental health outcomes should be considered in future research.

Keywords Sleep quality, Older adults, Perceived social isolation, Social media use

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Introduction

Social media use (SMU) by older adults has increased greatly in recent years. Although SMU is thought to decline with age, findings suggest an increasing willingness of older adults to incorporate social media into their daily routines [1]. Recent reports from highly developed countries show that more than two-thirds of adults aged 65–74 years and approximately half of those aged 75 years and older regularly visit social networking sites (SNSs) [1–4]. Moreover, there is substantial debate concerning the impact of SMU on older adults' mental well-being.

In contrast to young age groups for whom a majority of related literature has focused on negative SMU-related mental health consequences [5–8], studies on the effect of SMU on older adults' health reported equivocal findings [9]. While some studies have demonstrated that higher SMU is significantly associated with better subjective psychosocial well-being, lower levels of psychological distress, perceived loneliness [10], and improved cognitive function [11], other studies reported no association or a negative association. For example, a study from the United States reported a significant association between SMU and mental distress but no relieving effect of SMU on older adults' loneliness [12].

With regards to the relationship between SMU and depression among older adults, some studies have reported significant associations whereas others have found little or no association [13]. These varied study results can be explained by methodological differences in the research design including age definition of older age groups, participants' recruitment methods, various measurements of internet use (including all SNSs and technology-based communication systems [e.g., e-mail]), and utilizing different scales to assess mental health [2, 14].

Understanding how SMU may impact the mental well-being of older adults is of paramount importance, particularly if it affects important aspects of mental health. A significant proportion of older adults face at least two major mental health issues during aging including poor sleep quality and social isolation. It is estimated that as much as half of older adults suffer from sleep initiation and maintenance problems [15, 16]. Reduced depth and duration of sleep with spontaneous arousal and prolonged awakening are characteristics of sleep patterns during aging [17]. Although older adults typically report higher levels of satisfaction with their social relationships, they are more likely to have smaller social networks and fewer social interactions [18]. Social isolation is usually referred to an objective state representing low frequency of relationships and contacts with others. However, loneliness or perceived social isolation is a subjective state where an individual feels a discrepancy between actual and desired levels of social relationships [19]. Therefore, feelings of loneliness are not necessarily caused by being alone, but reflect feelings of disconnectedness and not belonging [20]. Poor sleep quality and poor social interactions (especially subjective social isolation) have been found to negatively impact older adults' behaviors, mental health, and physical well-being [21–23].

Social isolation and loneliness are the most extensively investigated mental health outcomes of SMU among older adults. The majority of previous studies support the assumption that using online social networking sites has a direct positive impact on reducing the feelings of loneliness and perceived social isolation and indirectly affects feelings of social well-being through improving social capital. However, some studies have reported inconclusive results and some have reported the negative impact of problematic SMU on feelings of social connectedness [2, 24]. Studies which have specifically investigated the associations between SMU and sleep quality among older adults are scarce. A study by Tian et al. [25] reported a positive association between mobile phone addiction and poor sleep quality among older adults. Additionally, related studies on adults suggest a negative impact of nighttime portable electronic device use on sleep quantity and quality [26, 27].

In the conceptual framework of the present study, SMU may have a direct relationship with sleep quality and perceived social isolation as two important health outcomes among older adults. Additionally, psychological distress is a major influencing factor that may have a relationship with these aforementioned outcomes. Previous studies show that psychological distress has been consistently reported as a significant predictor of sleep quality [16, 28, 29] and social and emotional loneliness [30–32] among older adults. Moreover, there have been numerous reports suggesting that frequent SMU can impact perceived social isolation [12, 33–35], and sleep quality [25–27, 36–38].

The aim of the present study was to examine the relationships between older adults' psychological distress and frequency of SMU with their sleep quality and perceived social isolation. The target population included individuals aged 60–80 years that could be considered as late middle-aged adults (age range between 55 and 64 years) and older adults (aged 65 years and older). Mediation and moderation models were used to test the mediating and moderating effects of psychological distress on the relationship between the frequency of SMU as the independent variable (X) and the mental health outcome (sleep quality/perceived loneliness) as the dependent variable (Y). A mediated (indirect) effect is defined as a situation where the effect of one variable to another variable

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is partially or totally determined through a third variable (mediator) [39]. A moderation effect means that the effect of an independent variable on a dependent variable depends upon the levels of a third variable (moderator) [40].

Given the relative lack of research on this topic, it was hypothesized that: (i) SMU would predict sleep quality and perceived social isolation (H_1), (ii) psychological distress would predict sleep quality and perceived social isolation (H_2), (iii) SMU would mediate/moderate the relationship between psychological distress and sleep quality (H_{3a}) or perceived social isolation (H_{3b}), and (iv) psychological distress would mediate/moderate the relationship between SMU and sleep quality (H_{4a}) or perceived social isolation (H_{4b}).

Methods

Study setting and participants

A cross-sectional study was conducted from August to October 2022. Eligible participants were late-middle-aged and older adults aged 60–80 years living in Shiraz, Southern Iran. The inclusion criteria were: (i) being aged 60–80 years and residing in urban Shiraz; (ii) having internet access; (iii) ability to understand the content of the survey; and (iv) willingness to participate. The exclusion criterion was having a self-reported diagnosis of severe psychiatric and/or neurological disease which could affect sleep quality.

The required sample size (confidence level = 95%, margin of error = 5%, estimated population size = 120,000 and design effect = 2) was calculated to be 900 individuals. Older community dwellers including 434 males and 466 females (mean age = 67.5 years [SD ± 5.8]) were recruited based on a household survey conducted through face-to-face interview within urban neighborhoods of the city using a multi-stage cluster sampling approach. First, municipal areas of the city were numbered and six (out of 11) regions were randomly selected. In the next stage, a total of 19 neighborhoods were randomly selected from municipal regions proportional to their population size. In the final stage, 50 participants were randomly selected from each neighborhood. Within the neighborhoods, a list of households who had eligible members according to age was prepared and a simple random selection procedure was applied. For each selected household, if there was more than one eligible person, one of them was randomly selected. The enrollment process was continued until the required sample size was attained. Before the interview, participants were given a verbal explanation regarding study objectives and all participants provided written informed consent. Complete anonymity and data confidentiality was guaranteed. The study was approved by Shiraz University's Ethics Committee (Ref: IR.SUMS.MED.REC.1400.213).

Measures

Basic demographic information: This included age, gender, marital status (single or married), working status (working versus retired/housewife), educational level (low education < 12 years of schooling versus high education ≥ 12 years), and living status (lived alone or with others).

Self-rated physical health: This was assessed by a single question: (*"How would you generally rate your current physical health?"*) rated on a five-point scale from 1 (*poor*) to 5 (*excellent*).

Chronic medical conditions: This was assessed by asking participants if they had any common chronic medical conditions (e.g., hypertension, heart disease, stroke, cancer, etc.).

Frequency of social media use per week: This was assessed by asking participants to indicate how frequently they visited social media during a typical week: (i) never, (ii) less than once per week, (iii) 1–2 times per week, (iv) 3–6 times per week, (v) almost daily, (vi) 2–4 times per day, or (vii) ≥ 5 times per day. Participants were also asked to name specific social media platforms they visited at least once per week during the past month.

Average time spent on social media use per day: Participants were asked how much time they spent on social networking sites for personal purposes during a typical day: (i) 0–30 min, (ii) 31–60 min, (iii) 61–120 min, or (iv) > 120 min.

Social media use in bed before sleep: Participants were asked how often they used social media platforms in bed before going to sleep: (i) never, (ii) rarely, (iii) sometimes, (iv) often, or (v) always.

Self-reported history of diagnosed depression/anxiety: To assess this, participants were asked if they had ever been diagnosed with depression and/or anxiety by a primary care physician or a psychiatrist (yes/no).

Depression, anxiety and stress: The 21-item Persian version of the Depression, Anxiety and Stress Scale (DASS-21) was used to assess the current level of depression, anxiety, and stress during the past week assessed via three subscales [41]. Items are rated on a four-point scale from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). Total score is calculated by summing up all item scores where a higher score indicating more psychological distress. In addition to a total score for the whole scale, subscales scores were calculated to determine the presence of depression, anxiety, and stress among participants. It has been demonstrated that the DASS-21 tool has robust psychometric properties among a wide range of ages including older adults

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[42]. As a previous study showed that the DASS-21 can be used as a general score of psychological distress [43], in the present study's analyses, the total scale score was used as an overall measure of psychological distress. The McDonald omega coefficient of the whole scale in the present study was 0.92.

Sleep quality: The 19-item Persian version of the Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality over a one-month period [44]. The scale has seven domains comprising subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Items are rated from 0 (*no difficulty*) to 3 (*severe difficulty*). Scores range from 0 to 21 with higher scores indicating poorer sleep quality. A total PSQI score ≤ 5 indicates good sleep quality. Both global scores and component scores such as sleep latency show high test–retest reliability [45]. The McDonald's omega coefficient in the present study was 0.85.

Perceived social isolation: The 20-item Persian version of the UCLA Loneliness Scale–Revised (UCLA-R) was used to assess perceived social isolation [46]. Items are rated on a scale from 1 (*never*) to 4 (*often*). Scores range from 20 to 80, with higher scores indicating greater perceived loneliness [47, 48]. Also, to describe the distribution of high perceived social isolation among the study population, total UCLA-R scores were dichotomized based on previous findings suggesting that scores ≥ 47 represent a higher than normal level of perceived loneliness [49]. The McDonald's omega coefficient in the present study was 0.836.

Statistical analysis

Demographic characteristics were analyzed as frequencies/percentages for categorical variables and means/standard deviations for numerical variables. The Shapiro–Wilk test was used to assess normality of the data. Independent-samples *t*-tests were used to assess significant differences between the study variables. Pearson correlation tests were used to assess relationships between age, PSQI scores, frequency of SMU, and UCLA-R scores. Multiple linear regression analysis was performed to determine independent variables associated with sleep quality and perceived social isolation. When building the regression models, each of the variables listed above were evaluated in bivariate models, and those with *p*-values < 0.10 were considered for inclusion in the final regression analysis. Moderation and mediation analyses were conducted using Hayes' process macro (Models 1 & 4) with 5000 bootstrap samples. The mediating/moderating influence was considered positive if the *p*-value was < 0.05 and 95% confidence level of B statistic

did not include zero. SPSS v.26 (IBM, United States) was used for all statistical analysis (significance level *p* < 0.05).

Results

The majority of the participants were married (87%) and retired/housewife (71%). More than half had less than 12 years of education (57%). Approximately 4% had a history of diagnosed depression/anxiety within the past year. With regard to SMU frequency, more than half of the participants reported using social media at least once per day (53%) and 16.1% reported using social media platforms more than five times per day. Regarding average daily time spent on social media, more than one-third of participants reported visiting social networking sites between half an hour to 2 h (40.3%) and more than one-fifth reported more than 2 h of SMU per day (21.1%). Just under one-third of participants reported visiting social networking sites in bed before sleep most times or always (30.5%). The most common social media platforms used by participants during past month were *WhatsApp* (70.6%), *Instagram* (54%), *Telegram* (32.5%), *Twitter* (21.3%), *YouTube* (20.4%), *LinkedIn* (8.8%) and *Facebook* (5.9%), respectively.

Table 1 shows distribution of PSQI and UCLA-R scores according to the study variables. Approximately one-quarter (26%) reported poor sleep quality. PSQI scores ranged from 0–16 (mean = 4.2; SD ± 2.6). There were no significant differences between PSQI scores and their marital status, job status, educational level or living condition (*p* > 0.05). However, PSQI scores were significantly different for age (*p* = 0.008), gender (*p* = 0.021), frequency of SMU (*p* < 0.001), history of diagnosed depression/anxiety (*p* = 0.003), self-rated physical health (*p* = 0.003), and current depression, anxiety or stress (*p* < 0.001).

More than a quarter of participants (28.6%) reported high perceived social isolation. UCLA-R scores ranged between 20 and 62 (mean = 40.2; SD ± 8.3). UCLA-R scores were significantly different for age (*p* = 0.040), gender (*p* = 0.001), educational level (*p* < 0.001), living condition (*p* < 0.001), frequency of SMU (*p* < 0.001), history of diagnosed depression/anxiety (*p* = 0.041), self-rated physical health (*p* < 0.001), and current depression, anxiety or stress (*p* < 0.001). There were no significant differences between UCLA-R scores and their marital or job status (*p* > 0.05) (Table 1). Based on DASS-21 scores, 26.3% had depression, 41.5% had anxiety, and 10.8% stress.

Psychological distress was positively correlated with perceived loneliness and sleep quality (Table 2). Frequency of SMU was negatively correlated with perceived social isolation and sleep quality. There was also a negative correlation between frequency of SMU and psychological distress. Regarding covariates, there was weak positive correlations between age and psychological

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Table 1 Characteristics of study participants based on their sleep quality and perceived loneliness ($N = 900$)

Characteristics	Sleep quality index score# (mean ± SD)	UCLA loneliness score# (mean ± SD)
Demographics		
Age		
< 68 years	4.0 ± 2.6**	39.7 ± 8.6*
≥ 68 years	4.4 ± 2.5	40.9 ± 7.9
Gender		
Male	3.9 ± 2.5*	39.3 ± 8.3**
Female	4.3 ± 2.6	41.1 ± 8.2
Marital status		
Married	4.1 ± 2.6	40.1 ± 8.3
Single	4.4 ± 2.5	41.4 ± 7.9
Work status		
Working	4.1 ± 2.4	40.6 ± 9.0
Retired/Housewife	4.2 ± 2.6	40.1 ± 7.9
Educational level		
Low education (< 12 years)	4.2 ± 2.5	41.9 ± 7.7***
High education (≥12 years)	4.1 ± 2.6	38.1 ± 8.6
Living condition		
Alone	4.8 ± 3.1*	45.2 ± 5.8***
With partner / other family members	4.1 ± 2.5	39.7 ± 8.4
Social media use (SMU)		
Frequency of SMU		
No use to 3-6 times a week	4.6 ± 2.8***	43.1 ± 7.2***
Every day to > 5 times per day	3.7 ± 2.2	37.7 ± 8.4
Physical/mental health problems		
Self-rated physical health, n (%)		
Poor to moderate	4.4 ± 2.7*	42.0 ± 7.9***
Good to excellent	4.0 ± 2.4	38.8 ± 8.3
History of chronic disease, n (%)		
No	3.8 ± 2.6	41.6 ± 8.9**
Yes	4.2 ± 2.5	39.8 ± 8.0
History of diagnosed depression		
No	4.1 ± 2.5**	40.1 ± 8.3*
Yes	5.8 ± 3.5	43.1 ± 6.8
Current psychological state (assessed by DASS-21)		
Depression		
No	3.6 ± 2.1***	38.6 ± 8.4***
Yes	5.6 ± 3.0	44.9 ± 5.9
Anxiety		
No	3.5 ± 2.1***	36.9 ± 8.0***
Yes	5.0 ± 2.8	44.9 ± 6.1
Stress		
No	3.8 ± 2.3***	39.6 ± 8.3***
Yes	6.8 ± 2.9	45.5 ± 6.0

*($p < 0.05$), **($p < 0.01$), ***($p < 0.001$)

Higher mean scores indicate poorer sleep quality/higher perceived loneliness

DASS-21 Depression Anxiety Stress Scale-21 items

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Table 2 Correlations between age, psychological distress (DASS-21 scores), perceived loneliness (UCLA-R scores), and sleep quality (PSQI scores) (n = 900)

Variable	Analysis	Age	SMU	DASS-21	PSQI	UCLA-R	SRPH
Age	Coefficient	1					
	p-value[*]	-					
SMU	Coefficient	-0.331	1				
	p-value	<0.001[*]	-				
DASS-21	Coefficient	0.115	-0.284	1			
	p-value	0.001	<0.001[*]	-			
PSQI	Coefficient	0.097	-0.162	0.473	1		
	p-value	0.004	<0.001[*]	<0.001[*]	-		
UCLA-R	Coefficient	0.080	-0.314	0.508	0.201	1	
	p-value	0.016	<0.001[*]	<0.001[*]	<0.001[*]	-	
SRPH	Coefficient	-0.236	0.363	-0.153	-0.082	-0.160	1
	p-value	<0.001[*]	<0.001[*]	<0.001[*]	0.013	<0.001[*]	-

[*] *p*-values significant at the 0.01 level (2-tailed)

SMU Frequency of social media use, *PSQI* The Pittsburgh Sleep Quality Index, *DASS-21* Depression Anxiety Stress Scale, 21-item, *UCLA-R* UCLA Loneliness Scale-Revised, *SRPH* Self-rated Physical Health

distress, perceived social isolation, and sleep quality, and a low negative correlation between age and frequency of SMU. Additionally, self-rated physical health was positively correlated with frequency of SMU and negatively correlated with DASS-21, PSQI and UCLA-R scores.

Table 3 provides results of the bivariate and multivariate regression analyses of independent factors associated sleep quality among participants. Bivariate analysis showed that age, gender, living condition, history of chronic disease, history of diagnosed depression/anxiety, frequency of SMU, and psychological distress were associated with poor sleep quality. However, results of multiple regression analysis showed that psychological

distress was the only significant variable that independently predicted sleep quality among participants ($p < 0.001$). This finding suggests that the association of SMU with sleep quality was probably mediated by levels of psychological distress.

Results of bivariate and multivariate regression analysis of factors associated with perceived social isolation showed that educational level ($p < 0.001$), living condition ($p = 0.022$), psychological distress ($p < 0.001$), history of chronic disease ($p < 0.001$) and SMU, all were significantly associated with participants' perceived social isolation (Table 4). Mediation and moderation analysis of interactions between SMU and psychological distress

Table 3 Regression analysis of factors associated with sleep quality among older adult participants

Factors	Bivariate model		Multivariate model	
	β (95% CI)	*p*-value	β (95% CI)	*p*-value
Age	0.03 (0.01–0.07)	0.015	-0.02 (-0.03–0.02)	0.877
Gender	0.39 (0.06–0.73)	0.021	0.07 (-0.23–0.37)	0.638
Marital status	0.37 (-0.12–0.87)	0.140	-	-
Job status	0.15 (-0.06–0.36)	0.153	-	-
Educational level	-0.03 (-0.19–0.14)	0.726	-	-
Living condition	-0.71 (-1.27– -0.14)	0.015	0.16 (-0.36–0.68)	0.541
Self-rated physical health	-0.33 (-0.55– -0.12)	0.003	-0.01 (-0.22–0.21)	0.954
History of chronic disease	0.36 (-0.05–0.76)	0.082	0.35 (-0.03–0.73)	0.070
History depression/anxiety	1.86 (0.88–2.64)	<0.001[*]	0.83 (0.03–1.63)	0.042[*]
Social media use	-0.18 (-0.26– -0.11)	<0.001[*]	-0.03 (-0.10–0.05)	0.491
Psychological distress	0.14 (0.12–0.15)	<0.001[*]	0.13 (0.11–0.15)	<0.001[*]

[*] statistically significant

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Table 4 Regression analysis of factors associated with perceived social isolation among older adult participants

Factors	Bivariate model		Multivariate model	
	β (95% CI)	*p*-value	β (95% CI)	*p*-value
Age	0.15 (0.05–0.24)	0.002	-0.02 (-0.09–0.08)	0.971
Gender	1.74 (0.66–2.82)	0.002	0.01 (-0.94–0.95)	0.995
Marital status	1.29 (-0.32–2.91)	0.116	-	-
Job status	-0.51 (-1.71–0.68)	0.401	-	-
Educational level	-2.30 (-2.81–-1.79)	<0.001*	-1.35 (-1.90–-0.80)	<0.001*
Living condition	-5.42 (-7.23–-3.60)	<0.001*	-1.89 (-3.51–-0.28)	0.022*
Self-rated physical health	-0.33 (-0.55–-0.12)	0.003	0.08 (-0.59–0.76)	0.802
History of chronic disease	-1.78 (-3.09–-0.47)	0.008	-2.48 (-3.65–-1.32)	<0.001*
History depression/anxiety	2.97 (0.09–5.86)	0.043	-2.01 (-4.49–0.48)	0.113
Social media use	-1.15 (-1.38–-0.92)	<0.001*	-0.42 (-0.68–-0.16)	0.002*
Psychological distress	0.45 (0.39–0.51)	<0.001*	0.39 (0.34–0.45)	<0.001*

*: statistically significant

on study outcomes are presented in Table 5. Consistent with the results of multiple linear regression analysis, both frequency of SMU and psychological distress were significantly associated with sleep quality and perceived social isolation (therefore, H_1 and H_2 were supported).

With respect to the role of social media, SMU neither mediated nor moderated the association between psychological distress and sleep quality (therefore, H_{3a} was not supported). In contrast, SMU both mediated and moderated the association between psychological

Table 5 Results of hypotheses testing by mediation/moderation analysis

Hypothesis		Coefficient	LLCI	ULCI	P value	Supported
H1	SMU → PSQI	-0.185	-0.260	-0.111	0.000*	Yes
	SMU → UCLA	-1.152	-1.386	-0.919	0.000*	Yes
H2	DASS → PSQI	0.136	0.120	0.153	0.000*	Yes
	DASS → UCLA	0.451	0.397	0.505	0.000*	Yes
H3	(a) DASS → SMU (mediate) → PSQI					No
	Total effect	0.1321	0.1149	0.1493	<0.001*	
	Direct effect	0.1311	0.1136	0.1487	<0.001*	
	Indirect effect	0.0010	-0.0024	0.0046		
	(a) DASS→ SMU (moderate) → PSQI	-0.0413	-0.1444	0.0619	0.4327	No
	(b) DASS → SMU (mediate) → UCLA					Yes
	Total effect	0.4079	0.3538	0.4621	<0.001*	
	Direct effect	0.3931	0.3385	0.4480	<0.001*	
	Indirect effect	0.0149	0.0045	0.0292		
	(b) DASS → SMU (moderate) → UCLA	-0.9250	-1. 2709	-0.5791	<0.001*	Yes
H4	(a) SMU → DASS (mediate) → PSQI					Yes
	Total effect	-0.1309	-0.2147	-0.0472	0.0022*	
	Direct effect	-0.0220	-0.0986	0.0547	0.5738	
	Indirect effect	-0.1090	-0.1518	-0.0707		
	(a)SMU → DASS (moderate) → PSQI	-0.0001	-0.0079	0.0079	0.9971	No
	(b) SMU → DASS (mediate) → UCLA					Yes
	Total effect	-0.7423	-1.0312	-0.4533	<0.001*	
	Direct effect	-0.3942	-0.6602	-0.1281	0.0037*	
	Indirect effect	-0.3481	-0.4724	-0.2327		
	(b) SMU → DASS (moderate) → UCLA	0.1881	0.0858	0.2904	0.0003*	Yes

*p-values significant at the 0.05 level, LLCI/ULCI: Lower/Upper limit 95% Confidence Interval

SMU Frequency of social media use, *PSQI* The Pittsburgh Sleep Quality Index, *DASS-21* Depression Anxiety Stress Scale, 21-item, *UCLA-R* UCLA Loneliness Scale-Revised

distress and perceived social isolation (therefore, H_{3b} was supported). However, the mediating effect was negligible (just 4% of this association was mediated by SMU) (Figs. 1, and 2). Overall, these findings suggest that the SMU had a buffering effect on older adults' mental health mainly through moderating their perceived social isolation.

Regarding the role of psychological state, the results showed that psychological distress had a powerful mediating role, comprising 83% of the association between SMU and sleep quality (therefore, H_{4a} was supported regarding the mediating effect). This finding suggests that the association between SMU and sleep quality was largely mediated by the individual's psychological state. Furthermore, psychological distress had both mediating and moderating effect on the association between SMU and perceived social isolation (therefore, H_{4b} was supported). Psychological distress
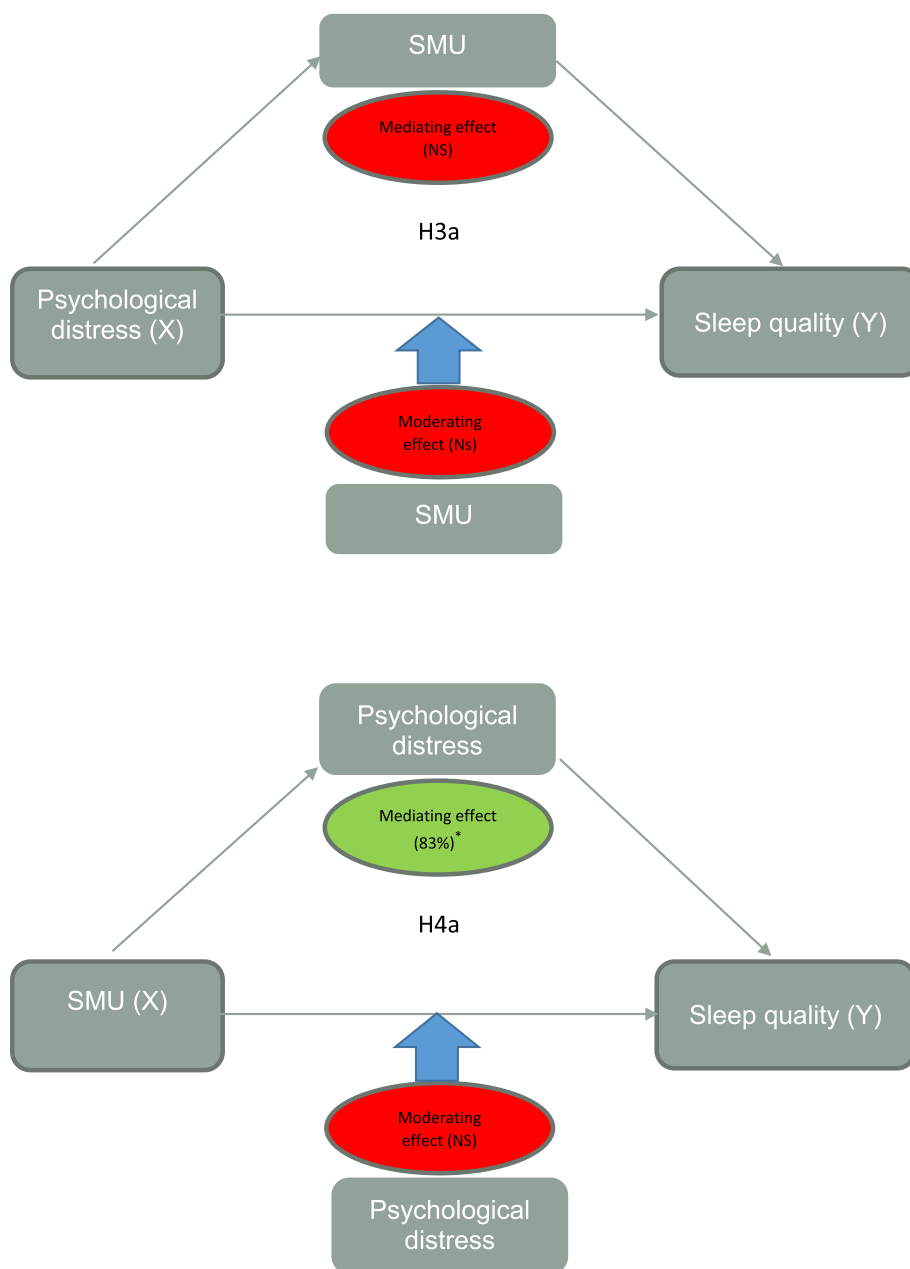

Fig. 1 Mediating and moderating effects of Social media use (SMU) and psychological distress on their relationships with sleep quality among the participants. (*: Statistically significant, NS: not significant)
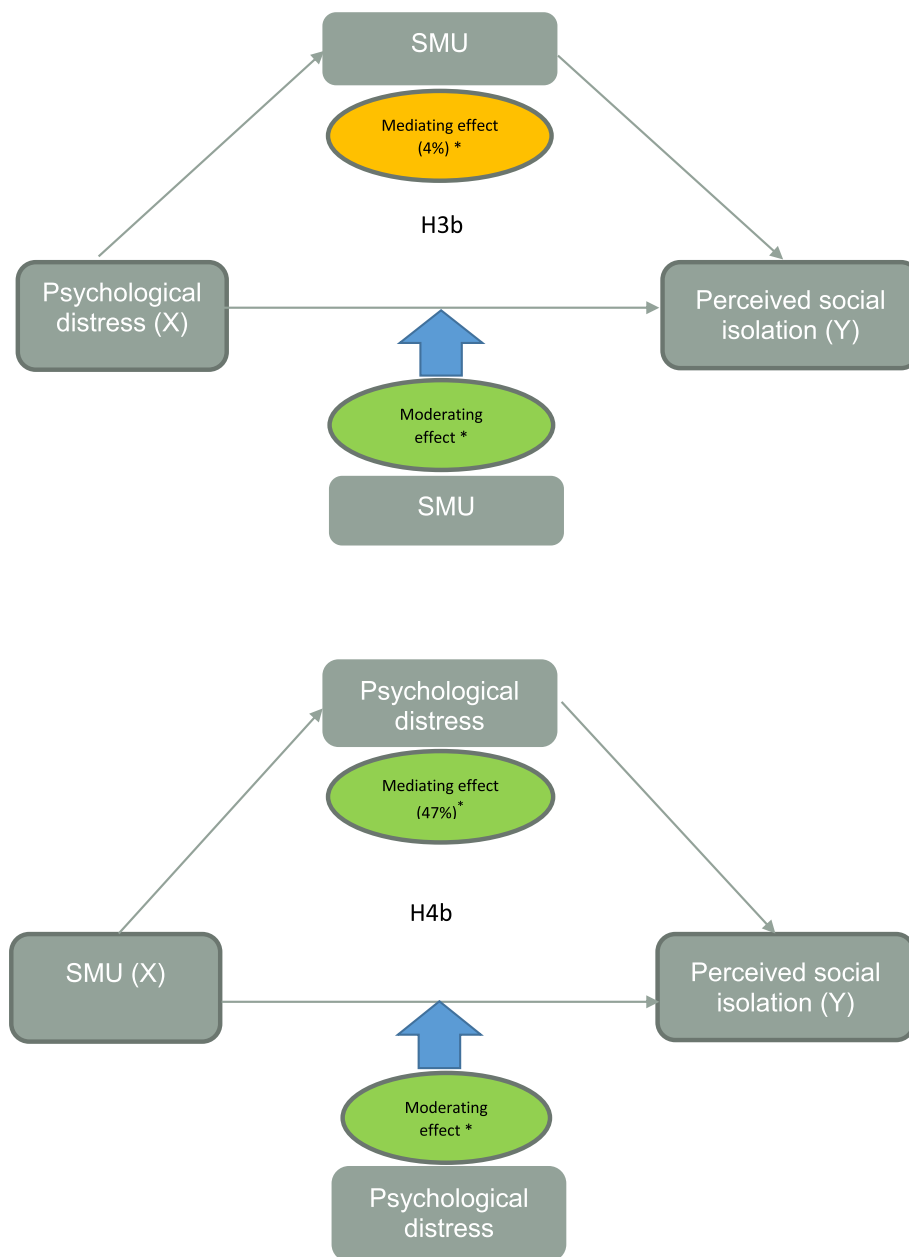
Fig. 2 Mediating and moderating effects of Social media use (SMU) and psychological distress on their relationships with perceived social isolation among the participants. (*: Statistically significant, NS: not significant)

accounted for just under half of this association (47%). This suggests that the psychological state is an important determinant of how SMU affects older adults' perceived loneliness.

Discussion

The present study examined the associations between SMU and two important mental health outcomes among older adults accompanied by interactions with psychological distress as a major influencing covariate. From a methodological point of view, it presents one of the few related studies dealing with multiple potential relationships based on mediation and moderation analyses. The study showed that greater SMU was associated with lower perceived social isolation, better sleep quality, and better self-rated physical health. However, these relationships were significantly mediated by the psychological state of the individual. The findings

provide support for the role of psychological distress as a key indicator in how SMU could affect older adults' sleep quality and perceived loneliness.

Some previous studies have similarly reported a positive effect of SMU on older adults' mental health [50] including a positive sense of well-being and greater life satisfaction [24, 51, 52] and less depressive symptoms [53]. In contrast, there have been reports on a negative correlation between SMU and older individuals' mental well-being [54]. Specifically considering sleep-related outcomes, some studies have reported a negative impact of SMU, especially in bed use, on both sleep quality and quantity [26, 27]. However, the majority of these studies were conducted with young individuals or individuals with a wide age range and did not specifically focus on older adults [7, 8, 55, 56]. The present study's results suggest that the relationship between SMU and sleep quality among late-middle-aged and older adults is largely dependent on an individual's psychological state. Therefore SMU may have either positive or negative effect on sleep quality based on pre-existing psychological distress. In line with the findings of the present study, a systematic review reported depressed mood and physical illness as the most consistently identified modifiable risk factors for older adults' sleep disturbances [16] and there are some reports of the positive effect of SMU on mental health-related factors, such as cognitive function, life satisfaction, perceived social isolation, and depression, which can all influence sleep quality [2, 35].

The present study's findings showed that *WhatsApp* was the most frequently visited social media platform among Iranian late-middle-aged and older adults. A previous population-based study in Iran [57] similarly reported *WhatsApp* as the most commonly visited social media platform among Iranian population. This platform is one of the most popular social media platforms among Iranians with multipurpose uses such as delivering multimedia content (photos and videos), receiving news and ideas and providing comments on them, and building social groups (family members, friends, business and academic groups). Therefore, *WhatsApp* use may be a good reflection of Iranian individuals' social media activity.

Overall, it appears that social media use by older adults is a complex issue that may have both positive and negative mental health outcomes through multiple influencing factors with unidirectional or bidirectional relationships. While SMU may decrease time spent with family [26], its effect on mental health outcomes varies depending on the presence of other influencing variables such as pre-existing mood states and the type of social media utilized [24, 34].

As findings showed the dual potential of SMU in mental well-being of older adults and its relationship

with psychological distress, strategies to reduce social isolation and to improve sleep quality must be tailored accordingly. Negative psychological states including depressed mood have been reported as the most consistently identified modifiable risk factors for older adults' sleep disturbances [16] and perceived loneliness [58]. Therefore, diagnosis and management of depressive and anxiety states may help them to have a more beneficial use of social media and feel less subjective social isolation. Strategies to relieve psychological distress among older adults can promote their mental health, improving their cognitive function, life satisfaction, sleep quality, and perceived loneliness [2, 35].

The present study highlighted the pivotal role of psychological state in how SMU may affect late-middle-aged and older adults' mental health (85% of association between SMU and sleep quality, and approximately half of the association with perceived loneliness were mediated by the participants' psychological state). Therefore, studies on this topic should consider the potential mediating effect of psychological distress when assessing the impact of SMU on mental health outcomes. Additionally, given the strong influence of psychological distress in the relationship between SMU and mental health outcomes, future studies should examine how SMU could be more pleasurable and satisfying among middle-aged and older adults, and how SMU may improve sleep quality and perceived loneliness among psychologically distressed older adults. Moreover, future studies need to address the effect of specific social media content on the mental health of older adults.

The present study was conducted on a population-based sample of older adults. Using a multi-stage cluster random sampling procedure resulted in the recruitment of individuals with different residential, educational and occupational characteristics which could be considered as proxies to selecting a socio-economically representative sample. Given the public health implications of older adults' mental health, the study may help clarifying the controversies regarding the direction and strength of potential associations between SMU, psychological distress, sleep quality, and perceived loneliness among this vulnerable age group. Some cross-sectional studies have reported associations between the aforementioned variables. However, in the majority of these studies the direction of associations and various interactions between influencing covariates were not evaluated.

Limitations
As a cross-sectional study with a modest sample size, the findings may be not generalizable to other populations.

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The identified associations cannot necessarily attribute causality; therefore, longitudinal studies are needed to confirm the associations. Moreover, older adults who did not have access to internet were not included in the study, so the comparison of the mental health status of these two groups was not possible. All the data were self-report which are subject to a number of well-known methods biases. For example, participants' history of diagnosed psychiatric disorders was based on self-report rather than a medical examination, and just included diagnoses by physicians (not clinical psychologists). Therefore, the actual prevalence might be underestimated. Additionally, social media use was assessed as a single variable and associations with respect to specific social media platforms were not evaluated. These limitations should be taken into account when interpreting the study's main findings.

Conclusion

SMU has a positive relationship with older adults' mental health mainly through moderating perceived social isolation. However, this relationship is highly dependent on individuals' psychological state. Further longitudinal studies are needed to verify these potential relationships.

Authors' contributions
RS conceived the presented idea, reviewed the literature and prepared the primary manuscript. FY contributed in the study design, data gathering and analysis. MDG contributed in reviewing and writing drafts and critically appraising the manuscript. All the authors read and approved the final manuscript.

Availability of data and materials
The datasets generated and/or analyzed during the present study are not publicly available due to institutional regulations and privacy restrictions but are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The protocol was approved by the Shiraz University's Ethics Committee (IR. SUMS.MED. REC.1400.213). All methods were carried out in accordance with the Declaration of Helsinki. The informed consent was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no conflict of interest.

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