

**Ten-year trends of the digital divides and its effect on healthy aging among older adults
in China from 2011 to 2020**

Supplementary materials

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Table S1. The exact province-to-region mapping and trends of digital access and usage divides for provinces covered by CHARLS

Province	Region	Digital access divide					Digital usage divide				
		2011	2013	2015	2018	2020	2011	2013	2015	2018	2020
Beijing	Eastern	38.1	21.9	49.6	7.7	12.8	84.1	87.4	82.6	45.1	43.0
Tianjin	Eastern	84.1	82.4	73.3	54.8	25.3	96.2	94.8	97.4	93.0	62.1
Hebei	Eastern	84.6	82.3	81.4	66.0	52.3	99.1	97.8	97.7	89.5	75.0
Liaoning	Eastern	91.3	82.5	79.6	60.3	46.1	99.6	98.8	97.0	89.5	70.1
Shanghai	Eastern	37.8	31.8	38.2	6.3	15.4	79.8	73.3	76.1	56.9	58.7
Jiangsu	Eastern	75.9	73.8	66.6	54.1	42.3	99.6	99.5	98.2	94.2	82.7
Zhejiang	Eastern	74.8	71.4	64.9	48.6	48.9	96.6	96.5	92.8	83.3	71.8
Fujian	Eastern	93.3	83.4	75.9	66.0	48.4	99.9	99.9	99.7	97.4	78.6
Shandong	Eastern	93.4	87.2	80.9	65.6	52.2	99.2	99.1	97.2	89.3	75.6
Guangdong	Eastern	78.1	77.9	75.3	55.3	42.3	99.9	95.9	94.4	86.4	71.9
Shanxi	Central	92.7	78.1	81.0	69.8	50.3	99.7	98.3	98.5	95.8	76.5
Jilin	Central	93.1	84.7	75.7	64.6	40.8	99.1	99.2	93.4	90.5	55.4
Heilongjiang	Central	83.1	67.6	68.4	53.3	43.7	97.1	93.6	94.3	80.9	53.8
Anhui	Central	96.3	95.5	93.3	78.5	65.9	99.7	99.4	99.2	98.0	89.8
Jiangxi	Central	89.0	78.0	76.0	58.1	39.7	98.6	97.2	95.4	92.4	71.8
Henan	Central	89.1	81.7	72.6	57.9	40.8	98.8	98.5	97.8	89.5	72.3
Hubei	Central	89.9	90.4	79.6	61.5	38.5	99.7	98.6	95.7	94.3	74.1
Hunan	Central	90.6	88.1	84.2	63.0	53.0	99.7	98.0	96.3	91.2	73.3
Inner Mongolia	Western	84.0	78.1	77.6	55.8	43.7	99.1	95.9	95.0	91.7	65.7
Guangxi	Western	79.8	77.3	69.8	53.0	38.9	98.3	98.3	96.1	87.2	78.0
Chongqing	Western	99.9	96.6	89.8	78.2	62.9	99.9	99.9	99.9	99.7	89.8
Sichuan	Western	95.4	92.0	85.8	61.4	51.0	99.9	99.8	99.5	97.9	87.0
Guizhou	Western	98.4	89.1	88.0	72.4	65.1	99.9	99.9	99.9	98.5	88.2
Yunnan	Western	96.2	94.2	91.4	79.3	60.6	99.9	99.8	99.7	99.3	89.4
Shaanxi	Western	85.5	83.8	72.8	59.8	46.6	99.2	97.0	96.5	88.0	71.8
Gansu	Western	92.9	93.0	86.9	61.8	52.2	98.4	99.9	97.6	91.9	79.5
Qinghai	Western	99.9	99.9	97.1	63.6	45.0	99.9	99.9	99.9	99.9	78.2
Xinjiang	Western	86.9	90.0	98.3	83.9	Miss	99.9	99.9	99.9	99.9	Miss

Table S2. Average marginal effects (percentage points) from IV ordered logit (2SRI) on the probability of high healthy ageing categories

Variable	$\Delta\text{Pr}(\text{HAI}=5)$	p	$\Delta\text{Pr}(\text{HAI}=4)$	p
Digital access divide	-1.43 (-1.74, -1.13)	<0.001	-5.29 (-6.37, -4.22)	<0.001
Digital usage divide	-0.58 (-0.93, -0.22)	0.001	-2.12 (-3.43, -0.82)	0.001

Notes: Estimates are average marginal effects (AMEs) from instrumental-variable ordered logit models implemented via two-stage residual inclusion (2SRI). Values are percentage points (pp) and represent the absolute change in the predicted probability of being in the specified HAI category when the digital divide indicator changes from 0 (no divide) to 1 (divide present), holding covariates at their observed values. All models adjust for covariates listed in Methods and include year and province fixed effects; standard errors clustered at the individual level. Negative numbers indicate lower probabilities associated with the digital divide. The values in parentheses are 95% confidence intervals.

Table S3. The second stage estimation of 2SLS regression of the digital access and usage**divide on healthy aging**

Outcomes	Digital access divide				Digital usage divide			
	β	SE	<i>P</i>	95%CI	β	SE	<i>P</i>	95%CI
No functional limitation	-0.164	0.019	<0.001	-0.201 ~ -0.127	-1.139	0.148	<0.001	-1.428 ~ -0.849
No multimorbidity	-0.064	0.019	0.001	-0.102 ~ -0.026	-0.445	0.137	0.001	-0.713 ~ -0.177
No cognitive impairment	-0.108	0.014	<0.001	-0.135 ~ -0.081	-0.750	0.106	<0.001	-0.959 ~ -0.542
No depressive symptoms	-0.169	0.018	<0.001	-0.204 ~ -0.133	-1.171	0.147	<0.001	-1.458 ~ -0.883
No social isolation	-0.101	0.016	<0.001	-0.133 ~ -0.069	-0.702	0.120	<0.001	-0.938 ~ -0.467
Healthy ageing index	-0.606	0.044	<0.001	-0.693 ~ -0.519	-4.207	0.406	<0.001	-5.002 ~ -3.412

Note: The coefficients reported are derived from the second stage of a two-stage least squares (2SLS) model and represent the Local Average Treatment Effect (LATE), that is, the causal effect identified for individuals whose digital divide status is influenced by the instrumental variable.

Table S4. Baseline characteristics: retained to 2020 vs lost

	Total	No lost to follow-up	Lost to follow-up	p-value
Sample	N=7176	N=6,608	N=568	
Age, mean \pm SD	68.3 \pm 6.9	67.9 (6.6)	72.4 (8.3)	<0.001
Sex, n (%)				0.023
Males	3609 (50.3)	3,297 (91.4)	312 (8.6)	
Females	3567 (49.7)	3,311 (92.8)	256 (7.2)	
Residence, n (%)				<0.001
Rural	4338 (60.5)	4,074 (93.9)	264 (6.1)	
Urban	2838 (39.5)	2,534 (89.3)	304 (10.7)	
Regions, n (%)				0.543
Eastern	2392 (33.3)	2195 (91.8)	197 (8.2)	
Central	2358 (32.9)	2183 (92.6)	175 (7.4)	
Western	2426 (33.8)	2230 (91.9)	196 (8.1)	
Marital status, n (%)				<0.001
Married	5578 (77.7)	5,200 (93.2)	378 (6.8)	
Unmarried	1598 (22.3)	1,408 (88.1)	190 (11.9)	
Education, n (%)				0.014
Illiterate	2668 (37.2)	2,432 (91.2)	236 (8.8)	
Primary school	3153 (43.9)	2,936 (93.1)	217 (6.9)	
Middle school and above	1355 (18.9)	1,240 (91.5)	115 (8.5)	
Economic level, n (%)				0.010
Low	4075 (56.8)	3,781 (92.8)	293 (7.2)	
High	3101 (43.2)	2,827 (91.1)	275 (8.9)	
Smoking, n (%)				0.006
No	4146 (57.8)	3,849 (92.8)	297 (7.2)	
Yes	3030 (42.2)	2,759 (91.1)	271 (8.9)	
Drinking, n (%)				0.022
No	5041 (70.2)	4,618 (91.6)	423 (8.4)	
Yes	2135 (29.8)	1,990 (93.2)	145 (6.8)	
Exercise, n (%)				<0.001
Hardly	4451 (62.0)	4,040 (90.8)	411 (9.2)	
Regularly	2725 (38.0)	2,568 (94.2)	157 (5.8)	
Health insurance, n (%)				0.010
No	475 (6.6)	422 (88.8)	53 (11.2)	
Yes	6701 (93.4)	6,186 (92.3)	515 (7.7)	
Digital access divide, n (%)				0.320
Yes	6416 (89.4)	5,915 (92.2)	501 (7.8)	
No	760 (10.6)	693 (91.2)	67 (8.8)	

Digital usage divide, n (%)				1.000
Yes	7101 (99.0)	6,539 (92.1)	562 (7.9)	
No	75 (1.0)	69 (92.0)	6 (8.0)	
Functional limitations, n (%)				<0.001
No	4435 (61.8)	4,180 (94.3)	255 (5.7)	
Yes	2741 (38.2)	2,428 (88.6)	313 (11.4)	
Multimorbidity, n (%)				<0.001
No	3839 (53.5)	3,597 (93.7)	242 (6.3)	
Yes	3337 (46.5)	3,011 (90.2)	326 (9.8)	
Cognitive impairment, n (%)				0.203
No	5792 (80.7)	5,345 (92.3)	447 (7.7)	
Yes	1384 (19.3)	1,263 (91.3)	121 (8.7)	
Depressive symptoms, n (%)				0.719
No	4414 (61.5)	4,069 (92.2)	345 (7.8)	
Yes	2762 (38.5)	2,539 (91.9)	223 (8.1)	
Social isolation, n (%)				<0.001
No	4820 (67.2)	4,488 (93.1)	332 (6.9)	
Yes	2356 (32.8)	2,120 (90.0)	236 (10.0)	
Healthy Aging Index	3.3 (1.3)	3.3 (1.3)	2.9 (1.3)	<0.001

Table S5. The second stage estimation of 2SRI regression of the digital access and usage divide on healthy aging using inverse probability weighting

Outcomes	Digital access divide				Digital usage divide			
	OR	SE	<i>P</i>	95%CI	OR	SE	<i>P</i>	95%CI
No functional limitation ^a	0.546	0.049	<0.001	0.458 ~ 0.650	0.696	0.090	0.005	0.541 ~ 0.897
No multimorbidity ^a	0.716	0.073	0.001	0.586 ~ 0.875	0.747	0.098	0.026	0.578 ~ 0.965
No cognitive impairment ^a	0.407	0.051	<0.001	0.318 ~ 0.521	0.443	0.120	0.003	0.261 ~ 0.752
No depressive symptoms ^a	0.561	0.053	<0.001	0.466 ~ 0.674	0.632	0.082	<0.001	0.491 ~ 0.814
No social isolation ^a	0.604	0.059	<0.001	0.498 ~ 0.733	0.617	0.035	<0.001	0.552 ~ 0.689
Healthy ageing index ^b	0.452	0.037	<0.001	0.386 ~ 0.531	0.708	0.070	0.001	0.582 ~ 0.860

Note: a represents the outcome as a binary variable and b represents the outcome as an ordinal variable.

Table S6. First-stage estimates for the digital access and usage divides

Endogenous variable	Model	Instrument coefficient (SE)	OR	p	KP rk Wald F	Wald χ^2
Internet access divide	Linear (LPM)	-0.008 (0.0002)		<0.001	2637.2	
	Logit	-0.049 (0.001)	0.951	<0.001		2413.06
Internet usage divide	Linear (LPM)	-0.001 (0.00009)		<0.001	162.06	
	Logit	-0.033 (0.0017)	0.968	<0.001		357.54

Note: The instrument is the community-level household Internet access rate measured in percentage points from 0 to 100. Linear probability first-stage models are shown for weak-instrument diagnostics and report the cluster-robust Kleibergen–Paap rk Wald F. Logistic first-stage models correspond to the 2SRI specifications and the OR column gives the odds ratio per 1-percentage-point increase in the instrument. All first-stage models adjust for the covariates listed in Methods and include year and province fixed effects, with standard errors clustered at the individual level. Larger KP rk Wald F values indicate stronger instruments, and the values here are well above conventional thresholds.