

Supplementary Table 1. Review of studies on the relationship between Internet use and depression.

Study, location	Study design, sample size	Outcome
Internet use as a risk factor		
Nie et al., (2017), China.	A cross-sectional study, data from the China Family Panel Studies (CFPS) 2010, 4,686 participants (Internet users aged 16-60).	Internet use predicted higher levels of depressive symptoms among all age groups.
Internet use has no effects		
Elliot et al., (2014), USA.	A cross-sectional study, data from the National Health and Aging Trends Study (NHATS) 2011, 6,443 participants (aged ≥ 65).	Internet use was unrelated to depressive symptoms.
H. Y. Lee et al., (2018), USA	A cross-sectional study, data from the NHATS 2011, 1,411 participants (aged ≥ 65 , Cancer survivors).	Internet use was unrelated to depressive symptoms. E-mail use was associated with decreased risk for severe depressive symptoms.
Lifshitz et al., (2018),	A cross-sectional study, data from the online survey, 306 participants	All four online functions use was unrelated to depressive

Israel. (aged ≥ 50 , Internet users). symptoms.

Internet use as a protective factor

Cotten et al., A cross-sectional study, data from Internet use reduced the
(2012), the Health and Retirement Survey probability of a depressed
USA. (HRS) 2006, 7,839 participants state by about 20-28%.
(retired, aged ≥ 50)

Cotten et al., A Longitudinal study, data from the Internet use reduced the
(2014), HRS 4 waves (2002-2008), 3,075 probability of a depressed
USA. participants (retired, aged ≥ 50) state by 33%.

Chopik, A cross-sectional study, data from Internet use for social
(2016), the HRS 2012, 591 participants connection was associated
USA. (aged ≥ 50) with lower levels of
depressive symptoms.

Jun & Kim, A longitudinal study, data from the Internet use was associated
(2016), Korean Welfare Panel Study 4 with lower levels of
Korea. waves (2012-2015), 6,306 depressive symptoms.
participants (aged ≥ 50)

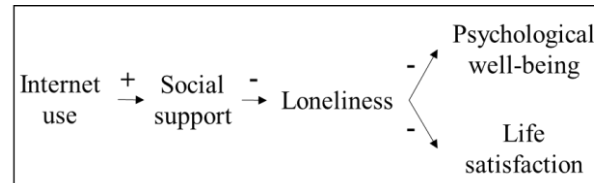
M. A. Lee et A cross-sectional study, data from Internet use was associated
al., (2020), the Survey of Living Conditions with lower levels of
Korea. and Welfare Needs of Korean Older depressive symptoms.
Persons 2017, 10,055 participants
(aged ≥ 65)

Yuan, (2020), A cross-sectional study, data from Internet use was associated
China. the Shanghai Urban Neighborhood with lower odds of having
Survey, 2,117 participants (aged mental health problems.
60-80)

Supplementary Table 2. Mechanisms of Internet use and depressive symptoms among older adults.

Study, location	Mechanisms		Study design	Outcome
Cotten et al., (2014), USA.	Using the Internet for maintaining interpersonal communication can overcome the social and spatial boundaries, increase social contact, reduce social isolation, increase social support, and reduce loneliness, then decline the depressive symptoms.	<pre> graph LR A[Internet use] -- "-" --> C[Depressive symptoms] B[Household size] -- "+" --> A_C_path style A_C_path width:0px,height:0px </pre>	A Longitudinal study, data from the Health and Retirement Survey (HRS) 4 waves (2002-2008), 3,075 participants (retired, aged ≥ 50).	Internet use reduced the probability of a depression and state by about 33%. Reduction in depression largest for people living alone.

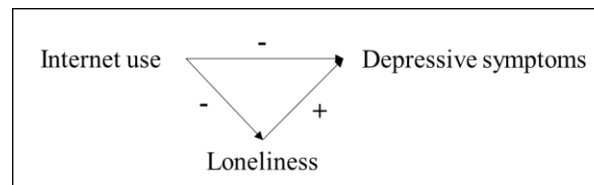
Heo et al., (2015), USA. Internet use links older adults with their family and friends, in turn,



increases social support, reduce loneliness, then promotes psychological well-being and life satisfaction.

A cross-sectional study, data from the Health and Retirement Survey (HRS) 2008, 5,203 participants (aged ≥ 50). Social support and loneliness were mediators between Internet use and indicators of well-being.

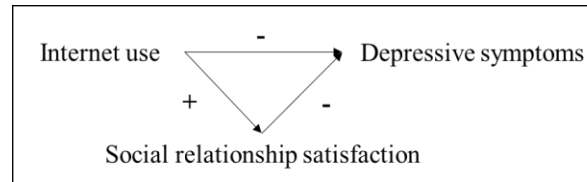
Chopik, (2016), USA. Internet use reduces loneliness by supporting exsisting social



activities with friends and enhanceing touch with new people, then reduces depressive symptoms. Internet use also reduces depressive symptoms by enhances convenience in life domains.

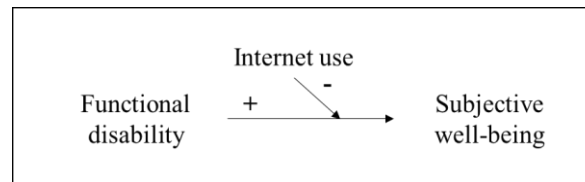
A cross-sectional study, data from the Health and Retirement Study (HRS) 2012, 591 participants (aged $\geq$ was mediated by reduced Higher Internet use was associated with fewer depressive symptoms. The links between Internet use and depressive symptoms were mediated by reduced loneliness.

Jun & Kim, Internet use increases (2016), social contact and Korea. social support, thus



decreasing loneliness, and increasing satisfaction with social relationship, then reduces depressive symptoms.

van Ingen et Internet use provides al., (2017), social and instrumental Netherlands. support to accomplish



50).

loneliness.

A Longitudinal Internet use was linked with study, data from lower levels of depressive he Korean Welfare symptoms.

Panel Study 4 The protective effects of waves Internet use on depressive (2012-2015), symptoms via mediated by 6,306 participants the positive influence on (aged ≥ 50). social relationship satisfaction.

A cross-sectional SNS use and online study, data from the shopping were reduced the Longitudinal negative impact of function

daily task for older adults who faced negative life events, then moderates the impact of function disability (negative life events) on subjective well-being.

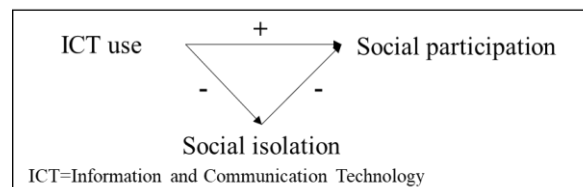
Internet Studies for disability on subjective the Social Sciences well-being.

2014, 2,162

participants (aged $\geq$

55).

Srivastava & Internet use supports
Panigrahi, various activities
(2019), India. overcome social and



A cross-sectional Social isolation was the study, data from the mediator of the association face to face survey between ICT use and social

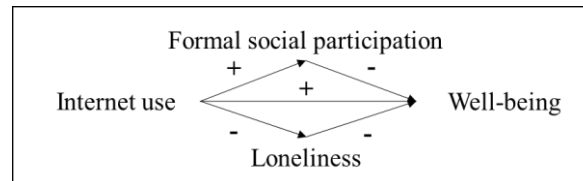
spatial boundaries, and then motivates to participate in new activities. used snowball participation.

Using Internet for connecting can reduce social isolation (means sampling, 240

increase in social network), in turn, a larger social network increasing participants (aged $\geq$

social participation. 60).

Szabo et al., Using the Internet for
(2019), New Zealand. maintaining and creating
social relationship,

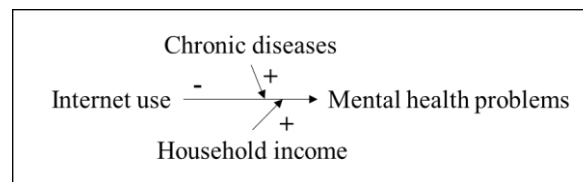


searching information and completing daily tasks can reduce loneliness, increase formal social participation, in turn, increase well-being.

A Longitudinal Social use of Internet was study, data from increased well-being via the New Zealand decreased loneliness and Health, Work, and increased formal social Retirement Study 3 participation.

waves Informal and instrumental (2013-2016), use of Internet was increased 1,165 participants well-being through increased (aged 60-77). formal social participation.

Yuan, (2020), Internet use provides
China. social interaction,
information, leisure,



convenience, and establishes a comfort with new technology, then

A cross-sectional Using the Internet more study, data from the frequently have substantially Shanghai Urban lower odds of having mental Neighborhood health problems.

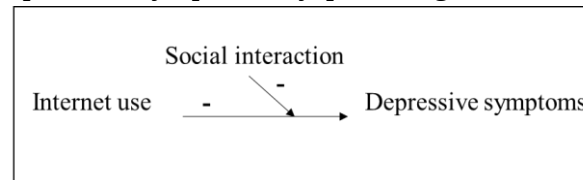
reinforces the positive association with mental health. Internet can be more useful for older adults with chronic diseases and low-income group by overcoming time, place, and economic disadvantages.

Survey 2017, Older adults with chronic diseases and in low-income group were benefited more from Internet use.

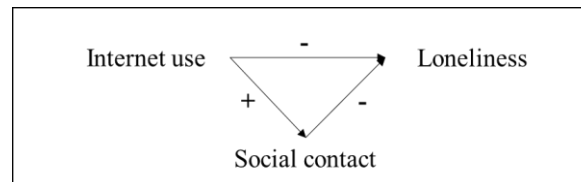
Lee et al., (2020), Internet use can reduce depressive symptoms by providing self-esteem and a sense of control when older adults successfully adopt and use technologies. Also, Internet use maintains and enhances social relationship and provides leisure activities to reduce loneliness, then reduce depressive symptoms. Internet can be more useful for older adults with lower levels of social interaction between their friends and neighbors.

A cross-sectional Internet use was reduced study, data from the depressive symptoms.

Survey of Living The effect of Internet use on Conditions and depressive symptoms was Welfare Needs of more beneficial for older Korean Older adults with lower levels Persons 2017, social interaction between 10,055 participants their friends and neighbors. (aged ≥ 65).



Yu et al., Internet use can
(2020), USA. enhance existing social
relationships and create
new opportunities for social contact, then reduce loneliness.



Longitudinal data Internet use was associated
from the Health with decreased loneliness
and Retirement and more social contact.
Survey (HRS) 3 The mediating effect of
waves social contact accounts for
(2006-2014), using 42% of the total effect.
hierarchical linear
model, 5,240
participants (aged $\geq$
65).

Supplementary file. Summary of missing values.

The amount of missing data for the key variables were, respectively: 1047 (7.7%), 591 (4.3%), and 1081 (7.9%) for depressive symptoms at T1, T2, and T3; 60 (0.4%) and 20 (0.1%) for social participation at T1 and T2; and 60 (0.4%) for Internet use at T1.

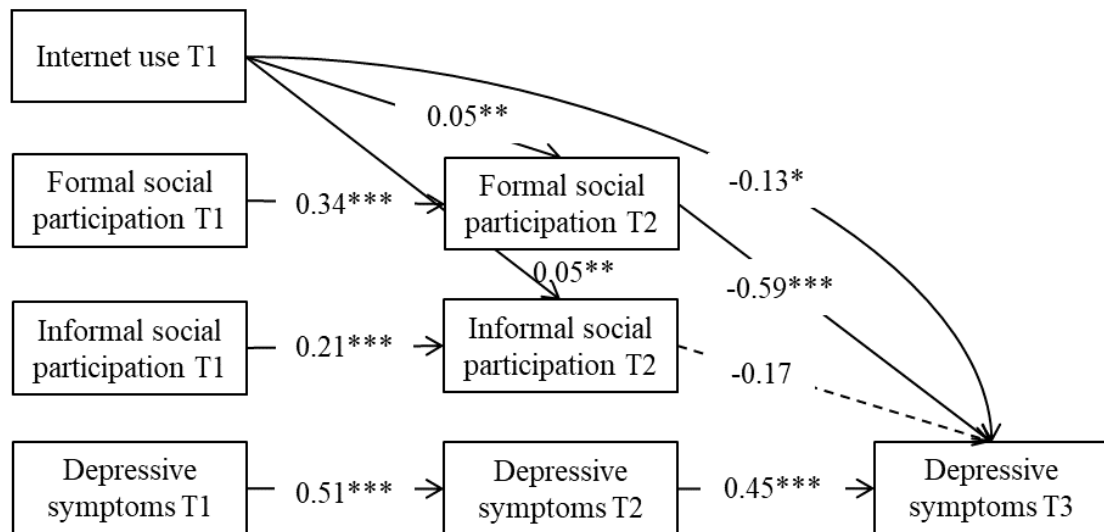
The amount of missing data for covariates were: 1 (0%) for marital status, 232 (1.7%) for retirement status, 176 (1.3%) for limitations in activities of daily living, and 283 (2.1%) for living with children at T1; and 2289 (16.7%) for total household per capita consumption at T3.

Supplementary Table 3. Baseline characteristics of individuals with complete follow-up data (i.e., T2 and T3) and those lost to follow-up.

Characteristic				Follow-up T1-T3	Only T1 or T1-T2
Unweighted	total	number	of	13671	4051
participants					
Age					
Mean (SD)				59.6 (9.3)	62.5 (11.8)
Gender					
Male				6471 (47.3%)	2119 (52.3%)
Female				7200 (52.7%)	1932 (47.7%)
Residency					
Urban				4871 (35.6%)	2219 (54.8%)
Rural				8800 (64.4%)	1832 (45.2%)
Education					
Illiterate				3636 (26.6%)	1031 (25.5%)
Primary school and lower				5547 (40.6%)	1454 (35.9%)
Junior middle school				2907 (21.3%)	826 (20.4%)
Senior middle school and higher				1581 (11.6%)	738 (18.2%)
Retirement					
No				9411 (70.0%)	1918 (50.6%)
Yes				4028 (30.0%)	1871 (49.4%)
Marital status					

Single	1577 (11.5%)	744 (18.4%)
Partnered	12093 (88.5%)	3305 (81.6%)
Total household per capita consumption		
Median (Min, Max)	7232 (0, 302196)	8526.7 (0, 302196)
Living with children		
No	6188 (46.2%)	1755 (45.1%)
Yes	7200 (53.8%)	2132 (54.9%)
Chronic conditions		
Mean (SD)	1.4 (1.4)	1.6 (1.6)
Limitations in activities of daily living		
Mean (SD)	0.3 (0.8)	0.6 (1.3)
Internet use		
Mean (SD)	0 (1)	0.1 (1.2)
Formal social participation		
Mean (SD)	0 (0.5)	0 (0.6)
Informal social participation		
Mean (SD)	0 (0.6)	-0.1 (0.6)
Depressive symptoms		
Mean (SD)	7.9 (5.8)	7.7 (5.9)

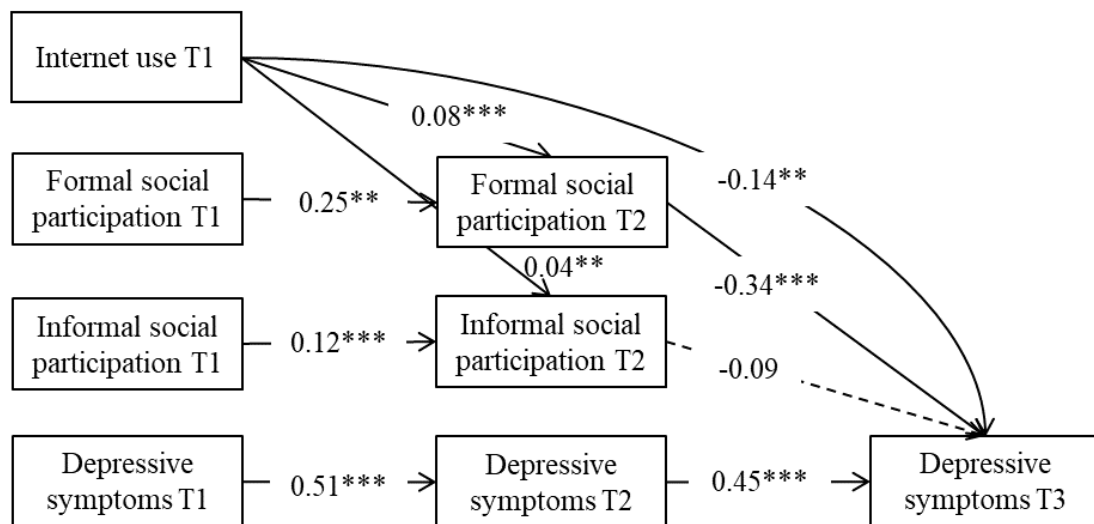
Supplementary Fig. 1 The result of focused longitudinal mediation using full information maximum likelihood imputation to deal with the missing values.



The model yielded a good model fit ($SRMR = 0.01$; $CFI = 0.99$; $RMSEA = 0.06$).

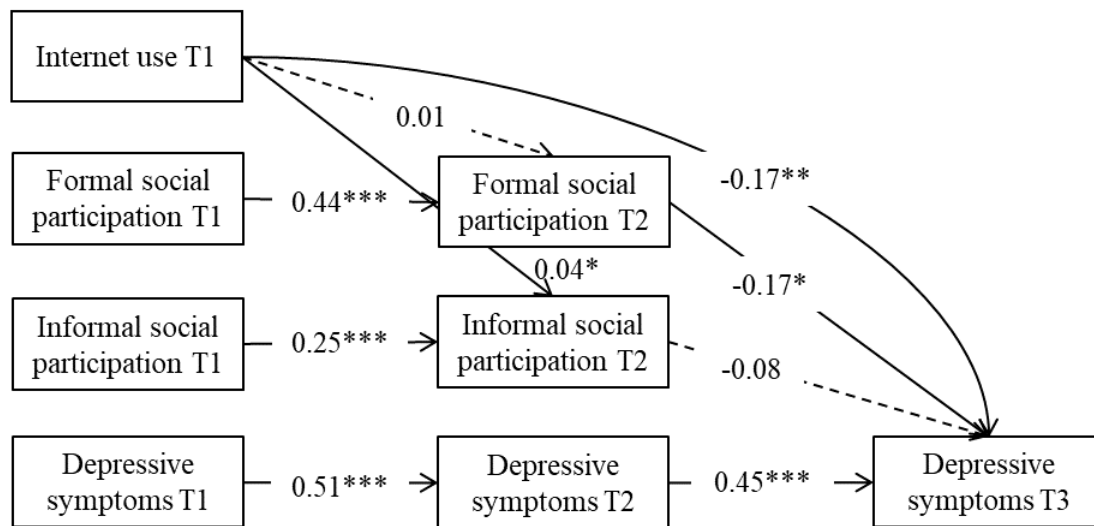
The total effect of Internet use T1 on depressive symptoms T3 was -0.16 ($SE = 0.07, p = 0.02$). Internet use at T1 through increases formal social participation at T2 to reduce depressive symptoms at T3 (indirect effect = -0.03 , $SE = 0.01, p = 0.03$). However, the predicted relationship began with Internet use at T1 to informal social participation at T2 to depressive symptoms at T3 was not supported.

Supplementary Fig. 2 The result of focused longitudinal mediation using reconstructed formal social participation facilitated by Internet use including activities (c) to (e) and informal social participation facilitated by Internet use including activities (g) and (h).



The model yielded a good model fit ($SRMR = 0.01$; $CFI = 0.99$; $RMSEA = 0.05$). The total effect of Internet use T1 on depressive symptoms T3 was -0.17 ($SE = 0.06$, $p < 0.01$). Internet use at T1 through increases formal social participation at T2 to reduce depressive symptoms at T3 (indirect effect = -0.03 , $SE = 0.01$, $p = 0.02$). The predicted relationship began with Internet use at T1 to informal social participation at T2 to depressive symptoms at T3 was not supported.

Supplementary Fig. 3 The result of focused longitudinal mediation using reconstructed formal social participation not facilitated by Internet use including activities (a) and (b) and informal social participation not facilitated by Internet use including activity (f).



The model yielded a good model fit (SRMR = 0.01; CFI = 0.99; RMSEA = 0.07). The total effect of Internet use T1 on depressive symptoms T3 was -0.18 (SE = 0.06, $p < 0.01$). The relationship began with Internet use at T1 to formal social participation at T2 (indirect effect = -0.002 , SE = 0.003, $p = 0.50$) and informal social participation at T2 (indirect effect = -0.003 , SE = 0.002, $p = 0.18$) to depressive symptoms at T3 was not supported.