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Supplementary information

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A meta-analysis of technology use and cognitive aging

In the format provided by the authors and unedited

Table S1. Description of studies meeting initial inclusion criteria that were excluded from the meta-analysis.
The studies are listed in alphabetical order by first author, with reasons provided for exclusion as well as a summary of the paper's findings.

Study	Reason for Exclusion	Reported Results
Almeida-Meza et al, 2021	Used information from the English Longitudinal Study of Aging (ELSA Wave 1 to Wave 8). Data from this study were already included in the meta-analysis (d'Orsi et al 2018).	Mobile phone use (HR = 0.80) was associated with lower rates of dementia 15 years later in maximally adjusted models including sex, marital status, education, wealth, physical health conditions (heart disease, stroke, hypertension, diabetes), depression, physical activity, smoking, and alcohol consumption. Internet use was associated with lower dementia rates in minimally adjusted models (HR = 0.74) but not significantly associated in maximally adjusted models (HR = 0.82).
Anatürk et al, 2021	Used information from the UK biobank. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Stable weekly computer use was associated with global cognition 8 years later (beta = 0.62, FDR q < .001). Covariates included age, sex, education, occupational status, assessment center, BMI, Mean Arterial Pressure (MAP), frequency of alcohol intake, sleep duration, the presence of depressive or anxiety disorders and the number of individuals living in a household.
Anderberg et al, 2020	Used information from the Swedish National Study on Aging and Care. Data from this study were already included in the meta-analysis (Berner et al., 2019).	Internet use was cross-sectionally associated with better cognitive performance on the MMSE (average marginal effects = 0.147, $p <$ .001) in a multivariate logistic regression that included sex, education, household economy, living arrangement, and self-reported health.
Augner, 2022	Used data from the Survey of Health, Ageing, and Retirement in Europe (SHARE Wave 6 in 2015). Data from this study were already included in the meta-analysis (Kamin & Lang, 2020)	Memory and verbal fluency were better in those with self-reported computer skills that were poor to fair and good/very/good/excellent than those that never used a computer (all contrasts p<.001).
Bakrania et al, 2018	Used information from the UK biobank. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Greater frequency of computer use (hours per day) was associated with better cognitive functioning 5.3 years later. Outcomes were significant for visual-spatial memory (OR = 0.96) and short-term numeric memory (OR = 0.92), but not fluid intelligence (OR = 0.99). Covariates included age, sex, baseline cognitive score, other sedentary behaviors (driving time, television viewing), body mass index, ethnicity, social deprivation index, employment status, education level, smoking status, alcohol drinking status, fruit and vegetable consumption, sleep duration, frequency of ≥10 minutes of walking, frequency of ≥10 minutes of moderate physical activity, frequency of ≥10 minutes of vigorous physical activity, number of cancers, number of noncancer illnesses, and number of medications/treatments.

Calhoun & Lee, 2019	Used data from the Health and Retirement Study (2013-2014). Data from this study were already included in the meta-analysis (Cho et al, 2023).	Computer use was longitudinally associated with better performance on the verbal analogies test one year later, such that a one-hour increase in computer use per week was associated with an improvement of 0.38 points in the cognitive measure. The regression model also included age, gender, and education.
Cansino et al, 2019	Used data from a cohort already included in the meta-analysis (Cansino et al, 2018).	Computer use frequency was one of 11 variables (out of 120) that was significantly associated with better outcomes on a source memory test in unadjusted analyses. In a logistic regression model of the 11 significant variables (age, anxiety, depression, metamemory in adulthood, cardiovascular system disease, heart rate, diastolic blood pressure, mean arterial pressure, liqueur consumption, anxiolytics, and hormonal therapy), computer use was removed following backward elimination.
Chen, Ji, & Shang, 2024	Used information from the China Health and Retirement Longitudinal Study (CHARLS) 2018 Wave. Data from this wave were already included in the meta-analysis (Liu, Wang, et al, 2023).	Frequency and variety of smartphone uses were associated with better global cognitive performance (betas = 1.2 and 1.3, *p*s $< .001$) after adjusting for age, gender, residential area, educational level, marital status, smoking status, drinking status, sleep time, self-rated health status, and the number of chronic diseases.
Choi et al, 2021	Used information from the National Health and Aging Trends Study (NHATS 2013, 2015, and 2017). Data from this study were already included in the meta-analysis (Amini et al., 2019).	Internet usage was longitudinally protective (*p*s$<.001$) of cognition, particularly tests of executive functioning in auto-regressive cross lagged models. Analyses controlled for age, gender, education, race/ethnicity, and depression.
Czaja et al, 2006	Used data from the Center for Research and Education on Aging and technology Enhancement (CREATE). The structural equation modeling coefficients were incompatible with OR/HR meta-analysis.	Greater levels of fluid intelligence and crystallized intelligence were cross-sectionally associated with more use of computers and internet. Analyses included controlling for age, ethnicity, and education. The authors concluded that greater intelligence was important for technology use.
Elliot et al, 2013	Used information from the National Health and Aging Trends Study (NHATS Wave 1 in 2011). Data from this study were already included in the meta-analysis (Amini et al., 2019).	Greater technology use (email/text frequency and having computer/internet) was cross-sectionally associated with better executive function ($r = .28$) and better memory functioning ($r = .39$) in unadjusted analyses. The authors also fit a structural equation model indicating cognition→technology use; the model also included age, education, income, social integration, activities of daily living limitations, self-rated health, and chronic diseases.
Geda, et al, 2012	Used information from the Mayo Clinic Study of Aging. Longitudinal data (Krell-Roesh et al, 2019) and cross sectional data (Geda et al, 2015) from this study were already included in the meta-analysis.	Greater use of computers plus moderate exercising was cross-sectionally associated with reduced risk of MCI (OR = 0.36, p = .001); using computers alone and not engaging in exercise showed an OR – 0.53 (p=.058). Analyses controlled for age, sex, education, depression, medical comorbidity, and caloric intake.

Gil-Peinado et al, 2023	Used information from the DeCo study. Data from this study were already included in the meta-analysis (Ramos et al., 2021).	Cognitive impairment was associated cross-sectionally with lower internet use in persons showing cognitive impairment on the memory impairment screening, semantic verbal fluency, or short portable mental state questionnaire in unadjusted analyses ($p < .001$).
Green et al., 2021	Used information from the Survey of Health, Ageing and Retirement in Europe (SHARE Wave 5 and 6 in 2013-2015). Longitudinal data from this study were already included in the meta-analysis (Kamin & Lang, 2020).	Internet usage was associated with better word recall in retired adults by 0.759 of a standard deviation. Analyses controlled for years retired, country, retirement year, body mass index, number of doctor visits, medical comorbidities, physical inactivity, alcohol use, smoking use, marital status, household size, living in city, town or countryside, home ownership, and household income.
Hamer et al, 2014	Used information from the English Longitudinal Study of Aging (ELSA Wave 4 and Wave 5 in 2008-2011). Data from this study were already included in the meta-analysis (d'Orsi et al 2018).	Internet use longitudinally predicted higher cognitive function (immediate recall, delayed recall, category fluency) two years later in models adjusted for age, sex, smoking, physical activity, alcohol, social class, disability, chronic illness, body mass index, baseline depression, and mutually for each sedentary behaviour (newspaper reading and TV viewing). There was not an interaction with time/wave.
Hartanto et al, 2020	Used information from the Midlife in the United States study (MIDUS II and III overlapped with data already included in the meta-analysis; Tun & Lachman, 2010). Structural equation modeling coefficients were incompatible with OR/HR meta-analysis.	Computer usage was longitudinally protective of executive functions over 9 years (*p*s<.001), controlling for age, sex, education, household income, and subjective social status. Remained significant (*p*s<.05) when additionally controlling for cognitive leisure activities (reading, playing word/card games, attending lectures/courses, and writing).
Hong et al, 2023	Used information from the National Survey of Older Koreans (NSOK 2020; referred to as the Living Profiles of Older People Survey 2020). Data from this study was already included in the meta-analysis (Lee & Kim, 2024).	Various types of digital abilities that were communication focused (e.g., sending text messages), information searching focused (e.g., browsing internet), music and video watching focused (i.e., on smart devices), and transaction focuses (e.g., online shopping) were cross-sectionally associated with better MMSE scores ($p < .001$). Analyses adjusted for age, sex, education level, marital status, and employment status.
Huxhold et al, 2020	Used information from the 2002 and 2014 German Ageing Survey (DEAS). Data from this study were already included in the meta-analysis (Mariano et al., 2021).	Internet access was associated with better cognitive ability on the digit symbol substitution test in the 2002 wave (OR = 1.91) and the 2014 wave (OR = 1.27). Analyses adjusted for education, gender, and income.
Ivleva et al, 2023	Used data from the Survey of Health, Ageing, and Retirement in Europe (SHARE) wave 8. SHARE cohort data were already included in the meta-analysis (Kamin & Lang, 2020).	Internet use was cross-sectionally associated with better memory recall and delayed memory recall ($ps < .001$) after controlling for age, gender, self-perceived health, country, years of education, and leisure activities (reading, playing cards/games, crossword

		puzzles/sudoku, participating in organizations, going to social or sports clubs, attending classes, volunteering).
Jia et al, 2022	Used information from the China Health and Retirement Longitudinal Study (CHARLS 2015-2018). Data from these waves were already included in the meta-analysis (Jin et al., 2019; Liu et al, 2023).	Internet use in middle aged and older adults with diabetes was cross-sectionally associated with better cognition in unadjusted analyses.
Jiang et al, 2022	Used data from the China Longitudinal Aging Social Survey 2016 (CLASS2016). Probit regression coefficients were incompatible with OR/HR meta-analysis.	Greater internet use frequency in older women was cross-sectionally associated with higher cognitive functioning (16-item screener). Analyses controlled for age, marital status, education, household registration, number of children, living environment, industry, income, regular exercise, and province.
Kamin et al, 2021	Used data from the Survey of Health, Ageing, and Retirement in Europe (SHARE 2013-2017). Data from this study overlap with what was already included in the meta-analysis (Kamin & Lang, 2020)	In a cross-lagged longitudinal analysis, internet use was predictive of better cognitive functioning, whereas the reverse direction (cognition→internet) showed less consistent associations. Analyses adjusted for age, sex, education, self-reported health, activities (volunteering, educational courses, sports of social clubs, community events, reading, word/number games, playing games with others, moderate physical activities, and vigorous physical activities), and baseline associations of internet, cognition, and activities variables.
Katayama et al, 2022	Used data from the National Center for Geriatrics and Gerontology Study of Geriatric Syndromes (NCGGSGS 2011). Data from this study overlapped with data that was already included in the meta-analysis (Kurita et al., 2021).	Computer use was longitudinally protective of objective cognitive decline (OR=0.60, after adjusting for direction-compatibility with the effect sizes in this meta-analysis), adjusting for age, sex, education, self-reported chronic diseases, number of medications, nutritional status, BMI, baseline cognitive function, physical functions, sleep duration, depression, interpersonal interaction, and active lifestyle (reading, hobbies, driving, engaging in brain games, using a video/DVD player, clubs/organizations, volunteering, visiting friends).
Kaye et al, 2014	Reported data from the Intelligent Systems for Assessing Aging Change (ISAAC) project. The coefficients were incompatible with OR/HR meta-analysis.	MCI and control individuals didn't differ for computer use at baseline, but over time, software-tracked computer use showed lower use in MCI individuals.
Kim & Ang, 2023	Used information from the National Health and Aging Trends Study (NHATS 2020). Data from this study were already included in the meta-analysis (Amini et al., 2019).	Internet and computer use were cross-sectionally associated with a lower rate of probable dementia (ORs = 0.16 and 0.18, ps < .001), but not significantly associated with classification of possible dementia (ORs = 0.84 and 0.73, respectively). Analyses controlled for age, gender, education, race/ethnicity, income, employment status, and health conditions.
Kim, Ang, & Fingerman, 2024	Used information from the National Health and Aging Trends Study (NHATS 2015; already included in the	Linked dyadic information on care givers and care recipients and observed that internet use was cross-sectionally associated with reduced probability of possible dementia classification, adjusting for

	meta-analysis by Amini et al., 2019) and the National Study on Caregiving (NSOC 2015).	care recipients' age, gender, race/ethnicity, education, living arrangement, income, rurality of residence, self-rated health, functional limitations, caregivers' average age, average education, and the total number of caregivers per care recipient.
Kim & Cha (2021)	Used data from the 2017 National Survey of Older Koreans. There was insufficient information available to include in the OR/HR meta-analysis.	A greater number of activities with electronic devices (including receiving/making phone calls, sending text messages, searching information like news and weather, taking photos and videos, listening to or downloading music, watching or downloading videos, games, social network or instant messaging, online shopping) was associated with better MMSE scores. Analyses controlled for gender, education, marital status, employment status, income, and household structure.
Kim & Han, 2022	Used longitudinal data from the Health and Retirement Study (2002-2018). Data from this study were already included in the meta-analysis (Cho et al, 2023).	Transitioning into using the internet was associated with improved cognitive functioning, especially for older adults, and slower rates of subsequent cognitive changes (all coefficients $p<.01$). Transitioning out of internet use was associated with worsening cognition and rates of cognitive decline. Analyses adjusted for age, gender, race/ethnicity, education, household income, marital status, number of health conditions, number of activities of daily living difficulties, and depressive symptoms.
Krakovska et al, 2021	Used data from the Health and Retirement Study (2018 and 2014). The machine learning techniques that were incompatible with OR/HR meta-analysis.	Computer usage was the only factor of 17 daily activities (including reading, playing games, socializing, volunteering, walking) that was consistently longitudinally protective against memory changes (*ps*<.01 in 65-74 age bands and *ps*<.05 in 75-84 age bands).
Krell-Roesch et al., 2017	Used information from the Mayo Clinic Study of Aging. Longitudinal data (Krell-Roesh et al, 2019) and cross sectional data (Geda et al, 2015) from this study were already included in the meta-analysis.	Computer usage was longitudinally associated with decreased risk of incident MCI (HR = 0.70, 95% CI: 0.57-0.85). Effects were larger than for reading books, playing games, craft activities, or social activities. Analyses adjusted for age, sex, and education.
Krug et al, 2018	Used data from the EpiFloripa Idoso study (2009-2014). Data from this study were already included in the meta-analysis (Krug et al, 2019).	Starting to use the internet across a four year period reduced the probability of cognitive impairment (MMSE scores) at the follow-up. (RR = 0.53, p =.006). Nonsignificant associations were observed for stopping or keeping to use the internet after adjusting for age, income, education, and presence of caregiver.
LaMonica et al, 2017	All participants in the sample were symptomatic (subjective cognitive impairment, mild cognitive impairment, and dementia groups).	Computer usage ($p < .001$) and smartphone usage ($p = .001$) were more frequent in persons with subjective cognitive impairment and mild cognitive impairment than in persons with dementia.
Lee & Tak, 2020	Abstract written in English, but main text was only available in Korean, preventing systematic review.	In the 2017 National Survey of Older Koreans study, digital literacy measures were associated with better cognitive functioning.
Levine et al, 2018	Used information from the National Health and Aging Trends Study (NHATS 2011-2014). Data from this study	Use of any everyday technology device in 2011 reduced the probability of new probable dementia in 2014, adjusted for age,

	were already included in the meta-analysis (Amini et al., 2019).	race/ethnicity, partner status, education, income, census track, perceived health, cigarette smoking, depression, medication use, total comorbidities, activities of daily living total, short physical performance battery, grip strength, and annual number of hospital stays.
Levy et al, 2014	Used data from the Health and Retirement Study (2009-2010). Data from this study were already included in the meta-analysis (Cho et al, 2023).	Internet users had lower rates of cognitive impairment than the general population (7.8% vs. 20.4%), OR=0.43. Analyses controlled for age, gender, race/ethnicity, education, family income, marital status, self-reported health, chronic conditions, and functional impairments.
Li et al, 2020	Used information from the China Longitudinal Aging Study (CLAS). Data from this study are already included in the meta-analysis (Li, Yue, & Xiao, 2022).	Internet usage (p = .023) was protective against incident MCI, in unadjusted analyses. In a Cox regression with 9 variables that were significant in unadjusted analyses, only male sex and reading remained significantly protective.
Li, Zhang, Gao, et al, 2023	Used information from the China Health and Retirement Longitudinal Study (CHARLS 2011-2018). Data from these waves were already included in the meta-analysis (Jin et al., 2019; Liu et al, 2023) and memory-related disorders was based on self-report of a diagnosis.	Internet use was longitudinally associated with greater rates of memory-related disorders (HR 0.58) after adjusting for age, gender, education, nationality, work status, resident area, marital status, health insurance, health behaviors (including smoking status, drinking status, restless sleep times), and activities of daily living.
Liang et al, 2023	Sample only included adults who reported using a digital device.	Using digital devices for multiple purposes (communication, social media, entertainment, video games, work, news, books, others) was cross-sectionally associated with better ACE-III scores relative to using digital devices only for communication. The effect was partially mediated when controlling for scores on a 24-item cognitive reserve composite.
Ling et al, 2020	Abstract written in English, but main text was only available in Japanese, preventing systematic review.	Use of a computer was associated with lower hazard ratios for dementia over six years in males in the Japan Gerontological Evaluation Study (HR = 0.65). Computer use showed larger effects than reading, playing games, and walking/jogging. Analyses adjusted for age, education, income, marital status, employment status, instrumental activities of daily living, comorbidities, obesity, hearing impairment, smoking, drinking, walking time, frequency of social activities, depression, emotional support, instrumental support.
Liu, Peng, et al, 2023	Used information from the China Health and Retirement Longitudinal Study (CHARLS) 2018 wave. Data from this wave overlaps with data already included in the meta-analysis (Liu, Wang, et al, 2023).	Internet use was cross-sectionally associated with better cognitive function (OR = 0.052), adjusted for age, gender, marital status, literacy, employment status, wage, pension, subsidy, pension insurance, medical insurance and accessibility to physical examination services.

Lu et al, 2024	Used information from the UK biobank cohort. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Frequency of computer use was associated with decreased risk for Alzheimer's disease (OR = 0.998, p=.013) in a Mendelian randomization approach adjusted for age, sex, genotyping chip, and the first 10 genetic principal components.
Macdonald & Hulur, 2021	Longitudinal data from the Health and Retirement Study were used (2006-2016). Data from this study were already included in the meta-analysis (Cho et al, 2023).	Better memory was associated with increased adoption of internet technologies (p<.01). Analyses adjusted for age, gender, race/ethnicity, education, marital status, income, instrumental activities of daily living, comorbidities, and depression.
Martino et al, 2023	Abstract written in English, but main text was only available in Spanish, preventing systematic review.	In a cross-sectional design, older adults who more frequently used smartphones and computers showed better MMSE scores (*p*s < .01), adjusted for age, education, performing mental calculations without a calculator, cerebrovascular conditions, diabetes, playing brain games, and taking medications for chronic conditions.
Morikawa et al, 2023	Used information from the National Center for Geriatrics and Gerontology Study of Geriatric Syndrome subcohort (NCGGSGS 2017). Data from this study were already included in the meta-analysis (Morikawa et al, 2022).	Computer usage and/or smartphone usage were cross-sectionally associated with better cognitive functioning (MMSE, $p < .001$) in unadjusted analyses.
Muurling 2022	Statistical approach was incompatible with OR/HR meta-analysis.	The study passively monitored phone calls and app use activity on smartphones in individuals classified as cognitively impaired or cognitively normal. The cognitively impaired individuals were similar to cognitively normal individuals on app duration but significantly differed on number of times apps were opened and number of calls weighted against number of unique contacts.
Oh et al, 2024	Used data from the National Survey of Older Koreans (NSOK 2020). Data from this study were already included in the meta-analysis (Lee & Kim, 2024).	Greater use of digital devices was cross-sectionally associated with better MMSE scores (p < .001) after controlling for age, gender, education, residential area, marital status, employment, living alone, and annual income.
Park, Choi, et al, 2019	Used data from 210 healthy older adults attending a medical center. Coefficients were incompatible with OR/HR meta-analysis (no standard errors of beta values).	Engaging in activities that used newer technologies (computers, internet, digital cameras) was not associated with MMSE scores in a regression that simultaneously included age, sex, education, working activities, TV/radio/newspapers, domestic chores, exercise, religious activity, social activities, cinema/theater, crafts/gardening, looking after grandchildren, volunteering, artistic activities, traveling, reading books, pet care, managing current accounts, and number of children.
Paolillo et al, 2024	Used data from the Advancing Research and Treatment of Frontotemporal Lobar Degeneration (ARTFL) study and Longitudinal Evaluation of Familial Frontotemporal Dementia Subjects (LEFFTDS) study. The battery usage variable was incongruent with other	Patients with dementia showed less smartphone battery usage than control individuals using a passive monitoring system of battery usage. Analyses controlled for age, sex, smartphone type, and estimated smartphone age.

	measures of general technology usage in the OR/HR meta-analysis.	
Resor et al, 2023	Used information from the Health and Retirement Study (2016 wave). Longitudinal data from this study were already included in the meta-analysis (Cho et al, 2023).	Greater frequency of emailing with children, other family, and friends (but not social media) was cross-sectionally associated with better performance on the number series task (curvilinear associations), adjusting for age, sex, education, race/ethnicity, marital status, and self-rated health.
Roberts et al, 2015	Used information from the Mayo Clinic Study of Aging. Longitudinal data (Krell-Roesh et al, 2019) and cross sectional data (Geda et al, 2015) from this study were already included in the meta-analysis.	Computer usage in late life (HR = 0.47, p = .008), but not midlife (HR=1.02) was associated with reduced risk of developing cognitive impairment. Analyses controlled for age, gender, and education.
Shin et al, 2021	Used information from the Health and Retirement Study (2000-2014 waves). Longitudinal data from this study were already included in the meta-analysis (Cho et al, 2023).	Computer usage was associated with better cognitive functioning (fluid and crystallized composite scores) in growth curve models (p < .001). Effect sizes were similar to some lifestyle activities (reading books and playing games) and larger than other lifestyle activities (reading papers, arts/crafts, music engagement, going to movies/concerts/lectures). Analyses controlled for gender, age, education, marital status, self-reported health status, medical comorbidities, IADL difficulties, depression, smoking, weight, alcohol use, number of living children, employment status, household income, net worth, and health insurance ownership.
Shi et al, 2023	Used information from the China Family Panel Studies (CFPS 2018). The cognitive composite measure did not separate subjective measures (memory for important things, self reported) from objective measures (vocabulary and numeracy).	Individuals with lower cognitive ability were less likely to adopt the internet (p<.01). Analyses controlled for age, gender, education, household income, insurance and pension, family size, marital status, and geographic location.
Silbert et al, 2016	Used information from the Intelligent Systems for Assessing Aging Change (ISAAC) study. Coefficients were incompatible with OR/HR meta-analysis.	Higher daily computer use (mouse movement data over one month) was associated with larger hippocampal volume (spearman's correlation=0.48), better delayed recall performance (coefficient estimate = 0.03, p = 0.03) and better semantic fluency (coefficient = 0.02, p = 0.049), but not Mini Mental Status or Trails B. Cognitive analyses controlled for age, gender, and education; volumetric analyses controlled for MMSE.
Slegers et al, 2009	Used information from a randomized controlled trial of 191 participants in a digital inclusion experiment.	There was no effect of the intervention on cognitive outcomes, adjusted for age, sex, education, and income. Within the intervention group, computer usage was analyzed with a median split. The computer-cognition associations were inconsistent. Some analyses favored heavy uses (e.g., better Stroop color word test and verbal memory scores at baseline, and better improvements in digit substitution over 4-months) whereas other analyses favored light

		users (increased verbal memory over 4-months and increased digit substitution between 4-months and 12-months).
Su et al, 2017	Used information from the China Longitudinal Aging Study (CLAS). Data from this study are already included in the meta-analysis (Li et al, 2022).	Using the internet was protective against mild cognitive impairment (OR= 0.238) in a sample of 1,005 elderly participants. Internet use showed nominally the largest protection relative to reading, smoking, alcohol drinking, tea drinking, exercise, hobbies, listening to music, calligraphy, chess and cards, photography, fishing, and Taiji.
Sun et al, 2023	Used information from the Prevention and Intervention on Neurodegenerative Disease for Elderly in China study (PINDEC). Data from this study were already included in the meta-analysis (Qi et al, 2021).	Using the internet was cross-sectionally associated with reduced odds of cognitive impairment for individuals with APOE E4+ (OR=0.89) and APOE E4- (OR=0.53), adjusting for age, sex, education, marital status, occupation, comorbidity, BMI, lifestyle factors (smoking, alcohol drinking, daily tea, regular exercise), and cognitively stimulating activities (reading, playing cards, socializing, participation in community activities).
Takeuchi et al, 2022	Used information from the UK biobank cohort. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Non-occupational computer usage frequency was protective against incident dementia over 5 years (HRs = 0.626 to .722, p = .001). Analyses controlled for age, gender, neighborhood SES, education, household income, current employment, metabolic equivalent of task hours, number of people in the household, height, BMI, self-reported health status, sleep duration, systolic blood pressure, alcohol use, tobacco use, race, medical comorbidities, driver jobs, and visuospatial memory task performance.
Tan et al, 2024	Used information from the UK biobank imaging visit assessment (2014). Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Computer use was cross-sectionally associated with better cognitive scores (summary score based on six cognitive tests), adjusted for age, sex, race, education, and socioeconomic status (Townsend deprivation index).
Umemuro et al, 2004	Used data from 47 older adults who took assessments in groups. There was insufficient statistical information for inclusion in OR/HR meta-analysis.	Computer use was cross-sectionally associated with significantly better performance on spatial orientation and field independence but not spatial visualization, associative memory, or perceptual speed. Internet use was associated with better spatial visualization, spatial orientation, and field independence but not associative memory or perceptual speed. Analyses were unadjusted.
Wan et al, 2023	Study included data from 583 older adults who completed study procedures in an online platform (Prolific). There was insufficient information available to include in the OR/HR meta-analysis.	Greater technology use (e.g., social media, online shopping, video communication) was associated with better immediate recall in older adults in a regression analysis that also included age, gender, race, delayed recall, education, retirement asset account, perceived usefulness, self-efficacy (mastery and constraints), and internet adoption age.

Wang, Xiao, et al, 2017	Used Information from the China Longitudinal Aging Study (CLAS). Data from this study were already included in the meta-analysis.	Internet usage was protective against amnestic MCI (OR = 0.24). The effect size was larger than other lifestyle activities including reading habits, social activities/hobbies, intellectual work before retirement, arts and crafts, exercise, and music engagement.
Wang, Chen, et al, 2024	Used information from the Health and Retirement Study (2012, 2013, and 2016 waves). Longitudinal data from this study were already included in the meta-analysis (Cho et al, 2023).	Internet uses—including informational, social, online shopping, and online banking uses—all showed direct effects on better cognition (TICS). Analyses controlled for age, gender, race/ethnicity, marital status, poverty, limitations in activities of daily living, number of chronic health conditions, and baseline cognition.
Williams et al, 2020	Used information from the English Longitudinal Study of Aging (ELSA Waves 1-7 from 2002-2014). Data from this study were already included in the meta-analysis (d'Orsi et al 2018).	Internet usage was protective against cognitive impairment measured as verbal fluency and episodic memory (risk ratios between 0.62 to 0.69). Effect sizes were larger than for most other lifestyle activities (reading, evening classes, social clubs, employment) and comparable to effect sizes for volunteering. Analyses controlled for age, gender, education, social class, age of finishing formal education, income, wealth, ethnicity, parental household structure, occupational classification, smoking, retirement age, participation in other activities, activities of daily living, caring, homemaking, self-rated health, self-rated hearing, self-rated eyesight, marital status, medical comorbidities, depression, and physical exercise.
Woods et al, 2023	Computer exposure data were incompatible with OR/HR meta-analysis.	Computer usage was associated cross-sectionally with better cognitive performance on a neuropsychological battery (N = 336), particularly for measures of executive function ($p < .001$) and memory ($p < .001$). Analyses controlled for education and computer anxiety.
Wu, Gu, et al, 2023	Used information from the UK biobank. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Moderate computer use was associated with lower risk of dementia (HR = 0.68), lower white matter hyperintensity volume, and greater hippocampal volume. Analyses adjusted for age, sex, body mass index, race, smoking status, alcohol drinking status, education level, visiting friends, living alone, physical activity, Townson deprivation index, healthy dietary score, family history of disease (including dementia, PD, and depression), hypertension, diabetes, and TV viewing time
Xavier et al, 2014	Used information from the English Longitudinal Study of Aging (ELSA Waves 1-5 in 2002-2011). The type of effect size reported was not clear; therefore, other data from this study were included in the meta-analysis (d'Orsi et al 2018).	Internet/e-mail usage predicted better delayed recall. The effect size was described as "a strong effect size of 0.996." This analysis controlled for age, gender, time, baseline cognitive function, wealth, education, digital literacy, physical disability, depressive symptoms, and diabetes.

Xu et al, 2024	Used information from the UK biobank. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Computer use was not associated with dementia or neuroimaging features after adjusting for cognitive test performance (prospective memory accuracy and response time and fluid intelligence), age, sex, ethnicity, socioeconomic status (Townsend deprivation index), education, employment status, self-reported smoking status, frequency of alcohol consumption, sleep duration, body mass index, depressive mood, history of hypertension, history of diabetes, and physical activity.
Yang et al, 2023	Used information from the UK biobank. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Computer use predicted dementia development across 12.4 years (HR = 0.85). They observed a reversed J shaped function such that moderate computer use was most protective. Analyses adjusted for age, sex, race, socioeconomic status (Townsend Deprivation Index), body mass index, systolic blood pressure, education levels, smoking status, alcohol consumption, total cholesterol, glycated hemoglobin, high-sensitivity C-reactive protein, glucose-lowering medications, antihypertensive medications, cholesterol-lowering medications, healthy diet scores, healthy sleep scores, family history of dementia, TV-watching time, driving time, APOE ε4 carrier and polygenetic risk score of Alzheimer's disease.
Yu & Fiebig, 2020	Used information from the China Health and Retirement Longitudinal Study (CHARLS) 2011, 2013, and 2015 waves. Data from this wave were already included in the meta-analysis (Jin et al., 2019).	Cross-lagged panel models indicated bidirectional associations between internet use and cognition. Analyses adjusted for age, gender, education, annual household expenditure per capita, impairment in performing any activities of daily living or any instrumental activities of daily living, severity of depression, living with children, urban residence, and geographic areas.
Yu et al, 2022	Used data from the 2014 and 2018 China Family Panel Study (CFPS). There was insufficient data for the meta-analysis (standard deviation of cognitive measure absent)	Internet usage for more than one activity ($p = .03$) and at least once a week ($p = .02$) were associated with better cognitive functioning (vocabulary measure). Analyses controlled for age, gender, education, household income, marital status, residency, self-rated health status, and retirement status.
Yuan et al, 2018	Used data from the Xiamen, China older adult study, overlapping with data already included in the meta-analysis (Yuan et al, 2019).	Smartphone use was cross-sectionally associated with better MoCA scores (OR=0.58, after adjusting for direction-compatibility with the effect sizes in this meta-analysis). Analyses adjusted for age, gender, area, education, marital status, BMI, hypertension, diabetes, and depression.
Yuan et al, 2023	Used information from the UK biobank. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Moderate computer use was associated with lower risk for Alzheimer's disease in minimally adjusted analyses (HR = 0.84), but was not a significant predictor (HR = 0.90) in analyses that adjusted for age, sex, education, ethnicity, alcohol use, BMI, socioeconomic

		status (Townsend Deprivation Index), smoking, myocardial infarction, diabetes, stroke, and hypertension.
Yue et al, 2023	Used information from the China Longitudinal Aging Study (CLAS). Data from this study are already included in the meta-analysis (Li et al, 2022).	Internet use was cross-sectionally associated with better cognition when comparing healthy controls to individuals with MCI or AD. Analyses were unadjusted.
Zhang, Boot, & Charness, 2022	Used data from the PRISM trial. The observational component of this study (i.e., amount of computer usage relative to change in cognitive performance over 12 months) reported data that were incompatible with OR/HR meta-analysis.	High-intensity computer users (n=75) showed improvements over 12 months on a measure of crystallized intelligence (Shipley Institute of Living Scale) relative to low-intensity users (n=75). No changes were observed in other cognitive domains or relative to a control group (n=150) (Bayes Factors supported the null hypothesis).
Zhang, Wang, et al., 2022	Used data from the 2018 China Family Panel Study (CFPS). Data from this study were already included in the meta-analysis (Xia et al., 2024).	Moderate internet use was associated with better literacy tests scores and math test scores (inverted U shape association), controlling for age, gender, residence, education, marital status, self-assessed socioeconomic status, employment status, comorbidities, activities of daily living, physical exercise, social relationships, and region.
Zhou Abuduxukuer et al, 2024	Used information from the China Health and Retirement Longitudinal Study (CHARLS) 2018-2020 waves. Data from this wave overlaps with data already included in the meta-analysis (Liu et al, 2023).	Using WeChat was associated with better performance on executive function, episodic memory, and global cognitive performance tests in cross-sectional analyses (*p*s < .001) and longitudinal analyses (*p*s < .001) that adjusted for age, gender, marital status, education, living area, smoking status, alcohol consumption, comorbidities, and insurance coverage.
Zhou, Chen, et al, 2020	Used information from the China Health and Retirement Longitudinal Study (CHARLS) 2011-2015 waves. Data from this wave were already included in the meta-analysis (Jin et al., 2019).	Internet use was associated with better total cognitive scores (beta = .64), controlling for year, education, marital status, living near children, retirement status, household income, alcohol consumption, smoking, # of types of non-communicable diseases, and # of types of lower body constraints.
Zhou, Cho, et al, 2023	Used information from the National Health and Aging Trends Study (NHATS). Data from this study were already included in the meta-analysis (Amini et al., 2019).	Older adults with cancer who used the internet for health purposes (e.g., refilling prescriptions) were cross-sectionally less likely to have a dementia diagnosis (OR = 0.16), controlling for age, sex, race/ethnicity, marital status, education, income, self-rated health, number of chronic conditions, number of difficulties with activities of daily living, anxiety and depression, physical performance, and grip strength.
Zhuang et al, 2023	Used information from the UK biobank. Longitudinal data from this study were already included in the meta-analysis (Raichlen et al, 2022).	Moderate computer use was associated with the lowest incidence of dementia 12.6 years later, followed by high daily use (HR = 1.17) and low/no use (HR = 1.41). Analyses adjusted for age, sex, ethnicity, UK Biobank assessment center, Townsend deprivation index, education, alcohol consumption, smoking status, BMI, SBP, physical activity, healthy diet score, use of antihypertensive drugs,

		use of lipid-lowering drugs, use of insulin, family history of dementia, and TV viewing.

Table S2. Descriptive information for studies meeting inclusion criteria for the meta-analysis.

Studies are ordered alphabetically, with notes on demographics, cognitive endpoints, analytical/methodological conversations necessary for inclusion, and covariates.

Study	N for sample included in meta-analysis	Baseline Age	Gender (% Female)	Notes on the portion of sample included	Main effect sizes reported/ source for OR analysis	Conversions employed for OR analysis	Outcome measure	Covariates for OR/HR analysis
Abdelsalam et al, 2022	270	65.99	55.56%	None	Table 2 (MoCA Scores)	Mean differences to odds ratio	Cognitive screening score (based on MoCA)	OR: derived (unadjusted)
Almeida et al, 2012	5506	75.5	0%	None	Though hazard ratios were reported, Table 2 provided information on N necessary to calculate odds ratio	Unadjusted raw N to unadjusted odds ratio	Dementia diagnosis	OR: derived (unadjusted); HR: age, educational attainment, size of social network, and presence of depression (GDS-15) or of significant clinical morbidity (Charlson Index), and MMSE
Amini et al, 2019	4860	78.95	59.12%	None	Table 4	None needed	Cognitive composite variable (based on immediate word recall and clock drawing tests)	OR: self-reported health status, falling down, functional limitations in ~12 ADLs (laundry, shopping, meal preparation, money management, walking 6 blocks, climbing 20 stairs, going out, moving inside the house/unit, getting out of bed, taking a shower, dressing, eating and bathing), Age, living status of alone vs partner/spouse, and level of education; also, social support, and vigorous exercises

Atlas et al, 2020	635	83.9	55.75%	None	Table 2 and Table 4	Independent group differences converted to OR	Cognitive screening (3MS)	OR: age, sex, and income
Berner et al, 2019	3555	73.76	58.6%	Two samples included in this study; pooled information and effect size included	Table 4 Model 2 (fully adjusted) OR used for analysis	None needed	Cognitive screening score (based on MMSE)	OR: MMSE at baseline; gender, age, education, functional limitations, and living situation (living alone)
Bernstein et al, 2021	60	73.4	27%	None	Table 3	Correlations to OR	Cognitive composite (global) based on UDS NACC	OR: derived (unadjusted)
Bertocchi et al, 2022	668	69.41	51.1%	Compared smartphone versus no cell phone groups	Table 3	Independent group differences converted to OR	MMSE	OR: derived (unadjusted)
Bordone et al, 2015	4891	64.06	51.6%	SOEP data only because ELSA data were already covered in the meta-analysis	Table 2a	Regression coefficients to OR	Symbol Digit Test 90	OR: age, sex, education
Cansino et al, 2018	1557	50.12	50.35%	None	Table S4	Correlations to OR	Source Memory test and MMSE	OR: derived (unadjusted)
Cho et al, 2023	18154	55.17	52.64%	None	Unadjusted OR was derived from frequencies presented in table 1; HR as reported	For OR analysis, frequencies as reported in table 1 were converted to a	Dementia diagnosis	OR: derived (unadjusted); HR: age, gender, baseline TICSm, race-ethnicity, generational cohort, educational attainment, marital status, household

					used in HR analysis	derived unadjusted OR; HR analysis was used as reported		income ratio relative to poverty level, self-reported health, region of residence, time on study, proxy, imputation status
de Rosso Krug et al, 2019	1197	73	65%	None	Pooled estimates from Table 3 for Started and Continuing Using	None needed	Cognitive screening score (based on MMSE)	OR: sex, age, household income, education level, and cognitive screening at baseline
Doi et al, 2013	3307	71.3	52.6%	None	Table 2	None needed	MCI diagnosis	OR: age, sex, BMI, education, medications, alcohol, smoking, walking speed, physical activity, and depression
d'Orsi et al., 2018	8238	64.4	54.93%	None	HR used as primary outcome; Used raw N in Table 1 to calculate odds ratio	Unadjusted raw N to unadjusted odds ratio	Dementia diagnosis	OR: derived (unadjusted); HR; sex, age, marital status, education, wealth, hypertension, diabetes, stroke, CHD, Cancer, impaired mobility, cognition index, depressive symptoms
Fazeli et al, 2013	604	73.06	59.52%	None	Table 4	Independent group differences converted to OR	Stroop task and Trail Making Test	OR: age, gender, race, education, depression, diabetes, hypertension, and cataracts.
Ferreira et al, 2014	3515	70.92	58.7%	We limited analyses to the sample that was >65 years	Used reported correlations in supplemental material converted to calculate effect sizes	For the older adult sample, a pooled effect size was estimated based upon correlations between non-cognitive	Composite effect size from measures of attention/working memory, episodic memory, and	OR: derived (unadjusted)

						training computer games in the older adult samples according to information based in the supplemental materials.	processing speed	
Geda et al, 2011	1321	80.45	48.5%	None	Adjusted odds ratio in table 2	None needed	Mild cognitive impairment diagnosis	OR: Age, sex, and education
Ghaiumy Anaraky et al, 2023	3984	75.85	55.7%	Computer use and internet use	Table 4	Regression coefficients to OR	Immediate recall, delayed recall, clock drawing, orientation tasks	OR: age, gender, living arrangement, education, race; limitations in activities of daily living, self-rated health
Hatzifilalithis et al, 2017	44	64.9	43.18%	None	Table 4	Correlations to OR	Trail Making Test, Immediate Recall	OR: derived (unadjusted)
Hopkins et al, 2023	895	78.8	54.3%	None	Tables S4-S5	Correlations to OR	Cognitive composite (10 tests that assess memory, executive functioning, language, processing speed and visuo-spatial processing)	OR: derived (unadjusted)
Howard et al, 2016	4620	81	69%	None	Multivariate (adjusted) odds ratio for computer	None needed	Cognitive performance scale	OR: controlled for decision making independence, STM

					activities is reported in Table 3			memory problems, not being understood by others
Ihle et al, 2020	897	74.33	69%	None	able to estimate effect size for this study	Correlations to OR	Trailmaking test performance (combined versions A and B)	OR: derived (unadjusted)
James et al, 2013	661	82.2	76%	None	Table 2	Correlations to OR	Cognitive composite (z-score based on 19 tests)	OR: derived (unadjusted)
Jin et al, 2019	11384	58.7	51.03%	None	Pooled estimates from text reported 4 year outcomes of cognition from smartphone or computer ownership	Independent group differences converted to OR	Cognitive composite variable (based on immediate and delayed word recall and mental intactness screener)	OR: age, sex, education, marriage, rural or urban residence, smoking, drinking, hypertension, diabetes, stroke
Kamin & Lang, 2020	29576	66.47	59%	None	Complex cross lagged panel analysis were the primary measures in this paper but did not lend themselves to meta-analysis; instead we estimated effect size from Point biserial correlations reported in the text between	Point biserial to odds ratios	Cognitive composite variable (based on immediate and delayed word recall, counting backward by 7s, and animal naming)	OR: derived (unadjusted)

					cognition and internet use			
Kesse-Guyot et al, 2012	2579	52.2	44.7%	None	Table 3, model D (fully adjusted) presents associations between cognitive functioning at 6 years; N and P values were used to estimate effect size		Composite effect size derived from executive function and verbal memory scores (based on principal component analysis of tests of delayed cued recall, trail making, digit span forward and backward, phonemic and semantic fluency)	OR: interval between first sedentary behavior assessment and cognitive evaluation, age, gender, supplementation group, education, occupational categories, time-dependent retirement status + baseline value, tobacco use status, BMI, CES-D score, general health status, history of cardiovascular diseases, diabetes and hypertension, delta of leisure-time physical activity, delta of remaining sedentary behaviors
Khoo & Yang 2020	1735	58.6	75%	None	Table A1	Correlations to OR	Cognitive test (five executive function tests in BTACT, Brief Test of Adult Cognition by Telephone)	OR: derived (unadjusted)
Kim & Kim 2014	213	66.6	51.64%	None	Table 4	Independent group differences converted to OR	MMSE	OR: none
Krell-Roesch et al, 2019	2000	77.8	50.1%	None	N of frequency of use by midlife and later and incident	Hazard ratios were the primary	Mild cognitive impairment diagnosis	OR: derived (unadjusted); HR: age, sex, education, and APOE

					MCI from table 2 were used to calculate an unadjusted OR; HR was used as reported.	analyses utilized; however raw N are reported and sufficient to converting to OR to estimate effect size		
Kurita et al, 2019	5300	75	52.9%	None	Odds ratio for computer use reported in text	None needed	Cognitive impairment defined by a composite score	OR: age, sex, education, employment, iADL limitations, number of chronic diseases, GDS score
Kurita et al, 2021	2010	71	52.5%	None	Adjusted odds ratios are presented in table 2; we used only the observed (not imputed) sample	None needed	Cognitive impairment defined by a composite score (based on immediate and delayed word recall, trail making A and B, and symbol digit substitution)	OR: age, sex, education, GDS depression, number of chronic diseases (hypertension, diabetes, hyperlipidemia, heart disease), IADL limitations, Employed, Walking Speed
Lee & Kim 2024	7849	72.28	58.5%	None	Page 4 correlation	Correlations to OR	MMSE	OR: sensory impairment
Li et al, 2021	5898	63.9	55.39	None	Regression predicting cognitive composite score in Table 2	Regression coefficients to OR	Cognitive composite variable (based on immediate and delayed verbal recall, digit span forward and backward,	OR: derived (unadjusted)

							and verbal fluency)	
Li et al, 2022	3020	71.41	53.98%	None	Odds ratios as reported in Table 2	None needed	Diagnosis (MCI or Dementia; pooled outcome)	OR: age, gender, smokers, tea drinkers, take exercise, diabetes, hypertension
Lin et al, 2020	235	82.58	58.72	None	Table 2	Independent group differences converted to OR	MoCA	OR: derived (unadjusted)
Liu et al, 2023	10325	60.3	44.8%	None	Table 2	None needed	MMSE	OR: age, sex, education level, smoking status, drinking condition, living alone, physical activities, social activities, hypertension, diabetes, dyslipidemia, stroke, chronic lung diseases, emotional, nervous, or psychiatric problems, memory-related disease, hearing disorder
Lu et al, 2016	2892	58.2	55.39	None	Adjusted odds ratio reported in table 3	None needed	Cognitive screening measure (based on MoCA)	OR: age, gender, BMI, education, live situation, smoking, drinking, reading, computer use, labor intensity, working time, hypertension, diabetes, hyperlipidemia, PVD, and CHD.
Mariano et al, 2021	3479	61.12	48.61%	None	Correlations as reported in Table 2	Correlation to OR	Cognitive test (information processing speed; digit symbol	OR: derived (unadjusted)

							substitution test)	
Morikawa et al, 2022	4601	73.63	56.8%	None	Regression coefficients as reported in table 2	Regression coefficients to OR	Composite effect size based on reported measures from an episodic memory instrument, trailmaking test A&B, and the digit symbol substitution test	OR: age, sex, body mass index, medication, eyesight, smoking history, education level, income level, gait speed, geriatric depression scale
Ng et al, 2012	871	65.2	66%	Included all participants	Table 5 (utilized "sometimes" and "often" reported data	Pooled sometimes and often effect sizes across 4 cognitive measures	Composite effect size based on reported measures from a cognitive screening instrument, attention/working memory, episodic memory, verbal fluency measures.	OR: age (years), gender, education (6 and >6 years), hypertension, diabetes, cardiac diseases, stroke, leisure time activities (score <8, 8–11, and >11), smoking, alcohol consumption, depression (GDS 5) and APOE-e4, and baseline cognitive domain scores
Park et al., 2020	1919	75.2	31.63%	None	Table 3 reported OR	Combined and inverted effect sizes for comparability to other studies	Cognitive screening measure (based on MMSE)	OR: age, sex, education, monthly money spent on cultural leisure (SES), volunteer work, self-rated health, exercise, IADL, depression

Qi et al, 2021	21732	69.39	51%	None	Table 2 adjusted odds ratio for smartphone use	None needed	Cognitive screening measures (based on MMSE and AD8)	OR: sex, age, living in rural area, non-widowed, education, worker, farmer, smoker, alcohol drinker, tea drinker, regular exercise, living with family, socialize with neighbors, read newspapers, BMI, hypertension, CHD, diabetes, stroke, hearing loss
Quialheiro et al, 2022	594	70.07	66%	Used follow up sample	Table 2; adjusted odds ratios	None needed	Cognitive screening measures (based on MMSE)	OR: sex, age, years of education, household income, self-reported comorbidities (stroke, arthritis, cardiovascular diseases, back pain, depression, diabetes, hypertension), and time
Raichlen et al, 2022	146651	64.59	49.54	None	Only included HR for hours of computer use	None needed (HR only)	Dementia diagnosis	OR: derived (unadjusted); HR: age, sex, physical activity, TV, education, Townsend deprivation index, ethnicity, APOE genotype, alcohol consumption, smoking status, chronic disease, depression, healthy diet score, BMI, social contact, and sleep
Ramos et al, 2021	497	68.8	73.4%	None	Table 7	None needed	Probable cognitive impairment	OR: age, subjective memory complaint, education, marital status
Raven et al, 2018	300	57.5	25.3%	None	Table 5	None needed	Trail Making Test and 3MS	OR: TMT based on age, gender, and race or ethnicity adjusted norms; 3MS based on age- and

								education-adjusted reference values
Shimokihara et al, 2024	302	75.2	61.92%	User versus non-user	Table S1	Independent group differences converted to OR	MMSE	OR: none
Slegers et al, 2012	594	62.45	52.4%	None	Unstandardized beta weights are reported in Table 5; authors provided information on N's at various time points	Unstandardized beta weights converted to odds ratios on several cognitive measures to create pooled effect	Composite effect size for attention/working memory, episodic memory, executive functioning, and processing speed.	age, sex and level of education, baseline performance on the particular cognitive test
Sommerlad et al, 2020	6050	55.9	30.7%	None	Figure 2; HR reported (only included HR analysis)	None needed (HR only)	Dementia diagnosis	OR: derived (unadjusted); HR controlled for: age, sex, education, occupational position, ethnicity, employment status, marital status, smoking, alcohol, exercise, body mass index, hypertension, diabetes, coronary heart disease, and stroke at leisure activity measurement
Sundararaman et al, 2021	35	74.75	60%	Smartphone and laptop/PC outcomes	Table 5	Correlations to OR	Cognitive test domains (immediate recall, delayed recall, working memory, verbal fluency, reasoning, processing speed)	OR: none

Tun & Lachman, 2010	2671	55.28	54.9%	Total sample	Reported beta weights	Used estimated pooled standard deviations and sample sizes across sample to convert beta weight to OR	Cognitive composite derived from executive and general cognition measures	age, sex, education, income, self-rated health, limitations in ADL
Wang et al, 2024	10470	71.06	56.59%	Only MHAS sample (others already included in meta-analysis)	Table 2	None needed	Cognitive tests (orientation, memory, executive function)	OR: age, gender, education, labour force status, household wealth, married or partnered, and co-residence with children; smoking, drinking, hypertension, stroke, cancer, and depressive symptoms
Wu et al, 2019	323	75.87	65.5%	None	Table 2 (cognitive effects by use criteria)	Created a pooled cognitive effect for key measures for device use and compared to the non-user group	Composite effect size from the attention/working memory, cognitive screen, episodic memory, executive functioning, processing speed, and verbal fluency measures reported	OR: derived (unadjusted)
Wu et al, 2023	10318	73.8	52.6%	None	eTable 3	None needed (HR only)	Dementia diagnosis	HR: age, gender, ethnicity, education, socioeconomic status index, living situation, smoking status, alcohol intake, body mass index,

								physical activities, comorbidities, depression, and frailty.
Xia et al, 2024	42548	59.58	51%	None	Table 2	Regression coefficients to OR	Cognitive tests: (vocabulary and figure tests)	OR: age, gender, urban/rural, education, retirement status, health condition, partner, number of children cohabiting, income, endowment insurance, and medical insurance
Yeung et al, 2023	525	68.7	66.7%	None	Table 2	Correlations to OR	MoCA	OR: derived (unadjusted)
Yildirim, E. & Ogel-Balaban, 2023	70	65.31	48.57%	None	Table 1	Independent group differences converted to OR	Cognitive tests (Digit span, free and cued selective reminding, digit symbol substitution, Stroop task, trail making test, and fluency tests)	OR: derived (unadjusted)
Yuan et al, 2019	2600	69.06	46.12%	None	Table 3	None needed	MoCA	OR: age, region, marital status, level of education, income, occupation, smoking, drinking, hypertension, diabetes, and depression

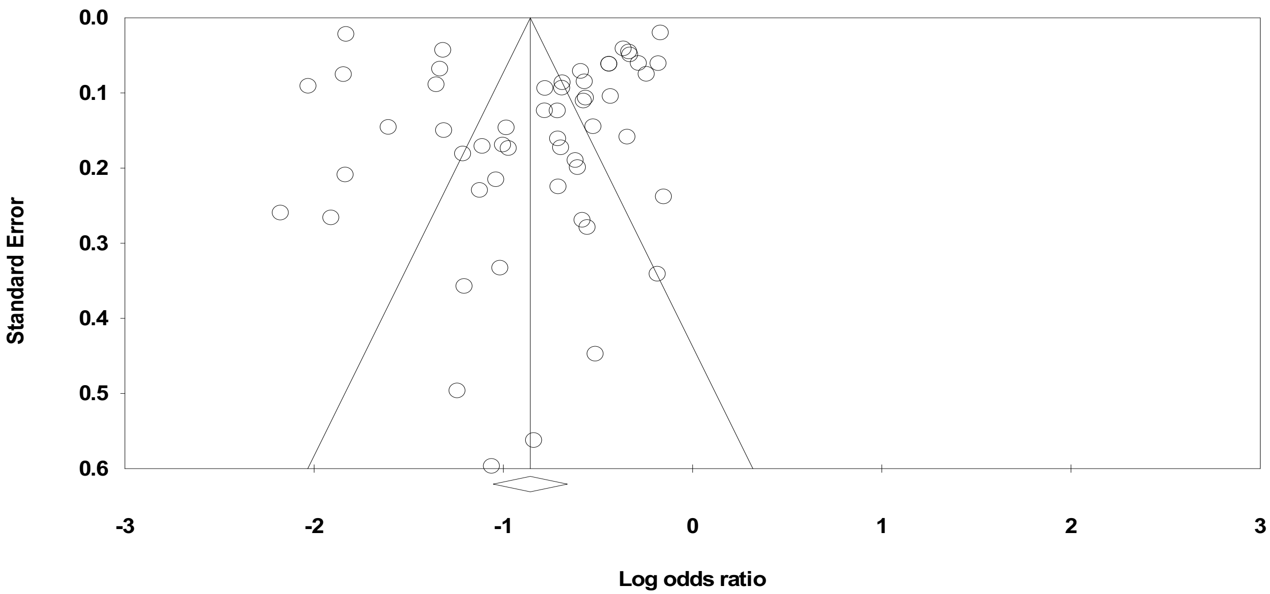

Figure S1. **Funnel plot of standard error by logs odds ratio**

The funnel plot shows 41% of studies to the left of the line. Duval and Tweedie's trim and fill method was used to assess the asymmetry of the funnel plot; it indicated no studies were missing. Furthermore, under the random effects model, Duval and Tweedie's method yields a point estimate for the combined studies of 0.450 (95% confidence interval: 0.441, 0.459) and these values were unchanged using trim and fill. In terms of a fail-safe N, given that the current meta analysis includes data from 54 studies with a z-value of -59.929 and corresponding 2-tailed p-value < 0.00001, the fail-safe N is estimated at 50433 (i.e. 50,433 null effect studies would need to be located for the meta-analysis p value to exceed 0.05). The Begg and Mazumdar correlation was significant but small (-0.247, *p* = .008). The Egger's test of the intercept was not significant (intercept (B0) = -0.205, 95% confidence interval: -3.99, 3.58, t=0.11, df=52, 2-tailed p-value = 0.91).

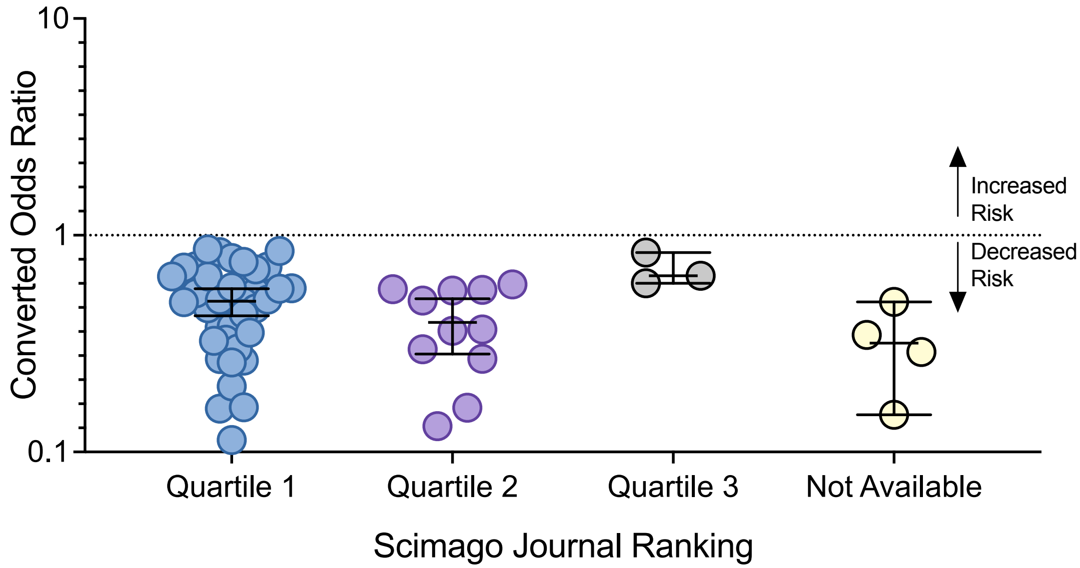

Figure S2. **Derived effect sizes (k=54) in relation to type of Scimago journal ranking.**
Most studies (66.7%) were published in Scimago-ranked Quartile 1 journals (top ranking), with an average Clarivate journal impact score of 4.19 (*sd* = 2.18). Odds ratios are plotted on a log-10 scale. The center bar indicates the mean value and the error bars reflect 95% confidence intervals.

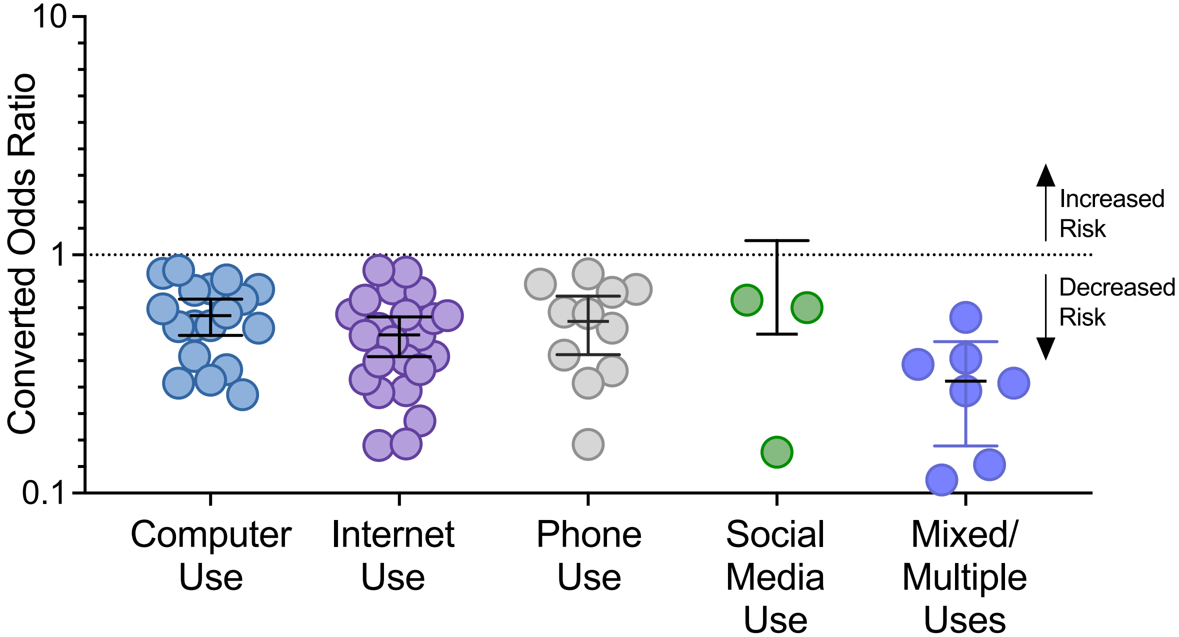

Figure S3. **Derived effect sizes in relation to type of technology studied.**
Odds ratios are plotted on a log-10 scale and are separated by computer use (k=18), internet use (k=23), phone use (k=11), social media use (k=3), and mixed/multiple uses (k=7). The center bar indicates the mean value and the error bars reflect 95% confidence intervals.

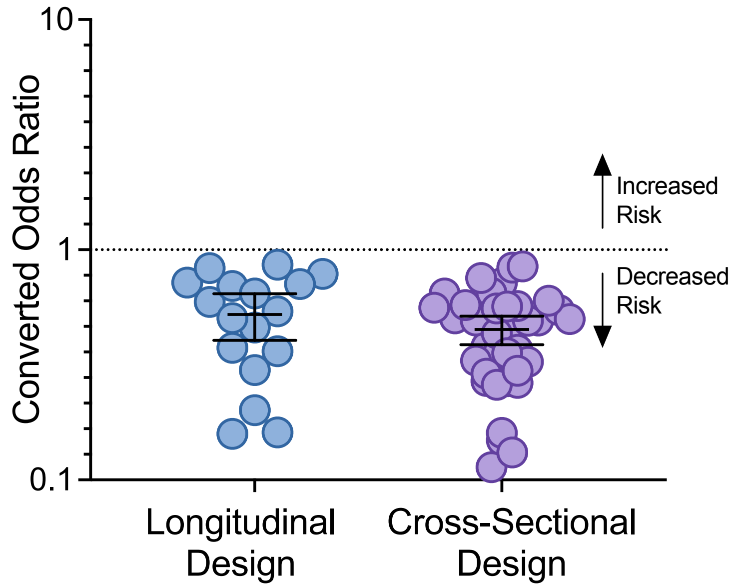

Figure S4. Derived effect sizes in relation to type of study design.
Odds ratios are plotted on a log-10 scale and separated by longitudinal (k=17) versus cross-sectional (k=37) designs. The center bar indicates the mean value and the error bars reflect 95% confidence intervals.

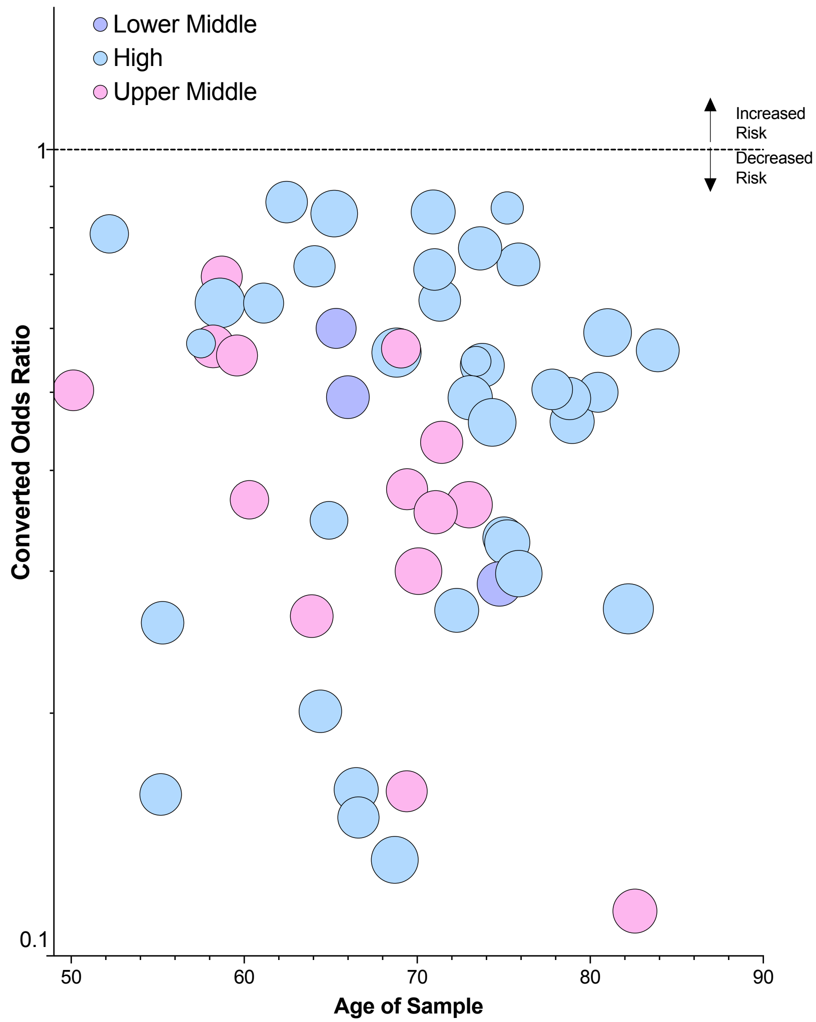

Figure S5. Bubble plot to illustrate the relationships between effect sizes, age, gender, and country-level income.

Study effect sizes are shown on the y-axis (k=54), average age is shown on the x-axis, country-level income as defined by the World Bank is shown as color brightness, and percent female in the study's sample is shown as the size of bubbles. One study was omitted from figure because only males were recruited. Odds ratios are plotted on a log-10 scale.

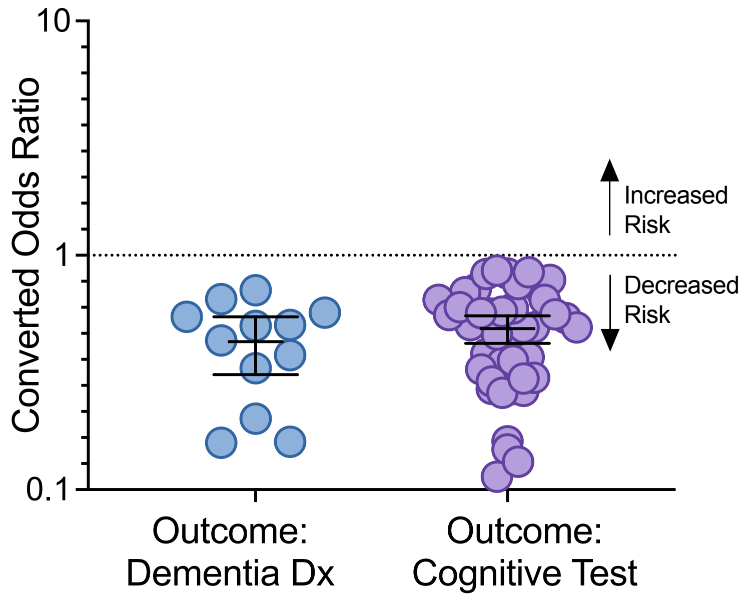

Figure S6. **Derived effect sizes in relation to types of outcome measures.**
Odds ratios are plotted on a log-10 scale and separated by studies using diagnostic variables (Dx, k=12) versus cognitive variables (k=42). The center bar indicates the mean value and the error bars reflect 95% confidence intervals.

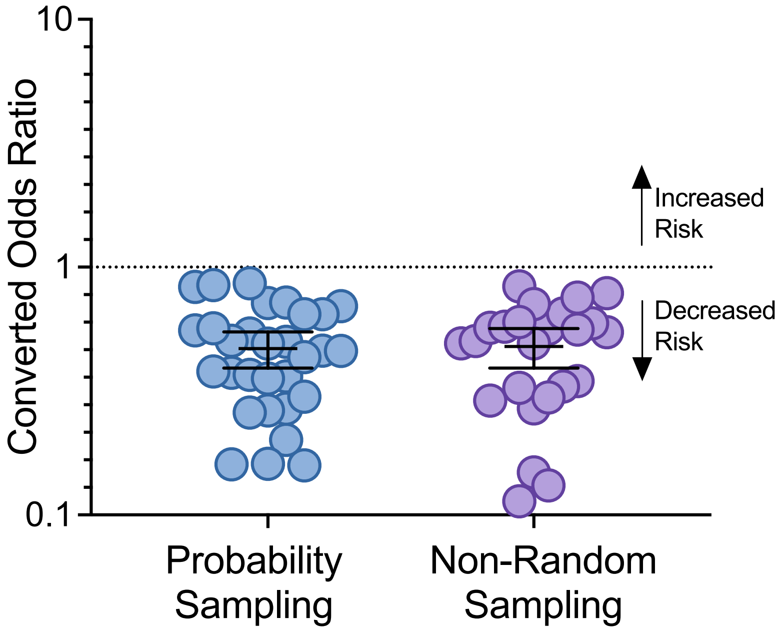

Figure S7. **Derived effect sizes in relation to sampling methodology.**

Odds ratios are plotted on a log-10 scale and separated by studies that used probability sampling methodology (k=30) versus non-random sampling approaches (e.g., convenience sampling; k=24). The center bar indicates the mean value and the error bars reflect 95% confidence intervals.

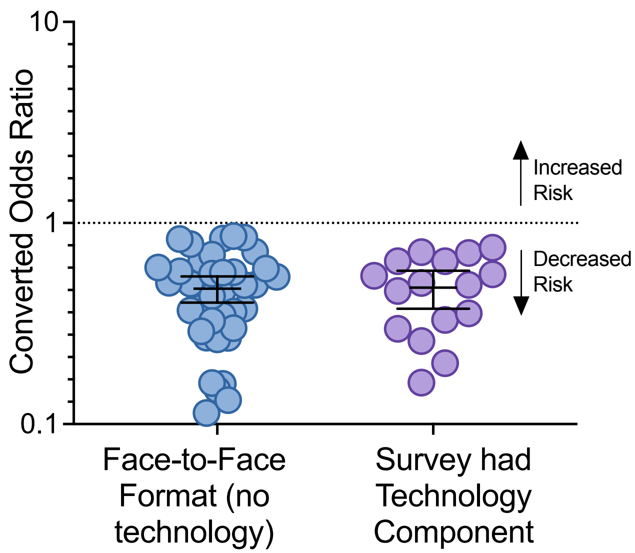

Figure S8. **Derived effect sizes in relation to technology requirements for participation.**
Odds ratios are plotted on a log-10 scale and separated by whether the study was conducted face-to-face (k=38) or required usage of technology during data acquisition (k=16). The center bar indicates the mean value and the error bars reflect 95% confidence intervals.