UNIVERSIDADE FEDERAL DE MINAS GERAIS

Faculdade de Medicina

Programa de Pós-Graduação em Medicina Molecular

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As associações entre tempo de tela e saúde mental no ciclo vital

Belo Horizonte, Minas Gerais, Brasil

2023

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AS ASSOCIAÇÕES ENTRE TEMPO DE TELA E SAÚDE MENTAL NO CICLO VITAL

Tese apresentada ao Programa de Pós-Graduação em Medicina Molecular da Faculdade de Medicina da Universidade Federal de Minas Gerais, como requisito para a obtenção do título de Doutor.

Linha de pesquisa: Neurociências

Doutoranda: Renata Maria Silva Santos

Orientador: Prof. Dr. Marco Aurélio Romano Silva
Coorientadora: Prof. Dra. Débora Marques de Miranda

Belo Horizonte, Minas Gerais, Brasil

2023

Santos, Renata Maria Silva.
SA237a As associações entre tempo de tela e saúde mental no ciclo vital [recursos eletrônicos]. / Renata Maria Silva Santos. - - Belo Horizonte: 2023.
215f.: il.
Formato: PDF.
Requisitos do Sistema: Adobe Digital Editions.

Orientador (a): Marco Aurélio Romano-Silva.
Coorientador (a): Débora Marques de Miranda.
Área de concentração: Medicina Molecular.
Tese (doutorado): Universidade Federal de Minas Gerais, Faculdade de Medicina.

1. Tempo de Tela. 2. Saúde Mental. 3. Estágios do Ciclo de Vida. 4. Longevidade. 5. Meios de Comunicação de Massa. 6. Dissertação Acadêmica. I. Romano-Silva, Marco Aurélio. II. Miranda, Débora Marques de. III. Universidade Federal de Minas Gerais, Faculdade de Medicina. IV. Título.

NLM: WS 462.5.T4

Bibliotecário responsável: Fabian Rodrigo dos Santos CRB-6/2697

UNIVERSIDADE FEDERAL DE MINAS GERAIS
FACULDADE DE MEDICINA
PROGRAMA DE PÓS-GRADUAÇÃO EM MEDICINA MOLECULAR

FOLHA DE APROVAÇÃO

AS ASSOCIAÇÕES ENTRE TEMPO DE TELA E SAÚDE MENTAL NO CICLO VITAL

RENATA MARIA SILVA SANTOS

Tese de Doutorado defendida e aprovada, no dia dez de outubro de dois mil vinte e três, pela Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação Medicina Molecular da Universidade Federal de Minas Gerais constituída pelos seguintes professores doutores:

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Documento assinado eletronicamente por **Marco Aurelio Romano Silva**, **Professor do Magistério Superior**, em 19/10/2023, às 10:42, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Mônia Aparecida da Silva**, **Usuário Externo**, em 19/10/2023, às 10:50, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Debora Marques de Miranda**, **Professora do Magistério Superior**, em 19/10/2023, às 11:31, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

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AGRADECIMENTOS

À Deus, pela força para passar por todas as etapas deste trabalho.

À minha família, por me incentivar na realização dos meus sonhos. Em especial ao meu marido Itamar e meus filhos Arthur e Athos, pelo apoio incondicional, pelo suporte nas horas mais difíceis, pela compreensão nas vezes em que não foi possível cuidar de tudo.

Ao meu orientador, professor Marco Aurélio, que acolheu minha proposta de desenvolver um trabalho de doutorado junto à sua equipe. Obrigada pela confiança! Obrigada por todo ensinamento e orientações!

À minha coorientadora, professora Débora, que tanto me ensinou, me conduzindo nas decisões desde a metodologia do trabalho, nas correções dos textos, até na escolha de revistas para publicar os resultados. Obrigada pela generosidade e paciência!

À Camila Mendes, pela amizade e pela parceria imprescindível na construção da metodologia e realização do trabalho.

Ao professor Jonas, pela ajuda com estatísticas e gráficos e pelas valiosas contribuições.

Aos alunos de iniciação científica do Laboratório Centro de Tecnologia em Medicina Molecular, em especial ao Guilherme, Yago, Maria Eduarda, Fernanda e Gabriela, agradeço a parceria. Vocês foram muito importantes para a concretização deste projeto!

Agradeço de forma muito especial à Samara, minha eterna aluna, mais que uma amiga, quase uma filha, que tem me acompanhado na condução deste trabalho, desde o início, com tanta dedicação. Agradeço também à seus pais João e Simone, pelo incentivo!

Aos demais colegas do Laboratório do Centro de Tecnologia em Medicina Molecular, em especial à Daniela Valadão, por todo suporte na condução do trabalho.

Por fim, à todos os meus amigos e colegas de trabalho que, de alguma forma, contribuíram para a finalização dessa etapa tão importante da minha vida!

O que a vida quer da gente é coragem

(Guimarães Rosa)

RESUMO

Introdução: O cotidiano está cada vez mais permeado pela tecnologia. A evolução das plataformas de mídia, além de otimizar a informação, tem um papel importante na aproximação das pessoas, sobretudo em contextos de isolamento social, como o vivido na pandemia da Covid-19. Pais, professores, pesquisadores e formuladores de políticas relatam preocupação com possíveis efeitos desfavoráveis do uso excessivo de telas, em especial, na saúde mental das pessoas. Como os indivíduos podem responder diferentemente a exposição às telas em cada etapa do desenvolvimento, este estudo tem o objetivo de investigar as associações entre tempo de tela e a saúde mental dos indivíduos nas diferentes fases do ciclo vital. Desde crianças, nos adolescentes, nos adultos até os idosos serão avaliados quanto aos potenciais efeitos da exposição às telas. **Método:** A investigação foi realizada por meio de quatro revisões sistemáticas da literatura. Uma pergunta PICO foi estabelecida, em conformidade com o Protocolo PRISMA, bem como foi realizado registro da revisão no PROSPERO e avaliado risco de viés por instrumentos padronizados. As bases de dados Scopus, Pubmed e PsycInfo foram escolhidas para busca do tema e os descritores foram escolhidos conforme a faixa etária e de acordo com o significado no MESH. Como o uso das telas tem se modificado ao longo dos anos, optamos por incluir apenas estudos dos últimos 10 anos. Amostras com as idades pertinentes a cada fase do ciclo vital, sem diagnóstico mencionado de problemas de saúde mental prévio, que utilizaram escalas para avaliar os diversos aspectos de saúde mental e que apresentaram associações diretas de tempo de tela com desfechos de saúde mental foram selecionadas. A perspectiva ao longo da vida foi norteadora para a comparabilidade e análise dos resultados. **Resultados**: Dentre os desfechos em saúde mental, depressão e ansiedade foram os que apareceram em todas as quatro fases investigadas do ciclo vital. As respostas à influência do tempo de tela na saúde mental foram diferentes em cada fase do ciclo vital. O uso de telas apontou fatores particulares com adolescentes apresentando mais autoagressão relacionada ao uso de telas; adultos mais estresse, idosos mais sofrimento psicológico e crianças apresentaram mais problemas de comportamentos. O conteúdo das telas demonstrou exercer impacto importante na saúde mental e não somente a contabilização do tempo. **Conclusão**: O indicador "tempo de tela" pode não ser o mais apropriado para as investigações dos efeitos da exposição a dispositivos de tela em resultados de saúde mental. Pesquisas futuras devem considerar a ideia de que nos encontramos irremediavelmente envolvidos pelas telas e resta descobrir maneiras de se conviver de forma saudável com essa nova realidade.

Palavras-chave: Tempo de Tela, Saúde Mental, Crianças, Adolescentes, Adultos, Idosos.

ABSTRACT

Introduction: Everyday life is increasingly permeated by technology. The evolution of media platforms, in addition to optimizing information, plays an important role in bringing people together, especially in contexts of social isolation, such as that experienced during the Covid-19 pandemic. Parents, teachers, researchers and policy makers report concern about possible unfavorable effects of excessive screen use, especially on people's mental health. As individuals may respond differently to exposure to screens at each stage of development, this study aims to investigate the associations between screen time and the mental health of individuals at different stages of the life cycle. Children, teenagers, adults and the elderly will be assessed regarding the potential effects of exposure to screens. **Method:** The investigation was carried out through four systematic literature reviews. A PICO question was established, in accordance with the PRISMA Protocol, and the review was registered in PROSPERO and risk of bias was assessed using standardized instruments. The Scopus, Pubmed and PsycInfo databases were chosen to search for the topic and the descriptors were chosen according to the age group and according to the meaning in MESH. As the use of screens has changed over the years, we chose to only include studies from the last 10 years. Samples with ages relevant to each phase of the life cycle, without a previous diagnosis of mental health problems, which used scales to assess the different aspects of mental health and which presented direct associations between screen time and mental health outcomes were selected. The lifelong perspective was a guide for comparability and analysis of results. **Results:** Among the mental health outcomes, depression and anxiety were those that appeared in all four phases of the life cycle investigated. Responses to the influence of screen time on mental health were different at each stage of the life cycle. The use of screens highlighted particular factors with adolescents presenting more self-harm related to the use of screens; adults more stress, elderly people more psychological suffering and children showed more behavioral problems. The content of screens has been shown to have an important impact on mental health, not just time tracking**. Conclusion:** The “screen time” indicator may not be the most appropriate for investigations of the effects of exposure to screen devices on mental health outcomes. Future research should consider the idea that we find ourselves irremediably involved in screens and that it remains to discover ways to live in a healthy way with this new reality.

Keywords: Screen Time, Mental Health, Children, Adolescents, Adults, Elderly.

LISTA DE GRÁFICOS

LISTA DE FIGURAS

ARTIGO 4

LISTA DE TABELAS

ARTIGO 1 - titulo: The associations between screen time and mental health in children: a systematic review

ARTIGO 2 -titulo: The associations between screen time and mental health in adolescents: a systematic review

ARTIGO 3 – titulo: The associations between screen time and mental health in adults: a systematic review

ARTIGO 4 – titulo: The associations between screen time and mental health in the elderly: a systematic review

SUMÁRIO

1. INTRODUÇÃO

A natureza ubíqua da tecnologia de comunicação digital permeia as atividades de vida diária na sociedade moderna (Qiu et al., 2021; Small et al., 2020). O desenvolvimento da tecnologia digital e das mídias sociais passou por uma fase transformadora no final dos anos de 1990. Surgiam os celulares, computadores e sites foram remodelados para integrarem-se ao cotidiano das famílias, e neste contexto nasciam os chamados "nativos digitais" (Boyd, 2014; Coyne, Padilla-Walker, & Howard, 2013). Hoje, convivem idosos desafiados a se envolverem com os novos dispositivos e recursos tecnológicos e jovens que não experimentaram a vida sem tecnologia (Ross et al., 2018). Adicionalmente, a pandemia COVID-19 fez o mundo vivenciar a necessidade de um uso ainda mais expressivo da internet e do tempo de tela (Marston et al., 2023; Wang, Xu, & Xie, 2022).

A estimulação sensorial crônica, como tempo excessivo em atividades com dispositivos baseados em tela, parece afetar o desenvolvimento cerebral, levando ao aumento dos riscos de problemas cognitivos, emocionais e comportamentais (Manwell, Tadros, Ciccarelli, & Eikelboom, 2022; Neophytou, Manwell, & Eikelboom, 2021). O uso frequente da tecnologia digital pode ter aspectos positivos em algumas funções cerebrais, como a cognição em idosos, no entanto, tem sido associado a desfechos desfavoráveis, como aumento dos sintomas do Transtorno de Déficit de Atenção e Hiperatividade (TDAH), comportamentos aditivos, funcionamento social prejudicado e problemas de sono (Small et al., 2020; Twenge, Cooper, Marceneiro, Duffy, & Binau, 2019).

Efeitos como sedentarismo e deslocamento do tempo de atividades enriquecedoras para se ater às telas também impactam na saúde mental (Boers, Afzali, Newton, & Conrod, 2019; Brown & Kwan, 2021; Gilchrist et al., 2021). Nos últimos anos, tem havido um crescente reconhecimento da importância da saúde mental para alcançar os objetivos globais de desenvolvimento. Em 2022, a *World Health Organization* (WHO) divulgou o Relatório Mundial de Saúde Mental, destacando a necessidade urgente de remodelar o ambiente das pessoas para transformar a saúde mental.

A saúde mental pode ser definida como um estado de bem-estar que permite aos indivíduos lidarem com os estresses usuais da vida e funcionar produtivamente (Fusar-Poli 2020; WHO, 2001). Em 2019, uma em cada oito pessoas no mundo vivia com um transtorno da saúde mental, sendo os transtornos de ansiedade e depressivos os mais comuns (WHO, 2022). Atualmente, há uso generalizado do termo 'saúde mental' como um eufemismo para 'doença mental' (Cattan, 2006). Há pouco consenso sobre uma

definição geral de saúde mental (Manwell et al., 2015). Por exemplo, a WHO inclui a funcionalidade e a realização do próprio potencial, como componentes centrais da saúde mental. Outras definições adicionam o desenvolvimento intelectual, emocional e espiritual, autopercepção positiva, sentimentos de autoestima, saúde física e harmonia intrapessoal (Bhugra & Sartorius, 2013).

Anteriormente à total onipresença das telas, já havia a preocupação em como as interações nas redes sociais e comunicação via computadores poderia afetar certos aspectos normais do comportamento humano e causar transtornos psiquiátricos (Pantic, 2014). A investigação da influência do tempo de tela na saúde mental, entretanto, têm observado que os resultados não são uniformes, demonstrando que a cada etapa do desenvolvimento, os indivíduos podem responder de determinada forma à exposição excessiva aos dispositivos de tela (Sun, Li, Zhang, & Zhang, 2022). Além das diferenças desenvolvimentais e comportamentais, observadas no ciclo vital, no que se refere à influência do tempo de telas na saúde mental, há de se destacar também o impacto do tipo de dispositivo e conteúdo veiculado (Griffioen et al., 2021; Zhang et al., 2022; Small et al., 2020).

O desenvolvimento humano é um processo multidimensional, cuja base é a interação contínua entre indivíduo e contexto (Underwood, George, & Burnell, 2023). A psicologia do desenvolvimento ao longo de toda a vida (*Lifespan*), busca mensurar a influência conjunta de variáveis individuais e sócio-históricas nos indivíduos (Neri, 2006). O paradigma "*ao longo da vida"* compreende uma sequência de mudanças previsíveis, de natureza biológica, que ocorrem ao longo das idades, e uma sequência previsível de mudanças, inclusive psicossociais, determinadas pelos processos de socialização ao qual as pessoas estão sujeitas (Baltes et al., 2004). A psicologia do desenvolvimento do ciclo de vida, atualmente abreviada como psicologia do ciclo de vida, lida com o estudo do desenvolvimento ontogenético. Uma das premissas dessa abordagem é o conceito de que o desenvolvimento pode ser usado para organizar as evidências sobre os processos adaptativos ao longo da vida. Desse modo, é esperado que cada período do ciclo de vida (infância, adolescência, idade adulta, velhice) tenha sua própria agenda de desenvolvimento e contribua para o ciclo vital do indivíduo, incluindo sua gama de plasticidades (Baltes, 2003). A perspectiva "*de ciclo de vida"* explica, por exemplo, por que pesquisadores costumam se interessar pelas sequelas da infância, na busca de suas consequências a longo prazo. Para entender a interação bebê-adulto, passa a ser

importante o reconhecimento de que os adultos também estão sujeitos a desafios de desenvolvimento (Baltes & Smith, 2004).

Paul Baltes, o teórico mais expressivo da perspectiva *Lifespan* do desenvolvimento humano, foi um psicólogo alemão que se dedicava ao campo da psicologia do envelhecimento (Scoralick-lempke & Barbosa, 2012). Segundo Freire, Resende & Rabelo (2012), as pessoas precisam se ajustar, enfrentar e obter vantagem das mudanças nas oportunidade e das dificuldades características de cada estágio da vida. A forma com que as pessoas conseguem fazer isso para manter o domínio sobre o próprio curso de vida é uma questão importante para a psicologia do desenvolvimento humano dentro da perspectiva *Lifespan*. Com intuito de entender o processo de melhoria do desenvolvimento pessoal e bem-estar, foi proposto o Modelo de Seleção, Otimização e Compensação ou modelo (SOC), dentro da perspectiva *Lifespan* (Freund & Baltes, 2002). De acordo com o modelo SOC, a seleção refere-se aos mecanismos que direcionam as interações indivíduo-ambiente para escolhas de domínios de vida onde deve haver maior investimento de tempo e esforço. A otimização seria a alocação e o refinamento de recursos internos e externos para alcançar elevados níveis de funcionamento nos domínios selecionados. Já os processos de compensação seriam respostas às perdas na capacidade do indivíduo que incluem processos psicológicos ou esforços comportamentais para melhorar a funcionalidade, buscando a manutenção de um determinado nível de funcionamento (Freire, Resende & Rabelo, 2012).

O modelo SOC busca explicar como efetivamente o desenvolvimento humano emerge, e como as mudanças desenvolvimentais de recursos, contextos e desafios ao longo da vida requerem uma reorganização adaptativa nos meios, metas e resultados (Rozario, Kidahashi & DeRienzis, 2011). De forma mais específica, há uma concepção da teoria do ciclo de vida que foca em um comportamento ou função (como percepção, processamento de informações, controle de ação, traços de personalidade, etc.). Nesta perspectiva, o objetivo é caracterizar as mudanças ao longo da vida nos processos associados à categoria de comportamento estudada (Baltes, Rösler, & Reuter-Lorenz, 2006).

A perspectiva *de ciclo de vida* centrada na função foi incluída para operacionalizar o presente estudo e tentar observar a influência do tempo de tela na saúde mental, ao longo da vida das pessoas. Todavia, uma pesquisa que acompanhe um mesmo indivíduo em todas as fases do seu desenvolvimento seria de difícil execução. Diante dessa realidade, aventou-se a possibilidade de verificar as respostas psicológicas ao tempo de tela em cada

fase da vida, ao mesmo tempo, em um número representativo de indivíduos, culturas e desfechos, como forma de sintetizar os resultados. As evidências geradas para cada fase do ciclo vital poderiam funcionar como um "continuum" na compreensão das respostas psicológicas e comportamentais das pessoas ao longo da vida.

Considerando, portanto, o atual contexto de interação com as telas e a necessidade de aprimorar o entendimento dos impactos dessa exposição na saúde mental dos indivíduos, ao longo do ciclo vital, este estudo emerge como oportunidade de contribuição robusta com o corpo sistematizado de literatura, para as tomadas de decisão nos cuidados e políticas de saúde.

Esta Tese está apresentada em conformidade com as orientações do Programa de Pós-Graduação em Medicina Molecular da Faculdade de Medicina da Universidade Federal de Minas Gerais (UFMG), sendo composta por essa introdução, revisão da literatura, objetivos e hipóteses, método, resultados, discussão e considerações finais. As seções de revisão de literatura e resultados serão apresentados sob a forma de quatro artigos científicos de revisão sistemática da literatura, em versão inglesa, como resultados da pesquisa desenvolvida.

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2. HIPÓTESES

Este estudo hipotetizou que tempos maiores de exposição às telas levariam à prejuízos na saúde mental. E que as respostas psicológicas à influência do tempo de tela na saúde mental poderiam ser diferentes, nas diferentes fases do ciclo vital

3. OBJETIVOS

3.1 Objetivo Geral

O objetivo deste estudo foi verificar o efeito do tempo de tela na saúde mental dos indivíduos, durante o ciclo vital.

3.2 Objetivos específicos

- Investigar as associações entre tempo de tela e desfechos de saúde mental em crianças;

- Investigar as associações entre tempo de tela e desfechos de saúde mental em adolescentes;

- Investigar as associações entre tempo de tela e desfechos de saúde mental em adultos;

- Investigar as associações entre tempo de tela e desfechos de saúde mental em idosos;

- Averiguar se as associações entre o tempo de tela e os desfechos de saúde mental apresentaram mudanças ao longo do ciclo vital.

4. METODOLOGIA

Esta pesquisa foi desenvolvida por meio de revisões sistemáticas da literatura, com abordagem qualitativa dos resultados. Buscando contemplar todo o ciclo vital, foi realizada uma revisão sistemática da literatura para cada fase, ou seja, para crianças, adolescentes, adultos e idosos. Os estudos foram minerados na tentativa de responder a seguinte pergunta: Qual o efeito do tempo de tela na saúde mental durante o ciclo vital?

4.1 Definição da estratégia de busca

O processo de definição da estratégia de busca e seleção dos artigos foi realizado em pares, com validação da estratégia pelos orientadores do trabalho. Inicialmente foram realizadas buscas preliminares nas bases de dados, com o objetivo de verificar o estado da arte no campo das associações entre tempo de tela e saúde mental. Com as buscas preliminares foi possível verificar o quantitativo de artigos, as bases mais produtivas, além dos descritores padronizados do *mesh* que forneceriam retorno de maior número de artigos nas bases de dados. De acordo com a estratégia PICO (Methley et al., 2014), a população do estudo seria composta pelos indivíduos em cada fase da vida, a intervenção seria representada pela exposição às telas e o desfecho (*outcome*) seria representado por quaisquer aspectos referentes à saúde mental, incluindo medidas relacionadas ao bem-

estar mental. Adicionalmente, os grupos de controle poderiam estar ausentes dos estudos observacionais incluídos.

4.2 Critérios de Elegibilidade

A etapa seguinte foi a determinação dos critérios de inclusão e exclusão. Esta foi uma etapa desafiadora, tendo em vista a importância de manter estudos relevantes para o tema, evitando-se, entretanto, o levantamento de número muito grande de artigos, o que inviabilizaria a pesquisa. Sendo assim, balizada pelo tema, pela estratégia de PICO e pelos descritores padronizados existentes no *mesh*, a estratégia de busca foi testada. O descritor "*mental health*" foi utilizado como um termo guarda-chuva, com intuito de incluir todos os possíveis desfechos relacionados à saúde mental, assim como o termo "*screen time*". Após a validação da estratégia de busca pelos orientadores, cada revisão foi registrada no site PROSPERO e conduzida por, no mínimo, dois pesquisadores. É importante destacar que os critérios de inclusão foram definidos com objetivo de incluir o máximo de artigos relevantes. Já os critérios de exclusão foram estabelecidos com intuito de conferir maior especificidade.

Como a revisão seria realizada para as quatro fases da vida, ficou definido que seriam incluídos artigos publicados a partir de 2010, com objetivo de acomodar estudos da última década em todas as quatro revisões. Permaneceriam na revisão somente artigos que avaliassem diretamente as associações entre o tempo de tela [ou seja, a quantidade de tempo gasto usando um dispositivo com tela, como smartphone, computador (PC), console de videogame, televisão (TV) e mais, para entretenimento ou uso educacional] e saúde mental, ou seja, (problemas de humor, problemas de internalização ou externalização, sofrimento psicológico, distúrbios do sono, aspectos relacionados ao bem-estar mental como autoestima, resiliência, florescimento, entre outros), com pelo menos uma variável avaliada. Estudos com amostra seletiva que apresentavam uso problemático de telas ou de internet seriam excluídos. Estudos em que as telas fossem utilizadas para auxiliar na funcionalidade, como cadeiras de rodas equipadas com telas, entre outros, também seriam excluídos. E finalmente aqueles estudos, cujas amostras já apresentassem problemas de saúde mental previamente diagnosticados, ou estivessem em atendimento em ambulatórios de psiquiatria ou serviços de saúde mental, seriam excluídos. Esse conjunto de estratégias foi adotado com intuito de diminuir a possibilidade de a amostra do estudo possuir alguma forma de seletividade.

4.3 Procedimentos

As revisões foram realizadas para cada fase do ciclo vital, de acordo com *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* – PRISMA (Page et al., 2021) e registradas no site PROSPERO. Para a revisão na fase da infância foram utilizados os seguintes descritores: "*screen time*", "*children*" e "*mental health*". Para a revisão na fase da adolescência foram utilizados os descritores "*screen time*", "*adolescents*" e "*mental health*". Para a revisão na fase adulta foram utilizados os descritores "*screen time*", "*adults*" e "*mental health*". E para a revisão dos idosos foram utilizados os descritores "*screen time*", "*elderly*" "*aged*" e "*mental health*". Todos os cruzamentos foram combinados com o operador *AND*, nas bases de dados PubMed, PsycInfo e Scopus.

O procedimento de triagem foi realizado aos pares, incluindo uma busca inicial independente. Após a exclusão dos registros duplicados, os títulos e resumos de cada estudo foram triados de acordo com os critérios de inclusão e exclusão. Os artigos elegíveis para leitura na íntegra foram selecionados, dois autores discutiram os resultados e chegaram a um consenso sobre os artigos a serem incluídos na revisão. Quaisquer discordâncias foram resolvidas por consenso com terceiro autor.

4.3.1 Extração de dados

Os seguintes dados foram extraídos de acordo com um formulário padrão que incluiu: primeiro autor, data, país de publicação, desenho do estudo, características da amostra e objetivos do estudo, avaliação de saúde mental, medidas de tempo de exposição à tela e principais associações encontradas. A alocação dos registros no formulário seguiu a ordem definida pelas normas das revistas em que os artigos foram submetidos. O termo autorreferido foi utilizado para indicar que o tempo de tela foi o tempo gasto em atividades baseadas em tela, relatado pelos pais ou responsáveis do participante, ou pelo próprio participante, em resposta a uma pergunta.

4.3.2 Avaliação de qualidade dos estudos incluídos

A avaliação foi realizada em pares e as discrepâncias foram resolvidas por consenso com um terceiro revisor. Para as revisões das crianças, dos adolescentes e dos idosos a Escala de Newcastle-Ottawa (ANEXO I) foi utilizada para verificar a qualidade metodológica dos estudos, com base em critérios relacionados à seleção e comparabilidade entre coortes e relacionados aos resultados do estudo (Wells et al., 2021). A qualidade metodológica dos estudos transversais foi realizada utilizando a Newcastle Ottawa adaptada para estudos transversais (ANEXO II) (Herzog et al., 2013). A pontuação máxima (9 pontos) representa alta qualidade metodológica (Fontela, Abdala, Forgiarini, & Forgiarini, 2018).

Para a revisão dos adultos, a ferramenta de risco de viés da *Cochrane Collaboration* (ANEXO III) (Higgins et al., 2011), foi usada para avaliar o risco de viés nos Ensaios Clínicos Randomizados (ECRs) incluídos. A qualidade metodológica dos estudos observacionais longitudinais foi avaliada pela Ferramenta de Avaliação Crítica do Instituto Joanna Briggs (JBI) para estudos de Coorte (ANEXO V) e dos estudos transversais com a JBI estudos transversais (ANEXO V) (Moola et al., 2020).

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6. RESULTADOS

Os resultados desta pesquisa serão descritos por meio dos quatro artigos provenientes das revisões sistemáticas, relativas a cada fase do ciclo vital. Para facilitar a análise, a seção de resultados foi adaptada de forma a acomodar os achados comuns à todo o ciclo vital sintetizados em gráficos, seguido dos artigos que originaram os dados. O artigo da revisão da fase da adolescência foi publicado em abril de 2023 na revista "*BMC Psychology*". O artigo dos adultos está submetido na revista "*Journal of Technology in Behavioral Science*". O artigo dos idosos está submetido, em fase de revisão na revista "*Behaviour & Information Technology*" e o artigo das crianças está submetido à revista "*Developmental Neuropsychology*", também em fase de revisão. As comprovações de submissão são apresentadas no (APÊNDICE A).

6.1 Características da amostra total

Os quatro artigos de revisão totalizaram 2.275.007 participantes. Foram 43 artigos incluídos na revisão das crianças, com 263,430 participantes, idade média de 7,01 anos. Na revisão dos adolescentes foram incluídos 50 artigos, totalizando 1.900.447 participantes com idade média de 14,85 anos. Foram 32 artigos incluídos na revisão dos adultos, com 77.219 participantes de idade média 29,45 anos e 17 artigos incluídos na revisão dos idosos, com 33.911 participantes, de idade média 66,73 anos.

6.2 Associações entre saúde mental e tempo de tela ao longo da vida

De todos os desfechos em saúde mental analisados pelas revisões sistemáticas, depressão e ansiedade foram os que apareceram em todas as fases do ciclo vital. Os gráficos 1 e 2 mostram a variação das associações entre níveis de depressão e ansiedade e tempo de tela, ao longo do ciclo vital, considerando o número de artigos que investigaram esses desfechos.

Gráfico 1 - Aumento dos escores de ansiedade e depressão no ciclo vital

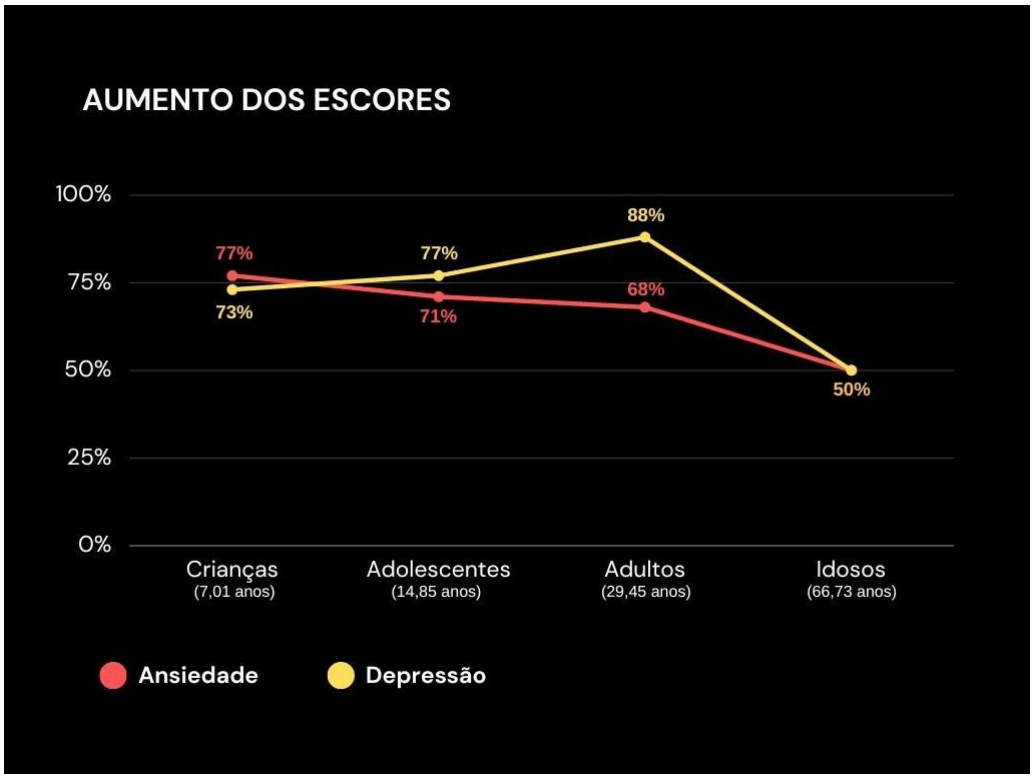
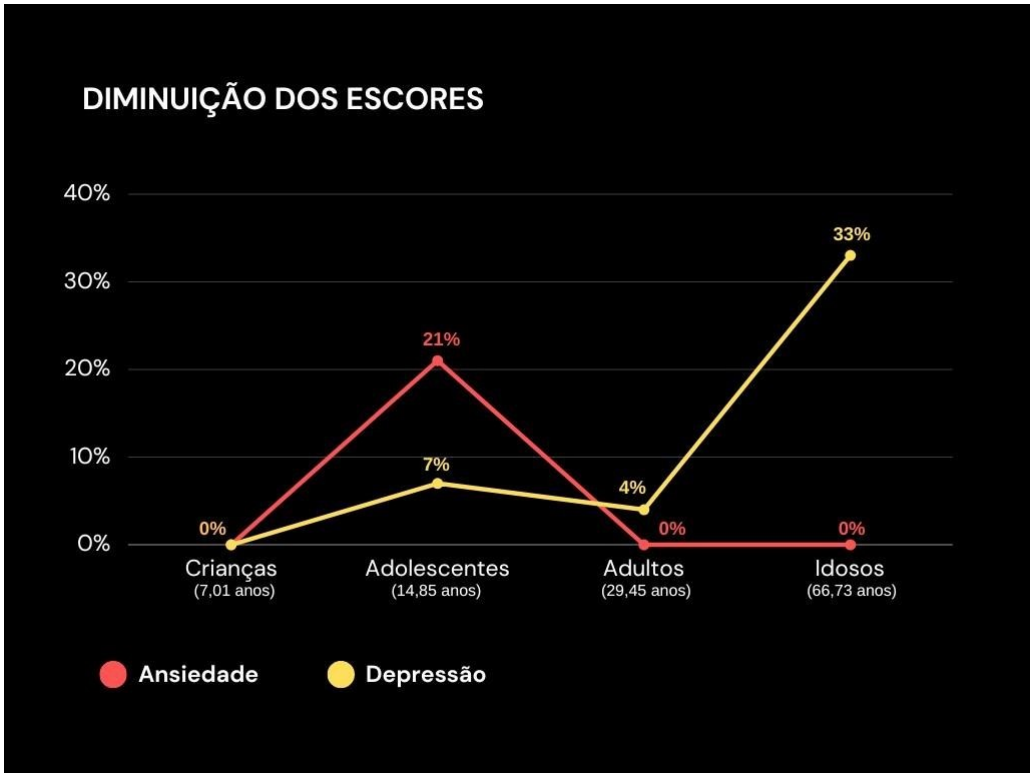


Gráfico 2 - Diminuição dos escores de ansiedade e depressão no ciclo vital



6.3 Artigo 1

The associations between screen time and mental health in children: a systematic review

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Abstract

Children are in direct contact with screens. We need to know if this is good for mental health. The study developed is a systematic literature review, conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and registered in Prospero with the number CRD42022379345. The search was defined according to the PICO strategy and conducted with the descriptors: "screen time", "children" and "mental health," combined with the operator AND on databases PubMed, PsycINFO, and Scopus. Were included 43 articles. Most studies found associations between screen time and children's mental health. Screen time was positively correlated with Attention Deficit Hyperactivity Disorder; Autism Spectrum Disorder; Oppositional Defiant Disorder; mood symptoms such as anxiety and depression; emotional, social and conduct problems, self-esteem, and sleep. Self-mutilation behaviors, suicidal ideation or

attempts were also associated with screens. The studies suggest that excessive screen time can worsen children's mental health.

Keywords: children; screen time; mental health; media

Introduction

The World Health Organization (WHO) and the American Academy of Pediatrics (AAP) recommend that children up to 2 years old avoid Screen Time - ST (time spent viewing screens, including television, smartphones, computer and tablets), while children from 2 to 5 years old should not exceed one hour a day (Guram & Heinz, 2016; Kaye, Orben, Ellis, Hunter, & Houghton, 2020; WHO, 2019). This is because early childhood plays a key role in children's development and health (Black et al., 2017; Xie, Deng, Cao, & Chang, 2020). In general, children learn more from their environment, observing adults and human interactions, and an excess of ST can hinder these opportunities (Cai, 2019).

Despite the recommendations, there is a tendency to increase the time children spend in front of screens (Chen & Adler, 2019; Madigan, Browne, Racine, Mori, & Tough, 2019; Ribner & McHarg, 2021). Digital technology permeates people's daily lives, providing a means of communication and entertainment (Pandya & Lodha, 2021), and the proliferation of ST has even reached young children (Ribner & McHarg, 2021; Suleman, Sughra, Riaz, & Akbar, 2023). Although there are suggestions of positive effects in children such as promoting learning (Myers, LeWitt, Gallo, & Maselli, 2017; Pagani, Fitzpatrick, & Barnett, 2013), excessive ST has been linked to harmful effects on the development of health in children, compromising behavior and mental health (Dumuid, 2020; Kerai, Almas, Guhn, Forer, & Oberle, 2022; Kostyrka-Allchorne, Cooper, & Simpson, 2017; Tamana et al., 2019).

The mental health of children and young people have been a global public health concern (Bruha, Spyridou, Forth, & Ougrin, 2018). Data prior to the COVID-19 pandemic already showed a global prevalence of around 15% of mental health disorders in children and adolescents (Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015). Among the most common psychiatric disorders that can be identified in childhood are attention deficit/hyperactivity disorder (ADHD), anxiety disorders, behavior problems and depression (Perou et al., 2013). Common internalizing and externalizing symptoms

include anxiety, depression, and conduct problems (Gobrial, 2019). Some of these conditions, however, can co-occur (Bitsko et al., 2022).

In a previous review, moderately strong associations were found for children between ST and depressive symptoms and weaker ones between ST and behavior problems, anxiety, hyperactivity, inattention, and poor sleep (Guerrero, Barnes, Chaput, & Tremblay, 2019). Elevated ST was also associated with irritability and negative mood (Xie et al., 2020). Canadian preschool children with excessive ST had a 7-fold increased risk of meeting criteria for attention deficit hyperactivity disorder (ADHD) (Tamana et al., 2019). In China, children with TS ≥ 2 h/day had an increased risk of having emotional symptoms, conduct problems, hyperactivity, as well as behavioral symptoms of autism spectrum disorder (Wu et al., 2017).

In the digital era, parents face difficulties in proposing an ideal ST for their children (Chong, Teo, & Shorey, 2023). Among 1,200 households surveyed in the United States of America (USA), 45% of children preferred activities such as watching screens or playing games on devices compared to non-screen activities such as playing with a sibling or friend (Shin & Gweon, 2020). In previous investigations, our team found that exposure to screens was associated with the cognitive component of attention in children. With the common extensive use of screens, it is now necessary to understand the associations between ST and mental health that currently occur among children and this review intends to compile this evidence.

Method

This review was conducted in compliance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA (Page et al., 2021) and was registered at PROSPERO, under number CRD42022379345. A search was performed on 05/01/2023 with the following question: Is there any association between screen time and mental health in children? For this, the following descriptors were used: “screen time”, “children” and “mental health,” combined with the operator AND on databases PubMed, PsycINFO, and Scopus. The adopted strategy tried to increase the sensitivity of the searches, expanding the range of outcomes with the umbrella term mental health, and searching in all or any fields of the articles**.** In accordance with the PICO strategy, the study population was composed of individuals in the childhood and the intervention will be represented by exposure to screens. As outcomes, any aspects related to mental health

will be considered, including measures related to mental well-being, and the control groups may be absent from the observational studies included.

Inclusion criteria: (1) articles that directly assessed associations between screen time [i.e., the amount of time spent using a device with a screen such as a smartphone, computer (PC), video game console, television (TV) and more, for entertainment or educational use] and mental health, that is, (mood, internalization or externalization problems, sleep disorders, aspects related to mental well-being such as self-esteem), with at least one variable evaluated; (2) studies that measured mental health outcomes through validated scales/instruments; (3) studies with children, average age between 0 and 12 years; (4) articles published since 2010. Exclusion criteria: (1) studies carried out with children diagnosed with problematic internet use, (2) sample composed of children already diagnosed with mental health problems or being followed up in psychiatry outpatient clinics, (3) research that used screen-based devices to aid functionality and (4) case reports and case series.

The screening procedure was performed in pairs, including an initial independent search. After duplicate records were deleted, the titles and abstracts of each study were screened according to the inclusion and exclusion criteria. The articles eligible for full reading were selected and the two authors discussed the results and reached a consensus on articles to be included in the review. Any disagreements were resolved by consensus with the third author.

Data extraction

The following data were extracted according to a standard form that included: first author, date, country of publication, study design, sample characteristics and study objectives, mental health assessment, measures of screen time exposure, and main associations found. The allocation of records in the form followed the alphabetical order of the authors. The term self-reported was used to indicate that screen time was the time spent on screen-based activities, reported by the participant's parents or guardians, in response to a question. When the study applied a validated instrument or performed an objective measurement of screen time, it was indicated in the form.

Quality Assessment

The Newcastle-Ottawa Scale was used to ascertain the methodological quality of the studies, based on criteria related to selection and comparability between cohorts and

related to study outcomes (Wells et al., 2021). The methodological quality of the cross-sectional studies was performed using the adapted Newcastle Ottawa for cross-sectional studies (Herzog et al., 2013). The evaluation was performed in pairs and discrepancies were resolved by consensus with a third reviewer. The maximum score (9 points) represents high methodological quality (Fontela, Abdala, Forgiarini, & Forgiarini, 2018).

Results

A total of 6.998 records were identified in the databases, using the search strategy described above. After removing 590 duplicates, 6.408 articles were screened by title and abstract. The screening process excluded 6.322 notifications for not meeting the pre-established criteria. Thus, 86 articles were selected for full reading and 43 studies were included in this review. The reasons for excluding the other records and the entire selection process are described in detail in the PRISMA Flowchart (Additional File 1) (APÊNDICE B).

Characteristics of the studies

The 43 articles included totaled 263.430 participants, distributed in 12 longitudinal and 31 cross-sectional studies, published from 2013 to 2023. Table 1 (Additional File 2: Table 1) (APÊNDICE C) shows the distribution of this sample by country. Participants' ages ranged from 6 months (Monteiro, Rocha, & Fernandes, 2021; Liu et al., 2021), to 14 years (Cartanyà-Hueso et al., 2022). In the pooled sample, there was a greater participation of boys, however, one study did not provide this data (Guxens et al., 2019). Data extracted from the included studies are summarized in Table 2.

Table 2. Descriptive characteristics of the included studies

Author, year, country, type of study	N / Age / Gender / Purposes	Mental Health (MH) - assessment	Screen Time (ST) measurements	Main Associations
Ahmed et al., 2022 Egypt Cross-sectional	N: 564 Mean age: 8.77 years 58.9% boys To investigate associations of time spent on online gaming applications with behavioral problems, sleep	Behavioral problems: Strengths and Difficulties Questionnaire (SDQ) Alexithymia: Children's Alexithymia Measure (CAM) Emotion regulation: 9-questions derived from Swanson Nolan and Pelham (SNAP-IV)	Screen time was categorized based on the number of hours used for online gaming applications: Group 1 = participants use internet gaming apps for 1–2h Group 2 = participants use internet gaming apps for 3–4h	Children who used internet gaming applications for more than 6 h had a higher proportion of abnormal responses on the emotional symptoms and hyperactivity scales and highest percentage of poor sleep quality. The total score of emotional dysregulation and alexithymia was lower in participants who used Internet game applications for 1 to 2 h and higher

	problems, alexithymia, and emotion regulation.	Sleep Habits: Children's Sleep Habits Questionnaire (CSHQ-A)	Group 3 = participants use internet gaming apps for 5–6h Group 4 = participants use internet gaming apps for more than 6h	in children who used Internet game applications for more than 6 h. Using internet gaming apps was associated with emotional problems (p=.002), conduct problems (p=.001), hyperactivity difficulties (p=.015), peer problems (p=.04) and the total difficulties (p=.001). Small to medium effect sizes.
Ayu et al., 2020 Indonesia Cross-sectional	N: 70 Age: 3, 4, 5 and 6 years 50% boys To investigate the relationship between the use of mobile devices and children's health status.	Mental health: Mental Health Problem Questionnaire	Questionnaires on mobile gadget usage consisting of 10 questions on the following topics: gadget and ownership status, mobile gadget usage, type of gadget, and applications used.	39 preschoolers used devices more than one hour a day, and 36 of them had a deviant mental health status. There was a significant relationship between mobile device use based on duration of use and problem mental health status (p<0.001, OR (CI): 10.8 (3.32-35.12). Large effect size.
Bagarić et al., 2022 Croatia Cross-sectional	N: 655 Mean age: 5 years 53% boys To examine the correlation between total screen time and mental health indicators in children.	Internalized and externalized behaviors: Child Behavior Checklist (CBCL)	A questionnaire designed to collect data on children's and parents' habits regarding electronic media use was used. Total time spent on children's other activities (physical activity, playing with peers, outdoor activities) and the total time children spent with their parents were counted separately.	Children with highest levels of anxiety-depression are those who spend more screen time, but also spend more time in outdoor activities, while children with lowest levels of anxiety-depression spend much time outdoors and little screen time. Small to medium effect sizes.
Bruggeman et al., 2019 Belgium Cross-sectional	N: 13,871 Mean age: 10 years 50% boys (due to a technical error, the gender of only 8444 children (50% boys and 50% girls) was registered) To investigate the relationship between the use of digital media and psychological well-being among children aged 9–12 years.	Happiness: “How happy do I usually feel?” and “How happy did I feel yesterday?” The answers were given on an 11-point Likert scale (0 = very unhappy, 10 = very happy). Positive and negative affect: Positive and Negative Affect Schedule for children	Frequency of use in hours and reasons for using digital media: 5-point Likert scale (0=less than 1 h a day, 1=about 1 h a day, 2=about 2 h a day, 3=about 3 h per day, 4=more than 3 h per day). Kind of social contacts: The item started with the text: “If I use a PC/laptop/tablet/ smartphone, I have contact with …” Answers were given on a five-point Likert scale (0=never, 1=almost never, 2=sometimes, 3=often, 4=very often). Facebook: questions which were based on the Facebook Intensity Scale	The results revealed rather weak linear relationships (r's<0.10), but at the same time it has been shown that highest frequency users of digital media in terms of daily use had a relative risk of 2.0 and beyond to score lower on well-being. In the specific group of children who have a Facebook profile (N=2,528, 18.2%), their offline social network was a much stronger predictor of well-being compared to their online social network. Mean levels of well-being and happiness were specifically lower in the category of highest use of digital media (p<.0001), and this pattern emerged for the different types of social media. Small effect sizes.

Cardoso-Leite et al., 2021 Switzerland Cross-sectional	N: 118 Mean age: 10,38 years 51.69% boys To investigate the relationship between children's media use and attention and behavior control skills, psychological distress, psychological functioning, and sleep.	Psychological distress: K-6 distress scale Emotional and behavioral problems: Strength and Difficulties Questionnaire (SDQ) Attentional problems: The Conners Teacher's Rating Scale and Conners Parent's Rating Scale Sleep: custom-made sleep questionnaire	Media multitasking inventory (total number of hours of media content consumed per day, media multitasking index and the total number of hours of video gaming per day) Video gameplay questionnaire (e asks about which video games children play, on what device and how frequently ("often," "sometimes," "rarely").	More time playing video games was associated with lower levels of distress (r= -0.38, p=.006, n=55, medium effect size). High levels of media multitasking are linked to higher levels of psychological distress (p<.01), lower socio-emotional functioning (p<.01) and worse sleep quality. More time playing video games is associated with greater response speed in attentional control tasks (r=0.26, p=.024, n=77, small effect size), without, however, a concomitant increase in error rates that could have been indicative of increased impulsivity or inattention (p>.756).
Cartanyà-Hueso et al., 2022 Spanish Cross-sectional	N: 4,073 Mean age: 9,31 years 50.9% boys To assess the relation between leisure screen time and emotional and behavioral problems in Spanish children	Emotional and behavioral problems: Strengths and Difficulties Questionnaire (SDQ-9)	2 questions: "During leisure time of the child, how long does the child spend in front of the screen, including laptop, tablet, TV, videos, videogames or screen of mobile phones?" differentiating between weekdays and weekend days. These questions had 3 possible responses: never or almost never, less than 1 h, and 1 h or more. In addition, parents that answered "1 h or more" in a weekday and/or in a weekend day also reported the average number of hours spent in front of a screen daily, ranging from 1 to 12 h.	Male subjects were more likely to be at risk of developing emotional and behavioral problems (9.4% vs 6.0%). ST affects male emotional symptomatology (Prevalence Ratio [PR] 4.15, 95% CI 2.10-8.19) and female hyperactivity/inattention (PR 2.86, 95% CI 1.35-6.05). Children older than 6 years old, children spending at least 180 min using screens for leisure were more likely to be at risk of developing emotional and behavioral problems than children using screens for leisure less than 1 h daily (PR 2.07, 95% CI 1.22-3.50).) It was not possible to calculate the effect size.
Chen et al., 2020 China Longitudinal	N: 29,461 Mean age: 4.4 years 54,3% boys Evaluate the association between screen exposure during the ages of 0–3 years and preschoolers' autistic-like behaviors and the mediating roles of the frequency of caregiver-child interaction, sleep duration and level of participation in outdoor activities.	Autistic-like behaviors: Autism Behavior Checklist (ABC)	Electronic screen exposure was measured according to a set of questions answered by the primary caregiver, who was asked to indicate how long on average his/her child spent viewing screens every day (TV, mobile phones, tablet, video games, etc.). These questions were repeated every year since child's birth. Response options were categorized into 0 (none), 1 (<30 min/day), 2 (30–60 min/day), 3 (60–90 min/day), 4 (90–120 min/day), and 5 (>120 min/day).	Results indicated that screen exposure during age 0-3 years was associated with the presence of autistic-like behaviors at preschool age, and the strength of the association/effect size improved with increasing average daily screen time. (Odds Ratios (ORs) ranging from 1358 for <30 min/day to 4026 for >120 min/day). Caregiver-child interaction frequency and sleep duration mediated 5.32% and 1.19% of the association variance, respectively, but outdoor activities did not mediate the association. Logistic model: 0,266 non-adjusting and 0,249 adjusting. Large effect size.

Choi et al., 2021 South Korea Cross-sectional	N: 331 Mean age: 8.3 years 51.1% boys To identify the association between excessive exposure to screen media and behavioral and emotional problems in elementary school students.	Emotional and behavioral syndromes: Korean version of the Child Behavior Checklist (K-CBCL)	Parent-reported ST was defined as the total time children used screen media devices (TVs, PCs, tablet PCs, smartphones, video game consoles, and handheld game consoles), and the number of days each device was used. used for a week. Response options for average amount of media use per day were "none" (=0), "less than an hour" (=1), "1-2 h" (=2), "2-3 h " (= 3), "3-4 h" (=4) and "4 h or more" (=5).	Scores of the excessive screen use group were higher (54,35±6,34) than the control (53,61±5,51) (t=0,73; p=0,463), regarding anxious and depressive behaviors. Scores for externalizing (p<0,05), social problems (p<0,05) and rule-breaking behavior (p=0,018), higher in the overuse group compared to the control. It was not possible to calculate the effect size.
Chu et al., 2023 United States of America (USA) Longitudinal	N: 11,633 Mean age: 9,9 years. 51,2% boys. To determine prospective associations between initial screen time and suicidal behaviors two years later.	Suicidal behaviors: Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS-5), a computerized tool based on DSM-5.	Participants answered questions about their typical ST use through the ABCD Youth ST Survey, based on previously validated measures. Modalities included viewing/streaming TV shows or movies, watching/streaming videos, playing video games, texting, video chatting, and social media.	In models adjusted for covariates, each additional hour of total screen time at baseline was prospectively associated with 1.09 higher odds of reporting suicidal behaviors at two-year-follow-up (95% confidence interval [CI] 1.03–1.14). The modalities most strongly associated with suicidal behaviors were texting, video chat, videos, and video games, with adjusted OR ranging between 1.18 and 1.36. Small effect size.
De Pasquale et al., 2021 Italy Cross-sectional	N: 162 Mean age: 9.4 years 48.1% boys To assess the prevalence of video games use and addiction in a sample of Italian children during the COVID-19 pandemic and their association with anxiety symptoms.	Anxiety and depression: Test of Anxiety and Depression (TAD) Anxiety states: Children's Anxiety Meter—State (CAM-S)	Video Game Addiction Scale for Children (VASC)	CAM-S positively related to video game use (r=.19; p<.05). There was no correlation between anxiety levels and VASC score. In boys CAM-S positively correlated with video game involvement (r=.26; p<.05), while trait anxiety correlated with more frequent video game use (r=.34; p<.01), lifestyle and time-use problems (r=.27; p<.05), and self-control (0.26; p<.05). In girls, CAM-S correlated positively with video game use (r=.22; p<.05), while trait anxiety correlated with video game use (r=.31; p<.01) and video game involvement (r=.28; p<.05). Anxiety state was a predictor of video game use and dependence (p=.01). Small to medium effect sizes.
Dennison-Farris et al., 2017 USA Cross-sectional	N: 121 Mean age: 10.5 ± 1.6 years 39.7% boys To determine the associations between depressive symptoms and obesogenic behaviors in school-aged American	Depressive symptoms: Child Depression Inventory	Self-report: ST behavior questions from the Project Eating Among Teens survey assessed time spent watching TV, using a PC, playing sedentary electronic games, and playing non-sedentary electronic games on weekdays and weekend days. Questionnaire responses included "0h/day,"	Higher depressive symptoms were associated with more hours per weekday ST with "other" (o que é other) electronics use. In addition, higher depressive symptoms were associated with more hours per weekend day spent watching TV/videos, using a PC, playing sedentary video games, "other" electronic uses, and total ST hours.

	Indian children in Oklahoma.		"0.5h/day," "1h/day," "2 h/day," "3h/day," "4h/day," and "5+ h/day."	Medium effect size for watching TV/videos, using PC, and playing sedentary video games. Small effect size for other electronic uses and total ST per weekend day. Small effect size for total ST and depressive symptoms.
Fors & Barch, 2019 USA Cross-sectional	N: 4,139 Mean age: 10 years, SD: 0.61 52.2% boys To examine child and parent reports of electronic media use (EMU) in relation to parent-reported depression and anxiety.	Anxiety and Depression: Child Behavior Checklist (CBCL)	Self-report by the child: Adolescent Brain Cognitive Development (ABCD) Screen Time Survey (STQ). Self-report by parents: different and short STQ.	Parent weekend report of general EMU was a significant independent predictor of anxiety (t=3.43, p =.001). The child's weekend EMU report and the parent's weekend EMU report were significantly related to depression (t=2.38, p=.017 and t=3.79, p<.001, respectively), while no EMU reports during the week were significantly related to depression. It was not possible to calculate the effect size.
Guerrero et al., 2019 Canada Cross-sectional	N: 11,875. Mean age: 9.91 years. 52,1% boys. To examine the associations between ST (types and content) and problem behaviors, and to determine whether these associations were mediated by sleep duration. Using baseline (cross-sectional) data (2016–18) from the Adolescent Brain Cognitive Development (ABCD) study,	Emotional and behavioral syndromes: The Child Behavior Checklist (CBCL). Sleeping duration: Parent Sleep Disturbance Scale for Children	Recreational ST was measured using the Youth ST Survey. Children were asked to report the number of hours spent on a typical weekday and weekend day for the following six ST types: watching TV/movies, watching videos, playing video games, texting, visiting social networking sites, and using video chat. Children responded to each question using a 7-point scale: none, < 30 min, 30 min, 1h, 2h, 3h, or ≥ 4h. ST content was assessed with two items, whereby youth were asked to report how often they played mature-rated video games and watch R-rated movies.	Every one hour increase in watching TV/movies was related to a 5.9% increase in rule-breaking behavior (IRR=1.059), 5% increase in social problems (IRR=1.050), 4% increase in aggressive behavior (IRR=1.040), and 3.7% increase in thought problems (IRR=1.037). The indirect effects of watching videos produced the largest effect; every added hour increase in watching videos were associated with reduced sleep duration, which consequently was related to a 1.7% increase in anxious/depressed, 1.3% increase in thought problems, and 1.1% increase in withdrawn/depressed. Incidence rate ratios (IRRs), the exponentiated B values, were calculated as an estimate of effect size. Small effect size.
Guxens et al., 2019 Netherlands Cross-sectional	N: 3,102 Age: 5 years Gender: Not available To separately assess the association of radiofrequency electromagnetic field (RF-EMF) exposure from different sources, including environmental exposure from mobile phone base stations and indoor sources and mobile phone and cordless phone calls, and two proxies of how much	Emotional and behavioral problems (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior): Strengths and Difficulties Questionnaire (SDQ).	Was asked mothers about the duration of PC/video games use including computer, Playstation, and Xbox at home or at a friend's house and TV watching including TV, DVD, and video at home or at a friend's house of their child. Was categorized the exposure in 4 groups: none, < 0.5 h/day. 0.5–1 h/day, and ≥1 h/day for computer/video games use and < 0.5 h/day, 0.5–1 h/day, 1–1.5 h/day, and ≥1.5 h/day for TV watching.	Associations were between children exposed to higher levels of RF-EMF from mobile phone base stations and mother-reported emotional symptoms (OR 2,08, CI 95% 1,03 to 4,19, small effect size) and between children who watched TV ≥1.5 h/day and mother reported hyperactivity/inattention (OR 3,13, CI 95% 1,16 to 8,43, medium effect size).

	time children spend looking at screens, in particular PC/video games use and TV watching, with emotional and behavioral problems in 5-years-old children.			
Hosokawa & Katsura, 2018 Japan Cross-sectional	N: 1,642 Mean age: 6.88 years (SD=0.35) 51.2% boys Clarify the association between the use of mobile devices, such as smartphones and tablets, and emotional and behavioral problems in first-grade elementary school children.	Emotional symptoms: Strengths and Difficulties Questionnaire (SDQ)	Reported by parents. Average use time (in minutes) of mobile devices, on a typical day. The cut-off point was 60 min. Children who used mobile devices for an average of less than 60 minutes on a typical day were considered "non-regular users" and those with an average of more than 60 minutes on a typical day were considered "regular users".	Emotional symptoms (high score: 5-10): non-regular users n=172 (12.2%) and regular users n=40 (17.4%). The crude OR for emotional symptoms relative to non-regular users was 1.54 (95% CI [1.06-2.24], p=.025) for regular users. The IPTW-OR for emotional symptoms was 1.53 (95% CI [0.99-2.43], p=.057) for regular users. Small effect sizes. Relative to non-regular use, regular use of mobile devices without educational purpose was significantly associated with conduct problems (OR: 1,94, CI 95% [1,15–3,28], p=.014) and hyperactivity/inattention (OR: 1,85, 95 % CI [1,20–2,85], p=.005). Small effect sizes.
Janiri et al., 2020 USA Cross-sectional	N: 7,994 Mean age: 9.9 years 53% boys To identify and rank risk and protective factors for childhood suicidal	Suicidal thoughts and behaviors: Kiddie Schedule for Affective Disorders and Schizophrenia for DSM-5 (KSADS-5). Internalized and externalized behaviors/ Emotional and behavioral syndromes: The Child Behavior Checklist (CBCL).	Self report: ABCD Youth Screen Time Survey. Daily average; range from 0-24 hours	Child-reported risk of suicide increased with longer weekend screen use (OR 1·3, IC 95% 1·2–1·7). Small effect size.
Kahn et al., 2021 Israel Cross-sectional	N: 145 Mean age: 4.9 years (SD=0.7) 50.3% boys To assess the moderating effects of objectively measured sleep duration, timing and quality on the relation between screen time and behavior problems in preschool children.	Emotional and behavioral problems: Strengths and difficulties questionnaire (SDQ-P) Sleep: Mini-Motionlogger actigraph	Parents reported the average amount of minutes per day in which their child was exposed to screens over the past week, including TVs, desktops, laptops, tablets and mobile phones. This was reported in an open-ended question, completed online at the end of the sleep assessment week.	Greater screen exposure was associated with increased behavior problems in children with short sleep duration (9.24 h; b=2.44, SE=0.73, p<.001, 95% CI [0.99, 3, 88]). ST was not associated with behavior problems for children with moderate sleep durations (9.85 h/b=1.01, SE=0.56, p=.08, 95% CI [-0.11, 2.11]) and long (10.46 h/ b= −0.43, SE=0.85, p=.61, 95% CI [−2.11, 1.24]. The significance zone was identified at 9.88 h (b=1.15, SE=0.59, p=.05, 95% CI [0.00, 2.32]), in children who sleep 9.88 h or more, ST and behavior problems were not significantly related. Increased screen exposure was associated with more externalizing problems for children with low sleep duration (b=1.64, SE=0.49, p=.001, 95% CI [0.67, 2.60]) and

				moderate (b=0.87, SE=0.37, p=.02, 95% CI [0.13, 1.60]), but not for long duration (b=0.10, SE=0.55, p=.85, 95% CI [-0.98, 1.19]). The significance zone was recognized at 9.94 h (b=0.76, SE=0.38, p=.05, 95% CI [0.00, 1.52]), ST and the externalization problems were significantly related only to children who got ≤ 9.94 h of sleep per night. Small effect sizes.
Kidokoro et al., 2022 Japan Cross-sectional	N: 15,726 Mean age: 9.5 years 50,9 % boys To examine the associations between various types of screen behavior and depression, taking into account exercise and sleep among children and adolescents.	Depression: questionnaire developed by the American Psychiatric Association.	The parents helped the children to answer the questionnaire. (1) How long do you watch TV, videos, DVD? (2) How long do you watch online videos? (3) How long do you use social media? (4) How long do you play online games? Participants were asked to report the time spent on each screen behavior in a week. ST reference group: 0–30 min.	Children with more than 2 h/day on social media had higher prevalence of depression than the reference group. More time spent watching TV was associated with lower prevalence of depression. Girls with more than 2 h/day playing online games had a higher prevalence of depression than the reference group. Boys with more than 2 h/day on online videos had higher prevalence of depression than the reference group. Small effect sizes.
Konok & Szőke, 2022 Hungary Longitudinal	N: 98 Mean age: T1: 4.9 years T2: 8.2 years 55,1% boys To analyze bidirectional longitudinal associations between behavioral difficulties and Mobile Touchscreen Devices (MTSD) use.	Behavioral difficulties (hyperactivity/inattention, conduct problems, emotional symptoms and peer-relationship problems): Strength and Difficulties Questionnaire (SDQ)	Digital Kids Questionnaire, with questions about demographics, characteristics of the child's MTSD use (frequency and duration of use, typical activities the child engages in on the MTSD), digital parenting styles, parental role-modelling (frequency of parental mobile use and attachment to their mobile phones), and parental attitudes and beliefs regarding early MTSD use. Parents were asked whether (Yes/No) and how much their child uses tablets and smartphones.	Behavior problems (hyperactivity/inattention) at T1 significantly associated with MTSD use at T2 (B = 0,092; SE = 0,045; χ 2 1 = 4,104; p = 0,043). T2 peer relationship problems (B = 0.118; SE = 0.059; χ21 = 4.079; p = 0.043) significantly predicted T2 MTSD use. Small effect sizes.
Kostyrka-Allchorne et al., 2020 England Cross-sectional	N: 520 50.2% boys Age range: 3-11 years To examine the direct and indirect associations between childhood psychopathological symptoms, screen use, media multitasking, and participation in non-digital recreation.	Symptoms of Attention Deficit Hyperactivity Disorder (ADHD), conduct problems and emotional problems: Strengths and Difficulties Questionnaire (SDQ).	Parents reported on the amount of time children spent daily on 6 media activities: watching TV, listening to music, using a smartphone, using a tablet, using a PC, playing game consoles and reading. Responses ranged from 'None' to 'More than 4 h'. Average daily media use was calculated by taking the midpoint of each response option (min=0 increasing in steps of 0.5 h to max=4).	Screen use was positively correlated with emotional symptoms (r=.11, p=.014), ADHD symptoms (r=.11, p=.013) and conduct problems (r=.10, p=.022). Media multitasking was positively correlated with emotional symptoms (r=.11, p=.009). Small effect sizes. There was a weak positive direct association between digital media use and conduct problems (β=.10, p=.015) indicating that children who spent more time using digital media had elevated symptoms of conduct disorder. Small effect sizes.

			Adapted media multitasking questionnaire.	
Kushima et al., 2022 Japan Longitudinal	N: 74,846 Age range: 1-3 years 51.1% boys To examine the association between screen time in infancy and the development of autism spectrum disorder (ASD) at 3 years of age.	Screening for ASD at 1 year: Ages & Stages Questionnaires (ASQ-3) ASD: mothers were asked the following question when their child turned 3 years of age: "Have they ever been diagnosed with ASD by a doctor from the age of 2 years until now?" An option of 2 responses was provided, which were labeled as "yes" or "no" respectively.	The mothers were asked about the number of hours spent per day they let the child watch TV or DVDs. The responses were collected as variables and categorized as, "none (no ST)," "less than 1 h," "1 h or more but less than 2 h," "2 h or more but less than 4 h," and "4 h or more."	Higher ST at 1 year of age (OR 2,31, 95% CI 0,52-10,19) was associated with statistically significantly higher odds of ASD at 3 years of age in boys. Small effect sizes. When "no screen" was the reference: less than 1 h, OR: 1.38 (95 % CI, 0.71-2.69; p=.35), 1 h to less than 2 h, OR: 2.16 (95 % CI, 1.13-4.14; p=.02), small effect sizes. From 2 h to less than 4 h, OR: 3.48 (95% CI, 1.83-6.65; p<.001) and more than 4 h, OR: 3.02 (95% CI, 1.44-6.34; p=.04), medium effect sizes. Among girls there was no association between ASD and ST. ST at 3 years old was not associated with ASD at age 3 years.
Li et al., 2022a China Cross-sectional	N: 805 Mean age: 9,1 years 55% boy To assess the independent and joint associations between cardiorespiratory fitness (CRF), ST and MH among Chinese school-aged children.	Depressive symptoms: Children's Self-Rating Depression Scale (DSRSC) Anxiety: Social Anxiety Scale for Children Self-esteem: Rosenberg Self-esteem scale	Information about ST was asked through the question - In the last week, how many hours p/day do you usually spend on TV, PC/tablet and cellphone? Response options included: None, <0.5 h/day, 0.5 to <1 h/day, 1 to <2 h/day, 2 to <3 h/day, and ≥ 3 h/day. Children with elevated ST were defined as those with ST ≥ 1 h/day.	Children with high ST had significantly increased risks for anxiety (OR: 1.72, 95% CI: 1.06-2.80) and low self-esteem (OR: 1.63, 95% CI: 1.07-2.48). Small effect size.
Li et al., 2021 Canada Longitudinal	N total: 2,026 N: 532 (mean age: 5.9 years and 51.7% boys) To determine whether specific forms of screen use (TV or digital media, video game, electronic learning, and video chatting) were associated with child and youth MH symptoms (depression, anxiety, conduct problems and irritability, hyperactivity, and inattention) during COVID-19.	Depression, anxiety, conduct problems, irritability, hyperactivity, and inattention: Strengths and Difficulties Questionnaire (SDQ).	Parent-reported child daily TV and digital media time, video game time, electronic-learning time, and video-chatting time collected between May 21, 2020, and April 9, 2021. For younger children (TARGetKids! cohort), daily screen time duration was measured continuously and collected every other week.	In younger children, higher TV or digital media time was associated with higher levels of conduct problems (age 2-4 years: β, 0.22 [95% CI, 0.10-0.35]; P < .001; age - 4 years: β, 0.07 [95% CI, 0.02-0.11]; P = .007) and hyperactivity/inattention (β, 0.07 [95% CI, 0.006-0.14]; P = .04). Small to medium effect sizes.

Lin et al., 2020 USA Cross-sectional	N: 11,875 Mean age: 9.91 years 52% boys To investigate relationships of different types of ST with mood symptoms in preadolescents using a network approach, accounting for theoretically important personality- and environmental-level factors (behavioral inhibition/activation systems (BIS/BAS) and parental monitoring).	Mood symptoms (depressive mood, anhedonia, and irritability for depression, and anger, decreased need for sleep, elevated mood and increased sexuality for mania): Kiddie Schedule for Mood Disorders and Schizophrenia for DSM-5 (K-SADS-5).	The scoring method was as follows: 0=no usage; 0.25=less than 30 min; 0.5=30 min; 1=1 h; 2=2 h; 3=3 h; and 4=more than 4 h p/day. Average daily ST was computed as the weighted mean of the ST on a typical weekday (multiplied by 5/7) and weekend day (multiplied by 2/7), rounded to the nearest integer. The assessment also included 2 age-inappropriate ST behaviors, namely "playing mature video games" and "watching R-rated movies." The frequencies of these two types of ST were rated as: 0=never; 1=once in a while; 2=regularly; 3=all the time.	"The results of multiple linear regressions based on bootstrapped networks showed that the increase of screen time on mature video games and R-rated movies were both significantly associated with the increase of the overall network connectivity (mature video games: $b = 0.02$, $t = 9.25$, $p < 0.001$; R-rated movies: $b = 0.05$, $t = 17.34$, $p < 0.001$) with an R2 of 0.25 and 0.19, respectively, after accounting for edge differences (i.e., all mood symptoms were increasingly tightly connected to each other as mature video game time or R-rated movie watching time increased)." Medium to large effect sizes.
Liu et al., 2021 China Longitudinal Prospective cohort	N: 2492 Age: 0.5, 2.5 and 4 years 51.8% boys Examine the effect of ST in early childhood on emotional and behavioral problems in children aged 4 years, based on a birth cohort study in China.	Emotional and behavioral problems: Strengths and Difficulties Questionnaire (SDQ)	The ST of children were reported by parents and guardians. At 0.5 years: "How many hours does the child spend on average every day: (1) watching TV and (2) using electronic products (cell phone, tablet, PC, etc.)?" At age 2.5: "How many hours did the average child spend each day in the last month: (1) watching TV? (2) using a cell phone? (3) using electronic products (PC or other electronic devices)?" At age 4: "How many hours does the child spend: (1) watching TV? (2) using PC? (3) using a cell phone? (4) using an iPad? (5) using other electronic devices?"	There were a positive association between ST at age 0.5 years and emotional symptoms (OR=1.55, 95% CI 1.04–2.32), conduct problems (OR=1.54, 95% CI 1.01–2.35) in girls, and hyperactivity (OR=1.36, 95% CI 1.02–1.80) in boys, at age 4 years. Small effect sizes. The associations between ST at age 4 years and total difficulties (OR=1.62, 95% CI 1.14–2.30), conduct problems (OR=1.76, 95% CI 1.22–2.54), hyperactivity (OR=1.41, 95% CI 1.05–1.89), peer problems (OR=1.43, 95% CI 1.11–1.85), and prosocial behavior (OR=1.62, 95% CI 1.17–2.24) were found in boys. Small effect sizes. Total difficulties (OR=1.89, 95% CI 1.25–2.87) and conduct problems (OR=1.96, 95% CI 1.28–3.00) were found in girls. Small effect sizes. There was no correlation between the ST at age 2.5 years and emotional and behavioral problems in both boys and girls.

Lobel et al., 2017 Holanda Longitudinal	N: T1 194 / T2 184 Mean age: T1 9,22 years T2 10,24 years Boys: T1 50,5% T2 48,9% Investigate possible relationships between violent video game content and externalizing, internalizing, and pro-social behavior problems.	Psychosocial health: Strengths and Difficulties Questionnaire (SDQ - Dutch version)	Frequency of play: (1) parent reports the number of hours their child plays on average per week; (2) child reports the number of hours they played video games during the last week.	Gaming frequency predicted an increase in internalizing problems from T1 to T2 (β=.137, p=.024). Play was not related to externalizing problems (β=.092, p=.125). Gaming frequency was not associated with changes in hyperactivity/inattention and pro-social behavior (β= -.053, p=.255, and β= -.022, p=.727), respectively. There was no association between violent gaming and conduct (β=.017, p=.788), or pro-social (β=.091, p=.176). Small effect sizes.
McArthur et al., 2022 Canada Cross-sectional	N: 1,994 Mean age: 36.35 months 51.1% boys To examine the association between hours of screen time (≤1 vs 2 vs ≥3 h/day) and children's developmental and behavioral outcomes.	Hyperactivity/Inattention ; Physical Aggression; Emotional Disorder/Anxiety; and Separation Anxiety: Child Behavior Checklist (CBCL)	A single item from the Nutrition Screening Tool for Every Preschooler (NutriSTEPTM) 18 was used to measure hours of screen time. Mothers indicated the time their child spent "watching TV, using the computer, and playing video games" on a typical day. Response options ranged from 1 h or less a day to 5 h or more a day. Because a low number of participants endorsed 4 h (n = 67) and 5 h or more a day (n = 25), these response options were collapsed into ≤1, 2, or ≥3 h/day.	hen comparing the ST categories of ≤1 vs 2 vs ≥3 h/day and relative at-risk status, there was an overall effect of ST (internalizing: Wald $\chi 2$ (2) = 22.15, p<.001; externalizing: Wald $\chi 2$ (2) = 11.89, p=.003). After adjusting for all covariates, children exposed to 2 vs ≤1 h/day of ST were more likely to score in the at-risk range for internalizing (OR 1.36, 95% CI 1.06–1.73) and externalizing (OR 1.30, 95% CI 1.02–1.65) problems. Children exposed to ≥3 vs ≤1 h/ day of ST were more likely to score in the at-risk range for internalizing (OR 1.90, 95% CI 1.41–2.55) and externalizing problems (OR 1.66, 95% CI 1.23–2.23). Small effect sizes. Further, the effect of 2 h/day of ST significantly differed from ≥3 h/day for internalizing (Wald χ 2 (1) = 6.82, p=.009) problems, but not for externalizing (Wald χ 2 (1) = 3.44, p=.064) problems.
Monteiro et al., 2021 Portugal Cross-sectional	N: 193 Mean age: 42,86 months Range: 6 a 82 meses 56% boys To analyze the association between ST exposure and emotional/behavioral problems of infants and children aged under 7 years, as manifested during the lockdown period in Portugal due to the coronavirus disease 2019 outbreak.	Behavioral and emotional symptoms: Baby Pediatric Symptom Checklist (BPSC) Preschool Pediatric Symptom Checklist (PPSC)	Exposure time (in hours) to TV, PC, video games, tablet, cellphone, and Internet, before and during the confinement, on weekdays and weekends, in a scale varying from 1 to 9 (1 = none, 2 = less than 1 h, 3 = 1 h, 4 = 2 h, 5 = 3 h, 6 = 4 h, 7 = 5 h, and 8 = more than 5 h).	Positive correlations between Total PPSC scores and total hours of screen exposure during confinement, on weekdays (r=.271, p=.000) and weekends (r=.266, p=.001). Small effect sizes. Positive correlation between total hours of screen exposure during weekend confinement (r=.168, p=.032) and the difference between total screen exposure during and before weekend confinement (r=.216, p=.006) and the PPSC Externalization scale, with small effect sizes. BPSC showed no significant associations.

Moulin et al., 2022 France Cross-sectional	N: 432 Age: 48.5% > 6 years and 51.5% ≤ 6 years. 51% boys To assess family and individual correlates of children's symptoms of emotional difficulties and hyperactivity/inattention.	Emotional and hyperactivity/inattention symptoms: Strengths and Difficulties Questionnaire (SDQ)	ST was assessed by the following questions: "During the preceding 7 days, how much time has your child spent in front of a screen (TV, tablet, PC, smartphone) p/day. We created the two following categories: "Less than 1h", vs. "More than 1h", based on the American Academy of Pediatrics new Recommendations for Children's Media Use.	ST exceeding 1 hour p/day associated with higher chances of high levels of emotional difficulties (OR 6,8, IC 95% 1,5 –30,9), with large effect size. The child's screen time (OR 1.3, 95% CI 0.9–1.9) was not associated with children's elevated levels of symptoms of hyperactivity/inattention.
Nagata et al., 2022 USA Longitudinal	N: 11,875 Mean age: 9.9 years (SD: 0.6) 51.2% boys To determine the prospective associations of contemporary screen time modalities with conduct and oppositional defiant disorder in a national cohort of 9-11-years-old children.	Conduct and oppositional defiant disorders: Kiddie Schedule Affective Disorders and Schizophrenia (KSADS-5)	ABCD Youth Screen Time Survey (participants answered questions about typical hours per day spent on six different screen modalities (viewing/streaming TV videos, playing videogames, texting, video chatting and social media)	Each hour of total ST p/day was prospectively associated with a 7% higher prevalence of conduct disorder (PR 1.07,95% CI 1.03–1.11) and a 5% higher prevalence of oppositional defiant disorder (PR 1.05,95% CI 1.03–1.08) at 1-year follow-up. Each hour of social media p/day was associated with a 62% higher prevalence of conduct disorder (PR 1.62,95% CI 1.39–1.87). Each hour of video chat (PR 1.21, 95% CI 1.06–1.37), texting (PR 1.19, 95% CI 1.07–1.33), TV/movies (PR 1.17, 95% CI 1.10–1.25), and video games (PR 1.14, 95% CI 1.07–1.21) p/day was associated with a higher prevalence of the oppositional defiant disorder. When examining thresholds, exposure to > 4 h of total ST p/day was associated with a higher prevalence of conduct disorder (69%) and oppositional defiant disorder (46%). It was not possible to calculate the effect size.
Neville et al., 2021 Ireland Longitudinal	N: 10,172 Age: 3,5,7 and 9 years 51% boys To examine the temporally stable and longitudinal associations between screen time and externalizing and internalizing behaviors in childhood.	Psychosocial development: Strengths and Difficulties Questionnaire (SDQ), reported by caregiver.	Caregivers reported the time (h/day) children spent watching TV and using electronic devices at each wave of data collection. "How much time does the average child spend in an average day looking at TV, videos, DVDs, PC, iPad, smartphones, and electronic gaming systems?" 3 years: ST was reported by caregivers in minutes and later converted into hourly categories. 5, 7 and 9 years: Daily ST was reported by caregivers based on response categories coded for consistency as 1= 'Less than 1h'; 2= 'One to less	Higher levels of ST were significantly associated with higher levels of externalizing and internalizing behaviors in each wave, with small effect sizes. A directional association of moderate effect size between higher levels of ST at age 5 and increased internalizing behaviors at age 7 was observed (sr2=0.04; 95% CI=0.004, 0.07). Higher levels of ST at age 7 were associated with a small decrease in internalizing behaviors at age 9 (sr2=-0.02; 95% CI= -0.04, -0.003). Small effect size.

			than 2h'; 3= 'Two to less than 3h'; and 4= '3 or more h'.	
Nicolì et al., 2022 Italy Cross-sectional	N: 483 Mean age: 7.27 years 47% boys To explore how activities that children carried out at home during the lockdown were related to their emotional and behavioral well-being.	Emotional and behavioral well-being: Strengths and Difficulties Questionnaire (SDQ)	Parents rated on an 8-point scale (from 1=less than half an hour to 8 = 7 h or more) how much time children dedicated to time on social networks, referring to time spent on social media; solitary ST that included watching TV, playing with videogames, and playing with the mobile phone.	More time spent on social media was associated with more emotional difficulties (B 0.50 CI 0.17 0.83). More solitary screen time activity was associated with more behavioral problems (B 0.16 CI 0.02 0.30). Small and large effect sizes.
Niiranen et al., 2021 Finland Longitudinal	N: 699 Age: 18 months and 5 years 52.4% boys To investigate the frequency of electronic media (e-media) usage by preschool children and the risks of high-dose e-media use on young children's psychosocial well-being.	Emotional and behavioral problems and inattention: Parent-reported questionnaires Five-to-Fifteen (FTF) and the Strengths and Difficulties Questionnaire (SDQ)	Parents reported the time a child spent engaged in e-media activities at both 18 months and 5 years of age. Separate questions were asked for weekday and weekend e-media use on how many hours a child watches programmers (including on TV or other devices), and (at 5 years) how many hours a child participates in electronic game-playing (on a computer, console devices, cellphones, tablets or other devices).	The use of electronic media at 18 months had less of a negative effect than at 5 years of age: A high amount of ST at 18 months was associated, after adjusting for children's age, gender, and parents' socioeconomic status (OR 1.64, p=.03) with an increased risk of SDQ peer problems. There was no increased risk of psychosocial problems with other FTF and SDQ subscales. At age 5, watching programs was associated with increased risk for attention and concentration difficulties (OR 1.91, p=.01), hyperactivity and impulsivity (OR 1.67, p=.03), emotional/internalizing symptoms (OR 1.71, p=.04) and hyperactivity (OR 2.43, p<.01) and conduct problems (OR 1.49, p=.04). The use of electronic games was associated with an increased risk of SDQ hyperactivity (OR 1.65, p=.02) only in the unadjusted model, while with the other subscales no increased risk appeared. Small to medium effect sizes.
Okada et al., 2021 Japan Cross-sectional	N= 4,105 Age: 9 and 10 years 50.7% boys To examine the association between duration of mobile devices usage and mental health problems, shown as behavior problems, using a large population-based sample of 4th grade children (i.e aged 9–10 years old).	Behavior problems (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems and prosocial behavior): Japanese language version of the Strengths and Difficulties Questionnaire (SDQ). Avaliados pelos cuidadores	The children were asked about their mobile device usage time using the question: 'On average, how long do you use mobile devices, such as mobile phone, smartphone, or tablet p/day?'. There are seven response items (i.e. do not use, less than an hour, 1–2 h, 2–3 h, 3–4 h, 4–5 h, and 5 or more hours). In addition, possession of mobile phone, smartphone, or tablet was also asked using the question: 'Do you have your own mobile phone, smartphone, or	For boys a protective effect of duration of mobile device use was found for 1-2h for pro-social behavior problems (OR: 0.73, 95% CI: 0.56-0.96), for less than 1h and 1-2h for total difficulties (OR: 0.68 [95% CI: 0.52-0.89] and 0.70 [95% CI: 0.53-0.94]), respectively. Use for 2 or more h was not associated with total difficulties, i.e., not a risk factor for total difficulty problems. Those who used mobile devices for less than 1h and 1-2h had a lower chance of hyperactivity/inattention, and those who use for 2 or more h showed no association with hyperactivity/inattention. Those

			tablet?', with a yes/no response.	who used for 2 or more h had higher odds of emotional problems (OR: 1.45, 95% CI: 1.01-2.08) and peer problems (OR: 1.66, 95% CI: 1.16-2.37). As for girls, a longer duration of mobile device uses consistently showed higher ORs for total difficulty problems (p<.001), emotional problems (p=.015), conduct disorder (p<.001), and peer problems (p<.001), but the association was not significant for hyperactivity/ inattention (p=.19) and pro-social behavior (p=.71). Small to medium effect sizes.
Parkes et al., 2013 United Kingdom (UK) Longitudinal	N= 11,014 Age: 5 and 7 years 48.9% boys To explore how time watching TV and playing electronic games at age 5 years each predicts change in psychosocial adjustment in a representative sample of 7-year-olds from the UK.	Psychosocial adjustment was reported by mothers: Strengths and Difficulties Questionnaire (SDQ)	Reported by mothers TV/video/DVD and playing PC or other electronic games, when the children were 5 years old. For both types of screen time, typical hours of exposure during the out-of-school period were measured on a 6-point scale: none, <1 h, 1-<3 h, 3-<5 h, 5-<7 h, 7 h or more.	Watching TV for 3h or more at 5 years predicted a 0.13 point increase (95% CI 0.03 to 0.24) in conduct problems by 7 years, compared with watching for under an hour, but playing electronic games was not associated with conduct problems. No associations were found between either type of ST and emotional symptoms, hyperactivity/inattention, peer relationship problems or prosocial behavior. There was no evidence of gender differences in the effect of ST. Small effect size.
Rakickienė et al., 2021 Lithuania Longitudinal	N: 78 Age: 4 to 6. T1 66,1 months (DP = 10,33) T2 66,4 months (DP= 10,6) 69% boys To analyze changes in Lithuanian pre-schoolers' emotional and behavioral problems during the first quarantine due to COVID-19 pandemic and their relations to the potential risk factors such as parental distress and increase in daily ST.	Emotional and behavioral problems: Child Behaviour Checklist	Parents provided information on screen time by answering separate Likert scale questions about the duration their child usually spends using various screen-based devices on both weekdays and weekends.	Results showed that children had more behavioral problems, spent more time on screens and were less physically active during the quarantine, and their parents were experiencing more distress than before. Large effect size
Roberston et al., 2022 USA Cross-Sectional	N: 11,780 Mean age: 9.91 (0.62) years 52% boys To examine the relationship between	Internalizing disorders: Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS-5).	Self-reported "watch TV shows or movies," "watch videos (such as YouTube)?", "Play video games on a PC, console, phone, or other device (Xbox, Play Station, iPad)?", "Text on a cellphone, tablet, or PC (e.g., GChat,	Youth spending 2 or more hours a day with all screen media (vs. less than 2 h) were more likely to fit diagnostic criteria for depressive disorders, self-harm, and suicidal ideation or attempts. TV watching was associated with suicidal ideation or attempt among both boys (RR 1.23, 95% CI 1.02,

	screen time and internalizing disorders in preadolescent children between the ages of 9 and 10.		WhatsApp, etc.)?", "visit social networking sites like Facebook, Twitter, Instagram, etc.?", and "video chat (Skype, Facetime, etc.)?" Response choices were coded as none = 0; <30 min = 0.25; 30 min = 0.50; 1 h = 1; 2 h = 2; 3 h = 3; 4+ h = 4.	1.47) and girls (RR 1.41, 95% CI 1.14-1.73). Gaming was significantly associated with suicidal ideation or attempt among both boys (RR 1.31, 95% CI 1.10-1.56) and girls (RR 1.23, 95% CI 0.92-1.65). Girls spending 7+ h a day on screens (vs. <1 h) were nearly four times more likely to have a depressive disorder and were twice as likely to have suicidal ideation or attempts or engage in self-harm. Boys spending 7+ h a day on screens (vs. <1 h) were twice as likely to have a depressive disorder and were nearly twice as likely to have suicidal ideation or attempts and non-suicidal self-injury. Small effect size.
Tansriratanawong et al., 2017 Thailand Cross-sectional	N: 200 Mean age: ST 0-1: 4.00 years ST 1-2: 4.34 years ST >2: 4.22 years 46% boys To describe electronic screen and new media use in preschool children and its association with externalizing and internalizing behavioral problems.	Emotional and behavioral problems (emotional reaction, anxiety/depression, somatic complaints, social withdrawal, sleep problems, attention problems, aggression, and other problems): Child Behavior Checklist (CBCL)	Caregivers were asked to complete questionnaires to enable the accumulation of data regarding media and screen use by their children and themselves. They were asked how much time their child spent using all types of screen on weekdays and weekends including TV, tablets, DVDs, mobile phones, electronic games, internet and social networks for both education and entertainment. The average viewing time per weekday, per weekend, and total time p/day were calculated.	Preschoolers with more screen viewing time did not have a significantly higher externalizing problem score than those with less screen time. Medium effect size.
Tezol et al., 2022a Turkey Cross-sectional	N: 210 (video gamers: 70 and no-gamers: 140) Mean age: 4.0 ± 1.0 years video gamers: 64.3% boy no-gamers: 44.3% boys To investigate the relationship between the psychosocial well-being and video gaming in preschool children.	Psychosocial well-being: Strengths and Difficulties Questionnaire (SDQ)	Mothers answered daily video game time using computer, smartphone, tablet or game console.	Older age, being a boy, having a daily screen time of more than 1 h, and parent(s) video gaming increased probability of video gaming [Odds (95% CI) = 1.49 (1.01-2.20), P=.0045; 3.00 (1.42-6.31), P<.004; 6.28 (2.86-13.80), P<0.001; 6.49 (2.77-15.23), P<.001, respectively]. Video game players and non-players had statistically similar SDQ scores. There was no association between video games and being borderline or abnormal in emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, pro-social behavior, and total difficulties. There was a weak correlation between total difficulties score and daily video gaming time (r=0.32, n=70, P=.006), while

				there was no correlation between prosocial score and daily Age: 48.5% > 6 years and 51.5% video gaming time (r=−0.23, n=70, P=.051). Small and medium effect sizes.≤ 6 years.
Tezol et al., 2022b Turkey Cross-sectional	N: 220 Mean age: 3.8 ± 1.1 years 52.3% boys To investigate the associations between excessive screen time and psychosocial well-being in a sample of Turkish preschool children.	Emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems and prosocial behaviors: Strengths and Difficulties Questionnaire (SDQ)	Mothers answered: "How many hours per day does your child usually spend in front of a TV, PC, smartphone or tablet screen? ST on weekdays and weekends, at home and away from home. Screen content was classified as age appropriate and adult programs. Two groups were identified according to daily ST as low (<1 h) and excessive (≥4 h) ST.	Emotional symptoms, conduct problems, peer relationship problems, and total difficulties scores were significantly higher in the children with excessive ST (p<.05), while the hyperactivity-inattention and prosocial scores were not different between the low and excessive ST groups (p>.05). After adjusting for potential confounders, the children with excessive ST had significantly increased OR for having conduct and peer relationship problems (OR [95% CI]: 2.62 [1.11-6.19], p=.028 and 2.57 [1.25-5.26], p=.010, respectively). Medium effect sizes
Xie et al., 2020 China Cross-sectional	N: 1,897 54.5% boys Age: 3-6 years To determine the effects of electronic exposure on behaviors of preschoolers. .	Preschooler behaviors (emotionally reactive, anxiousness/depression, aggressive behavior, attention problems, somatic complaints, withdrawn symptom and sleep problems): Child Behavior Checklist (CBCL)	An acceleration meter was used to record the children's behaviors. ST was defined as TV/DVD watching, tablet and smartphone use, and playing video games. Preschoolers were grouped based on ST less than 60 min or more than 60 min.	ADHD syndromes were higher in children with ST > 60 min (d'=0.46, p<.05). Small effect size. Children with ST > 60 min had higher oppositional challenging problem scores (d'=0.36, p<.05). Small effect size. Preschoolers with ST > 60 min tended to have more behavior problems (total problem: p=.024, R2=0.12, externalizing: p=.016, R2=0.14). Medium effect sizes.
Zhang et al., 2022 China Cross-sectional	N: 1,296 54.3% boys Mean age: 9.2 ± 0.4 years Investigate the association between several health-risk behaviors and MH among Chinese children.	Anxiety: Social Anxiety Scale for Children (SASC) Depression: Depression Self-rating Scale for Children (DSRSC) Self-Esteem: Self-Esteem Scale (SES)	Self-reported How many hours per day did you spend on the PC, play smartphone and watch TV in the last week? There were five options: 0-<0.5 h/day, 0.5-<1 h/day, 1-<2 h/day, 2-<3 h/day, ≥3 h/day. Children who reported ST ≥1 h/day was considered as high ST.	High ST was significantly associated with increased risk of anxiety (OR: 1.55, 95%CI: 1.12–2.15; p<0.01) and low self-esteem (OR: 1.64, 95%CI: 1.22–2.19; p<0.01). Small and medium effect sizes.
Zhao et al., 2022a USA Cross-sectional	N: 9,738 Mean age: 9,9 years 52% boys To understand whether certain brain regions/structures covary together more frequently than other regions in children and whether such brain structural covariation patterns are related to Screen Media Activity	Internalizing and externalizing symptoms: Child Behavior Checklist (CBCL) Sleep: Sleep Disturbance Scale for Children (SDSC)	Self-report Participants reported their engagement in six types of SMA activities including watching TV shows/movies, watching videos, playing video games, texting on an electronic device, visiting social networking sites, and video-chatting. For each SMA activity, participants were given one of the following choices: none, < 30 min, 30 min, 1 h, 2 h, 3 h, and 4+ h.	Variations in the hypothetical thalamus-prefrontal cortex-brainstem circuit was associated with total screen time (β=0.107, p=0.002) and externalizing behaviors (β=0.111, p=0.003). Small effect sizes.

(SMA) and behavioral measures associated with SMA, including sleep disturbance, psychopathology, and cognitive performance.	

Quality Assessment

Most of the studies (83.7%) presented high methodological quality, according to the items of the Newcastle-Ottawa scale. Table 3 shows the summary of the assessments of the articles, available in (Additional File 3) (APÊNDICE D).

Screen time and mental health assessments

The measurements taken for both screen time and mental health were very heterogeneous. Most of the time, screen time was self-reported and aspects such as self-esteem and sleep quality were considered in the mental health assessment. The data are described in detail in (Additional File 4) (APÊNDICE E).

Associations between screen time and mental health

Most studies observed associations between screen time and children's mental health. Only a few studies found no associations between screen time and mental health, and even fewer others found improvements. Those studies that found significant associations, most often the results were congruent across only a few studies. The outcomes evaluated were mostly emotional (depression and anxiety) and externalizing symptoms (eg ADHD and disruptive behaviors).

Behavioral problems and typical ADHD behaviors

Screen use in general was positively correlated with symptoms of Attention Deficit Hyperactivity Disorder ADHD ($p=.013$) (Kostyrka-Allchorne, Cooper, Simpson, & Sonuga-Barke, 2020). ADHD symptoms were higher in those children with more than 1-hour daily screen time ($p<0.05$) (Xie et al., 2020). Recent pandemics amplified the effect, since children spent more time on screens and had more behavior problems during pandemic isolation (Rakickiené, Jusiene, Baukiene, & Breidokiene, 2021). Positive correlations were observed between behavioral symptoms and total hours of screen exposure on weekdays ($p=0.000$) and weekends ($p=0.001$), also with small effect sizes in another research (Monteiro, Rocha, & Fernandes, 2021). Important to emphasize this time was marked by the restriction of school activities and leisure activities and there were many hours to spent in screens, and many have being long time behind the screens.

In the study by Cartanyà-Hueso et al. (2022), leisure screen time affected hyperactivity/ inattention in girls (OR 2.86, 95% CI 1.35-6.05), three hours was associated with greater likelihood of behavioral problems than < 1-hour daily leisure screen time. In boys screen time at 6 months of age was positively associated with hyperactivity at 4 years (OR=1.36, 95% CI 1.02-1.80). And screen time at age 4 was also positively associated with hyperactivity at age 4, with small effect sizes (OR=1.41, 95% CI 1.05- 1.89) (Liu et al., 2021). So, time in front of screens seem to matter to amplify symptoms of hyperactivity.

Some studies investigated screen time separately by devices or activity. More solitary screen activity was associated with more behavioral problems (B=0.16 CI 0.02 0.30) (Nicolì, Spinelli, Lionetti, Logrieco, & Fasolo, 2022). An association was found between watching TV ≥1.5 h/day and hyperactivity/ inattention (OR 3.13, 95% CI 1.16 to 8.43) with medium effect size (Guxens et al., 2019). And each additional hour of TV or digital media per day was associated with a higher mean score of hyperactivity/inattention in children 4 years and older (95% CI, 0.006-0.14; P=0.04) (Li et al, 2021). At age 5, watching programs was associated with increased risk for attention difficulties (OR 1.91, p=0.01), impulsivity (OR 1.67, p=0.03) and hyperactivity (OR 2.43, p<0.01), with small effect size (Niiranen, Kiviruusu, Vornanen, Saarenpää-Heikkilä, & Paavonen, 2021). Internet play for more than 6 hours was positively associated with hyperactivity (p=0.015) (Ahmed, Abdalla, Mohamed, Mohamed, & Shamaa, 2022). A positive association was also found between more than 1-hour mobile device use and hyperactivity/inattention (OR: 1.85, 95% CI [1.20-2.85], p=0.005) (Hosokawa & Katsura, 2018). Behavior problems (hyperactivity/inattention) were also longitudinally associated with use of Mobile Touchscreen Devices (MTSD) (p=0.043) (Konok & Szőke, 2022). These studies with mobile devices, however, also showed small effect sizes.

When changes were not evident

Some investigations found no significant changes in behavioral and ADHD outcomes considering exposure to screens, such as the study by Liu et al. (2021) which observed no correlation between ST and behavioral problems in boys and girls at the age of 2.5 years. Game frequency was not associated with changes in hyperactivity/inattention (β= -.053, p=.255) in the study by Lobel, Engels, Stone, Burk and Granic (2017). Screen time was not associated with elevated levels of hyperactivity/disattention symptoms (OR 1.3, 95% CI 0.9-1.9) in Moulin et al. (2022)

and in Tezol et al. (2022b) hyperactivity/disattention scores were not different between the low and excessive ST groups (p>0.05). No association between any type of ST and hyperactivity/inattention was found in Parkes, Sweeting, Wight and Henderson (2013), including no gender differences in the effect of ST. There was no association between playing video games or use of mobile for 2 hours and hyperactivity/ inattention symptoms (Okada, Doi, Isumi, & Fujiwara, 2021; Tezol, Yıldız, & Yalçın, 2022a).

When improvements were evident

There was also a study that found screen time positively associated with improvement in children's mental condition, with a small effect size. In Cardoso-Leite, Buchard, Tissieres, Mussack and Bavelier (2021), more time playing videogames was associated with a higher speed of response in attentional control tasks (p=0.024), without increasing the error rates typical of impulsivity (p>0.756).

Autistic-like behaviors

According to data from Chen et al. (2020), screen exposure during ages 0 to 3 years was associated with the presence of autistic-like behaviors at preschool age, and the strength of association/effect size increased with increasing average daily screen time. In Kushima et al.'s research (2022), higher screen time at 1 year of age was associated with higher odds of Autistic Spectrum Disorder (ASD) at 3 years of age in boys (OR 2.31, 95% CI 0.52-10.19). Compared to "no screen," 1 to 2 hours of screen time showed an association, with small effect size, of higher odds of ASD (P=0.02). Two to more than 4 hours of screen time were associated with higher odds of TEA, with medium effect sizes. Notably, among girls, there was no association between TEA and screen time. Furthermore, screen time at age 3 was not associated with TEA at age 3 in both. There is always a doubt if the individuals with TEA use more screens.

Conduct problems

Exposure to > 4 h of total ST per day was prospectively associated with a higher prevalence of conduct disorder (69%) in one study (Nagata et al., 2022). Screen use was positively correlated with conduct problems with small effect size in one study (p=0.022) (Kostyrka-Allchorne et al., 2020) and medium effect size in another study (p<0.05) (Tezol et al., 2022b). In Liu et al. (2021) there was positive association between ST at 6 months of age and conduct problems at 4 years in girls (OR=1.54, 95% CI 1.01-2.35) with small effect size. And ST at 4 years was associated with conduct problems in girls

(OR=1.96, 95% CI 1.28-3.00) and boys (OR=1.76, 95% CI 1.22-2.54) at 4 years, also with small effect sizes.

Considering devices and activities, watching TV for 3 hours or more at age 5 predicted an increase (0.13 95% CI 0.03 to 0.24) in conduct problems at age 7, with small effect size compared to watching for less than 1 hour, in one study (Parkes et al., 2013). In Li et al. (2021), each additional hour of TV or digital media per day was associated with a higher mean score of conduct problems in children aged 2 to 4 years (95% CI, 0.10-0.35; p<0.001) and 4 years and older (95% CI, 0.02-0.11; p=0.007). In another study, attending programs at age 5 was associated with increased risk for conduct problems (OR 1.49, p=0.04), with small effect size (Niiranen et al., 2021). A positive association, with small effect, was also found between more than 1 hour mobile device use and conduct problems (OR: 1.94, 95% CI [1.15-3.28], p=0.014) in Hosokawa and Katsura (2018). And higher mobile device use was associated with conduct problems (p<0.001) in girls (Okada et al., 2021). Also, playing internet games for more than 6 hours was associated with abnormal responses on conduct problems scales (p=0.001) (Ahmed et al., 2022).

When changes were not evident

Some studies found no associations between screen time and conduct problems, for example, in Lobel et al. (2017) there was no association with violent games (β=0.017, p=0.788), or video games in Tezol, Yıldız and Yalçın (2022a), or electronic games in Parkes et al. (2013). In Li et al. (2021), TV or media use was associated with conduct problems, but use of other types of screens showed no significant associations.

Oppositional defiant disorder and rule breaking

Exposure to more than 4 h of total ST per day was prospectively associated with a higher prevalence of Oppositional Defiant Disorder (ODD) (46%) in one study (Nagata et al., 2022). Scores for rule breaking (p=0.018) higher in the excessive screen use group compared to the control in Choi et al. (2021). Children with more than 1 hour per day of screen time had higher scores for challenging opposition problems (d'=0.36; p<0.05), with small effect size in another study (Xie et al., 2020). And each 1-hour increase in watching TV/movies was related to a 5.9% increase in rule-breaking behavior and a 4% increase in aggressive behavior, in Guerrero et al. (2019).

Emotional problems

Screen use in general was positively correlated with emotional symptoms (r=.11, p=.014), with small effect size, in Kostyrka-Allchorne et al. (2020). In Monteiro et al. (2021) there were positive correlations between emotional symptoms and total hours of screen exposure during pandemic confinement, on weekdays (r=0.271, p=0.000) and weekends (r=0.266, p=0.001), also with small effect sizes. Screen time greater than 1 hour per day was associated with higher odds of high levels of emotional difficulties (OR 6.8, 95% CI 1.5 -30.9), with large effect size in Moulin et al. (2022).

Emotional symptom scores were significantly higher in children with excessive ST ($p<0.05$) in one study, with medium effect size (Tezol et al., 2022b). And there was a positive association between ST in girls at age 6 months and emotional symptoms (OR=1.55, 95% CI 1.04-2.32) at age 4 years, with small effect size in another study (Liu et al., 2021). Compared to 1 hour of daily leisure screen time, 3 hours daily was associated with a higher likelihood of emotional problems in boys (OR 4.15, 95% CI 2.10-8.19) in one study (Cartanyà-Hueso et al., 2022).

Regarding devices and activities, playing internet games for more than 6 hours was positively associated with abnormal responses on the emotional distress and alexithymia scales (p=0.002) in one study (Ahmed et al., 2022). High level of media multitasking was positively associated with lower socioemotional functioning ($p<0.01$) in Cardoso-Leite et al. (2021). And in the study by Kostyrka-Allchorne et al. (2020), media multitasking was positively correlated with emotional symptoms (r=0.11, p=0.009), with small effect size. More time spent on social media was associated with more emotional difficulties (B=0.50 CI 0.17 0.83) in Nicolì et al. (2022). Positive association also between more than 1 hour mobile device use and emotional symptoms - OR 1.54 (95% CI [1.06-2.24], p=0.025), with small effect size in Hosokawa and Katsura (2018). And mobile device use for 2 or more hours was associated with higher odds of emotional problems (p=0.015), with small effect size, in another study (Okada et al., 2021).

When changes were not evident

Some studies have found no associations between screen time and emotional problems, as in Liu et al. (2021), who found no such correlation at age 2.5 years. Or in Parkes et al. (2013), which found no such correlation for any type of screen time. And one study found no association between playing video games and being borderline or

abnormal in emotional symptoms (Tezol et al., 2022a). There were also no associations between violent gaming and pro-social behavior (β=0.091, p=0.176), in the study by Lobel et al. (2017).

Social and peer problems

Scores for social problems ($p<0.05$) were higher in the excessive screen use group compared to the control group in Choi et al. (2021). Scores for peer relationship problems were significantly higher in children with excessive ST ($p<0.05$) in one study (Tezol et al., 2022b). And a high amount of screen time at 18 months was associated (OR 1.64, p=0.03) with an increased risk of peer problems in another study (Niiranen et al., 2021).

Considering devices and activities, in Guerrero et al. (2019) each one hour increase in watching TV/movies was related to a 5% increase in social problems. Playing internet games for more than 6 hours was associated with abnormal responses on the peer problems scales (p=0.04) in one study (Ahmed et al., 2022). Using mobile devices for 2 or more hours was associated with higher odds of peer problems in boys, with small effect size (OR: 1.66, 95% CI: 1.16-2.37), and in girls with medium effect size ($p<0.001$) (Okada et al., 2021). Peer relationship problems significantly predicted mobile touch screen device use (p=0.043), with small effect size (Konok & Szőke, 2022).

When changes were not evident

Some studies found no associations between screen time and social and peer problems. No association was found between any type of ST and peer relationship problems or pro-social behavior in one study (Parkes et al., 2013). Pro-social scores were not different between low and excessive ST groups ($p>0.05$) in another study (Tezol et al., 2022b). Gaming frequency (β= -.022, p=.727) or playing violent games (β=0.091, p=0.176) was not associated with changes in pro-social behavior in Lobel et al. (2017). And there was no association between playing video games and being borderline or abnormal in peer relationship problems or pro-social behavior in Tezol et al. (2022a).

When improvements were evident

There was also one study that found screen time positively associated with improvements in children's mental status. For boys a protective effect of duration of mobile device use for 1 to 2 h was found for pro-social behavior problems (OR: 0.73, 95% CI: 0.56-0.96) (Okada et al., 2021).

Mood symptoms

The study by Bagarić, Flander, Roje and Raguž (2022) found that children with higher levels of anxiety-depression are those who spend more time in front of the screen. Two studies found high screen time associated with higher risk of anxiety, Zhang et al. (2022) and Li et al. (2022a), with small effect sizes ($p<0.01$) and (OR: 1.72, 95% CI: 1.06-2.80), respectively. In another study, children who spent 2 or more hours per day on all screen media were more likely to fit diagnostic criteria for depressive disorders. Girls who spent more than 7 hours a day on screens were almost four times more likely to have a depressive disorder. Boys who spent more than 7 hours a day on screens were twice as likely to have a depressive disorder (Roberston, Twenge, Joiner, & Cummins, 2022). Overall electronic media use was a predictor of anxiety ($p=0.001$), whereas weekend electronic media use was related to depression ($p<.001$) in the study by Fors and Barch (2019).

Regarding devices and activities, one study found that anxiety was positively related to video game use ($r=0.19$; $p<0.05$) in boys and girls. Anxiety state was a predictor of video game use and dependence ($p=0.01$), with small and medium effect sizes (De Pasquale, Chiappedi, Sciacca, Martinelli, & Hichy, 2021). On the weekend, higher depressive symptoms were associated with more hours per day spent watching TV/videos, using a PC, playing sedentary video games, "other" electronics use, and total ST hours, in one study (Dennison-Farris, Sisson, Stephens, Morris, & Dickens, 2017). According to data from Kidokoro et al. (2022), more than 2h/day on social media was associated with higher prevalence of depression. More time spent watching TV was associated with lower prevalence of depression. Girls with more than 2 h/day playing online games had higher prevalence of depression. Boys with more than 2 hr/day in online videos had higher prevalence of depression, with small effect sizes. Screen time on age-inappropriate content, such as adult video games or R-rated movies (for ages 17+), was associated with multiple mood symptoms (irritability, depressed mood, anhedonia, and anger) in one study (Lin, Eaton, & Schleider, 2020).

When changes were not evident

Weekday electronic media use was not significantly related to depression in the study by Fors and Barch (2019) and there was no change in depression in three further studies (Li et al., 2021; Li et al., 2022a; Zhang et al., 2022).

Externalizing and internalizing symptoms

One study found a positive correlation between total hours of screen exposure and externalizing symptom scale considering the difference between total screen exposure before and during weekend pandemic confinement (r=0.216, p=0.006), with small effect size (Monteiro et al., 2021). In Choi et al. (2021), scores for externalizing were higher in the excessive screen use group compared to the control group ($p<0.05$). According to data from McArthur, Tough and Madigan (2022), 2h/day compared to ≤ 1 h/day of ST was associated with higher risk for internalizing (OR 1.36, 95% CI 1.06-1.73) and externalizing (OR 1.30, 95% CI 1.02-1.65) problems. And ≥3 h/day compared to ≤1 h/day of ST was associated with higher risk for internalizing problems (OR 1.90, 95% CI 1.41-2.55) and externalizing (OR 1.66, 95% CI 1.23-2.23), with small effect sizes. In Neville, McArthur, Eirich, Lakes and Madigan (2021), higher levels of ST were associated with higher levels of externalizing (r=0.29; 95% CI=0.18, 0.28) and internalizing (r=0.16; 95% CI=0.10, 0.22) behaviors, with small effect sizes. Higher ST levels at age 5 were associated with increased internalizing behaviors at age 7 (sr2=0.04; 95% CI=0.004, 0.07), with moderate effect sizes. Preschoolers with more than 1 hour of screen time daily tended to have more externalizing problems (p=0.016, R2=0.14), medium effect size, in one study (Xie et al., 2020). And variations in the hypothesized thalamus-prefrontal cortex-brainstem circuit were positively associated with total screen time (β=0.107, p=0.002) and externalizing behaviors (β=0.111, p=0.003), small effect sizes, in one study (Zhao et al., 2022a).

Considering devices and activities, game frequency predicted an increase in internalizing problems longitudinally (β=0.137, p=0.024), with small effect size in Lobel et al. (2017). Watching programs on TV was associated with increased risk for internalizing symptoms at age 5 years (OR 1.71, p=0.04), with small effect size in Niiranen et al. (2021).

When changes were not evident

Preschoolers with more screen time did not have a significantly higher externalizing problem score than those with less screen time in another study (Tansriratanawong, Louthrenoo, Chonchaiya, & Charnsil, 2017).

When improvements were evident

The study by Neville et al. (2021), noted that higher levels of ST at age 7 were associated with a small decrease in internalizing behaviors at age 9 (sr2=-0.02; 95% CI= -0.04, -0.003).

Suicide and self-harm

According to the results of Janiri et al. (2020), the child-reported risk of suicide increased with prolonged weekend screen use (OR 1·3, 95% CI 1·2-1·7), with small effect size. Data from Roberston et al. (2022) showed that children who spent 2 or more hours per day on all screen media were more likely to fit diagnostic criteria for self-harm and suicidal ideation or attempts, compared to less than 2 hours of screen exposure per day. Girls who spent more than 7 hours a day on screens were twice as likely to have suicidal ideation or attempts or engage in self-harm. Boys who spent more than 7 h a day on screens were almost twice as likely to have suicidal ideation or attempts and non-suicidal self-harm compared to less than 1 hour a day on screens.

Considering devices and activities, Roberston et al. (2022) also found that watching TV was associated with suicide ideation or attempt among boys (RR 1.23, 95% CI 1.02, 1.47) and girls (RR 1.41, 95% CI 1.14-1.73). In addition, gambling was significantly associated with suicide ideation or attempt among boys (RR 1.31, 95% CI 1.10-1.56) and girls (RR 1.23, 95% CI 0.92-1.65). A longitudinal study noted that the screen activity modalities most strongly associated with suicidal behaviors were text messaging, video chat, videos, and video games, with small effect sizes, OR between 1.18 and 1.36 (Chu et al., 2023).

Problems in mental health status and self-esteem

Children with high ST had significantly increased risks for low self-esteem in two studies, with small effect sizes (OR: 1.63, 95% CI: 1.07-2.48) (Li et al., 2022a) and (OR: 1.64, 95% CI: 1.22-2.19; $p<0.01$) (Zhang et al., 2022). Higher frequency of daily use of different types of social digital media, was associated with higher risk of lower well-being scores ($p<0.0001$) in one study (Bruggeman, Hiel, Hal, & Dongen, 2019).

Regarding devices and activities, in Cardoso-Leite et al. (2021) high level of media multitasking was linked to higher levels of psychological distress ($p<0.01$). And greater time spent using mobile devices was associated with problem mental health status ($p<0.001$, OR: 10.8 CI: 3.32-35.12) in another study (Ayu, Titik, & Yuli, 2020).

When improvements were evident

Cardoso-Leite et al. (2021), noted that more time playing video games was associated with lower levels of distress (r = -0.38, p=0.006) with moderate effect size.

Sleep problems

It was observed in one study that higher screen exposure was associated with greater behavior problems in children sleeping less than 9.88 hours per night (b=1.15, SE=0.59, p=0.05, 95% CI [0.00, 2.32]) and more externalizing problems for children sleeping less than 9.94 hours per night (b=0.76, SE=0.38, p=0.05, 95% CI [0.00, 1.52]), with small effect sizes (Kahn et al., 2021). Considering devices and activities, Ahmed et al. (2022) research revealed that children who used internet gaming apps for more than 6 hours had worse sleep quality than those who played for 1 to 2 hours. And the study by Cardoso-Leite et al. (2021) also found an association between high level of media multitasking and poorer sleep quality.

Discussion

The current study conducted a survey of the evidence surrounding the possible influences of screen time on children's mental health. Among the 43 studies involved in the investigation, only two found no unfavorable associations between screen time and mental health (Tansriratanawong et al., 2017; Tezol et al., 2022a). Most studies had small effect sizes, only 12 investigations had medium to large effect sizes (Ayu et al., 2020; Cardoso-Leite et al., 2021; Chen et al., 2020; Lin et al., 2020; Moulin et al., 2022; Nicolì et al., 2022; Rakickiené et al., 2021; Tansriratanawong et al., 2017; Tezol et al., 2022a; Tezol et al., 2022b; Xie et al., 2020; Zhang et al., 2022). The consistency is appearing around the long hours on screen are in fact deleterious for children, besides the lack of clarity about if these long hours are a cause of mental health problems or a condition where someone with symptoms hide. Anyway, the long hours should be an alert to pay attention on the mental health status of the children.

During the COVID-19 pandemic and social withdrawal (Ahmed et al., 2022; De Pasquale et al., 2021; Li et al., 2021; Monteiro et al., 2021; Moulin et al., 2022; Nicoli et al., 2022; Rakickienè, 2021; Tezol et al., 2022a), screen time may not have negatively impacted mental well-being, since it is commonly the only way to stay socially connected (Pandya & Lodha, 2021). However, the literature has shown that children under pandemic

stressors had better mental health associated with shorter screen times (Tandon, Zhou, Johnson, Gonzalez, & Kroshus, 2021). The use of screen media devices was already entrenched in children's lives long before the pandemic by COVID-19, and it was amplified by the pandemic and the social restrictions imposed, motivating research and public debate about the potential effects of media use on child development (Gueron-Sela, Shalev, Gordon-Hacker, Egotubov, & Barr, 2023). Prior to the pandemic, there were weak evidence for associations of screen time with behavior problems, anxiety, hyperactivity and inattention, psychosocial well-being, sleep, and self-esteem (Stiglic & Viner, 2019).

Indeed, even though children are spending more and more time with digital devices, most but not all studies observe negative effects on development (Shatskaya, Gavrilova, & Chichinina, 2023). No associations with screen time were also observed, for example, in hyperactivity and inattention (Liu et al., 2021; Lobel et al., 2017; Moulin et al., 2022; Parkes et al., 2013; Okada et al., 2021; Tezol et al., 2022a; Tezol et al., 2022b). Some studies also observed no associations with conduct problems (Lobel et al., 2017; Parkes et al., 2013; Li et al., 2021; Tezol et al., 2022a), in emotional problems (Liu et al., 2021; Lobel et al., 2017; Parkes et al., 2013; Tezol et al., 2022a), social problems (Lobel et al., 2017; Parkes et al., 2013; Tezol et al., 2022a; Tezol et al., 2022b), in depression (Fors & Barch, 2019), or externalizing (Lobel et al., 2017; Tansriratanawong et al., 2017). In few studies, improvement in some aspect of mental health was observed, for example greater attentional control and less distress associated with gaming (Cardoso-Leite et al., 2021) and less internalizing behaviors (Neville et al., 2021). So, there is a potential benefits and risks of screen media on the psychosocial development of children under 5 years of age in specific conditions (Ponti, 2023). However, the 2019 World Health Organization screen time guidelines do not recommend screen time for infants and children up to 2 years of age and <1 h/day for children 2 to 4 years of age (WHO, 2019).

The types of devices and their uses also change during childhood, corresponding to the shift from the primary activity of playing to learning activity (Shatskaya et al., 2023). Mothers of children aged 6 to 36 months perceived in their children educational benefits of watching TV, but also potential harms such as vision problems and decreased desire to engage in other activities (Beck, Takayama, Badiner, & Halpern-Felsher, 2015). In preschool children aged 3-5 years, parents also had strong feelings about the positive educational and entertainment impacts of watching TV, but also had strong fears that their

children would imitate bad behavior (Thompson, Jimenez-Zambrano, Ringwood, Tschann, & Clark, 2023).

An investigation of 101,350 children in the USA found excessive screen time positively associated with behavioral and conduct problems, autism spectrum disorders (ASD), and attention deficit hyperactivity disorder (ADHD). Children with 2, 3, 4 or more hours of screen time per day had 2.08 to 3.49 times odds of ASD, preschoolers with ≥4 hours of screen time per day had 1.76 times odds of behavioral and conduct problems and 1.85 times odds of ADHD (Qu et al., 2023). Several studies have reported associations between screen time and typical ADHD behaviors (Ahmed et al., 2022; Cartanyà-Hueso et al., 2022; Guxens et al., 2019; Hosokawa & Katsura, 2018; Konok & Szőke, 2022; Kostyrka-Allchorne et al., 2020; Li et al., 2021; Nicolì et al., 2022; Niiranen et al., 2021; Rakickienė et al., 2021; Xie et al., 2020), conduct problems (Ahmed et al., 2022; Hosokawa & Katsura, 2018; Kostyrka-Allchorne et al., 2020; Li et al., 2021; Liu et al., 2021; Nagata et al., 2022; Niiranen et al., 2021; Okada et al., 2021; Parkes et al., 2013; Tezol et al., 2022b), oppositional defiant disorder and rule breaking (Choi et al., 2021; Guerrero et al., 2019; Nagata et al., 2022; Xie et al., 2020), and autistic-type behaviors (Chen et al., 2020; Kushima et al., 2022).

There is a suggestion that media time is in fact associated with behavior problems, such as ADHD (Holton & Nigg, 2020). The literature mentions that screen time may be related to typical ADHD behaviors by making it more difficult to engage in activities that are considered to better stimulate cognitive skills and have longer attention spans during attentional development (Santos et al., 2022). This is because media stimulation to capture attention displaces learning opportunities with low developmental value for the brains of infants and young children (Lissak, 2018). There are some interesting common points between oppositional defiant symptoms and inattentive/hyperactivity symptoms, both made children difficult to handle. In this study we did not evaluate children with clinical cases diagnosed already, however in some of the reviewed data are very young and might have undiagnosed clinical features. Parents having children with symptoms of behavioral conditions may be more permissive to allow long hours of screen.

Not only excessive screen time, but early exposure, can have an impact on behavior. For example, one study found that children who used screens before the age of 2 had higher risks of impulsivity and hyperactivity problems compared to children with

late onset of screen exposure, independent of excessive use (Xiang et al., 2022a). This may be explained by developmental susceptibility, i.e. responsiveness to media modulated by the child's stage of cognitive, emotional, and social development (Piotrowski & Valkenburg, 2015). Young children may be more susceptible to the effects of violent or exciting media content than older children, considering that they are not fully able to differentiate reality from fantasy and do not fully understand the perspectives of others. In fact, recent studies have shown that the effect of violent media exposure on aggressive behavior is stronger in preschool children than in older children (Gueron-Sela et al., 2023). And that the association between excessive screen time and developmental and behavioral problems is stronger among preschoolers than older children (Qu et al., 2023).

Longer duration of screen time was associated with internalizing and externalizing symptoms (Choi et al., 2021; Lobel et al., 2017; McArthur et al., 2022; Monteiro et al., 2021; Neville et al., 2021; Niiranen et al., 2021; Xie et al., 2020; Zhao et al., 2022a). Other studies had already found this association as well (Eirich et al., 2022; Radesky, Peacock-Chambers, Zuckernan, & Silverstein, 2016). What the research also shows is that children who exhibit higher levels of psychosocial difficulties receive longer screen times (Radesky et al., 2016). A plausible basis for these findings would be that children may be exposed to violent and aggressive content while watching on-screen media. And according to social learning theory, after repeated exposures children may replicate aggressive behaviors toward others (Eirich et al., 2022). Additionally, greater parental smartphone dependence has been associated with more externalizing and internalizing behavioral problems in their children (Mortensen et al., 2023). Even, less parental concern about their own screen time has been associated with greater children's screen time (Veldman, Altenburg, Chinapaw, & Gubbels, 2023).

Here we observed that screen-based activities were also associated with worse scores of emotional and mood problems, such as anxiety and depression (Ahmed et al., 2022; Bagarić et al., 2022; Cardoso-Leite et al., 2021; Cartanyà-Hueso et al., 2022; De Pasquale et al., 2021; Dennison-Farris et al., 2017; Fors & Barch, 2019; Hosokawa & Katsura, 2018; Kidokoro et al., 2022; Kostyrka-Allchorne et al., 2020; Li et al., 2022a; Lin et al., 2020; Liu et al., 2021; Monteiro et al., 2021; Moulin et al., 2022; Nicolì et al., 2022; Okada et al., 2021; Roberston et al., 2022; Tezol et al., 2022b; Zhang et al., 2022). These data align with the literature (Xiang et al., 2022b). In Li et al. (2021), for example,

higher levels of video game time were also associated with higher depression and irritability scores, and greater TV or digital media time were associated with higher levels of anxiety and depression. Interestingly, anxiety and depression are common mental health conditions in pediatric patients (Pettitt, Brown, Delashmitt, & Pizzo, 2022). Surveys in the last decade have indeed revealed that screen time is positively associated with depressive symptoms in children (Saunders & Vallance, 2017; Stiglic & Viner, 2019), including as a predictive factor (Li et al., 2022b). According to Browne, Thompson and Madigan (2020), however, there may be a clinical reality that some children will be more affected by screen-based media exposure than others.

Even though it is more prevalent in childhood than you might think, depression is less common in young children (Bitsko et al., 2022), and here the results were no different: of the studies that found a positive association between ST and depression, most were with children between 9.5 and 10.5 years old (Dennison-Farris et al., 2017; Fors & Barch, 2019; Kidokoro et al., 2022; Robertson et al., 2022). Only one study found screen time positively associated with depression in 5-year-olds (Bagarić et al., 2022). Data from 2013-2019 from the USA showed that the most prevalent disorders from ages 3 to 17 were attention-deficit/hyperactivity disorder and anxiety, and from ages 12 to 17, one-fifth of youth had experienced a major depressive episode (Bitsko et al., 2022). Indeed, anxiety and depression are common psychological problems during school years. In particular, anxiety disorders have earlier onset, usually around 5.5 years of age (Solmi et al., 2022) and may act as precursors to depression (Orgilés, Morales, Fernández-Martínez, Méndez, & Espada, 2023). Depressive symptoms often manifest themselves through internalizing and externalizing behaviors and it can be difficult for adults to recognize them in children. Given the often nuanced nature of depressive symptomatology, parents and teachers are more likely to observe externalizing behaviors and misattribute them to conduct disorder, on the other hand, internalizing behaviors may be more difficult to directly identify (Anant et al., 2023). Anxiety and depression were also positively associated with ST in longitudinal studies (Xiang, Liu, Yamamoto, Mizoue, & Kuwahara, 2022b), reinforcing our cross-sectional findings.

Previous reports have revealed that in addition to increased depression, screen time negatively impacts self-esteem and psychological well-being (Saunders & Vallance, 2017). Screen time has even been found to negatively mediate the association between self-esteem and quality of life in children (Caamaño-Navarrete et al., 2022). Our results

agree with what the literature has observed, screen time was found to negatively impact children's self-esteem and mental well-being in two studies (Li et al., 2022a; Zhang et al., 2022). Additionally, some studies have revealed positive associations between screen time and socialization problems (Ahmed et al., 2022; Choi et al., 2021; Guerrero et al., 2019; Konok & Szőke, 2022; Niiranen et al., 2021; Okada et al., 2021; Tezol et al., 2022b). Aligned with our findings, current studies have found problems with pro-social behavior, peer interaction, and social competence associated with excessive exposure to screens (Hu, Bi, Wang, Liu, & Li, 2023; Wan, Fitch-Bunce, Heron, & Lester, 2021). In fact, it has already been established that activities involving parents and children contribute to the development of social competence, that is, pro-social behaviors, such as sharing readily and being considerate of others' feelings (Hendry, Gibson, Davies, McGillion, & Gonzalez-Gomez, 2023). And solitary screen-based activities can consume this time from children and parents.

Children's sleep was also affected by screen time in this review (Ahmed et al., 2022; Cardoso-Leite et al., 2021; Kahn et al., 2021). Other research has found significant associations of screen time and children's sleep. For example, children's nighttime sleep duration was significantly shorter in children who watched television for more than two hours or used media two hours before bedtime (Okano et al., 2023). TV time was negatively related to total sleep time and infants' nighttime sleep. Smartphone viewing time was negatively related to total sleep time and daytime sleep of infants (Lin et al., 2022). It appears that sleep disturbances, when they are a result of excessive screen time, are linked to internalizing, externalizing, and peer problems (Lissak, 2018). Furthermore, exposure to video games can increase psychophysiological arousal in children (Cheung, Bedford, Saez De Urabain, Karmiloff-Smith, & Smith, 2017). Consequently, arousal can disrupt relaxation before bedtime causing delayed sleep onset and reduced sleep time (Magee, Lee, & Vella, 2014). Even short sleep time can promote fatigue the next day, which can lead to increased sedentary screen-viewing behavior (Lissak, 2018). Parental lifestyle also has an influence on children's sleep habits (Okano et al., 2023). Those parents who offered screens to their children to spend time on household chores reported that their children had less total sleep time and shorter sleep episodes (Lin et al., 2022).

In general, the cross-sectional design of most studies may make it difficult to establish causality in associations. However, it can be seen that longitudinally screen time was associated with some outcomes such as hyperactivity and inattention problems (Li et

al., 2021; Liu et al., 2021; Niiranen et al., 2021; Rakickiené et al., 2021), conduct problems (Li et al., 2021; Liu et al., 2021; Nagata et al., 2022; Niiranen et al., 2021; Parkes et al., 2013), and ODD (Nagata et al., 2022). Socialization problems (Niiranen et al., 2021; Konok & Szőke, 2022), anxiety, and low self-esteem (Li et al., 2021). Autistic (Chen et al., 2020; Kushima et al., 2022) and suicidal (Chu et al., 2023) type behaviors. Internalizing and externalizing problems (Lobel et al., 2017; Neville et al., 2021; Niiranen et al., 2021). And in that context ours are in line with the literature (Zhao et al., 2022b). Undoubtedly, a larger volume of longitudinal investigations can help clarify whether the excessive supply of screens comes before or after the presentation of the behaviors.

Conclusion

This review has gathered evidence of the influence of screen time on children's mental health, especially on typical ADHD behaviors, emotional and mood problems, conduct, externalizing and internalizing problems, and socialization problems. TV, video game and mobile device time is positively associated with worse mental health risks. Today it seems that simply limiting screen time is not enough to ensure mental well-being, but enriching off-screen activities may be crucial to lessen the impact of exposure to the digital world. Lack of adequate hours of sleep at night, due to the presence of screens before bedtime, may lead children to more time in sedentary screen-based activities the next day. Future research initiatives should focus efforts on longitudinal studies dedicated to deeply understand the potential causal relationship of objective measures of screen time, as well as separately assessing the effects of each device, as children's psychosocial responses may differ depending on their screen use and the type of content they will be exposed to.

Limitations

This review has limitations such as the lack of individual patient data for longitudinal data, objective measures of screen time, which may present recall bias and parental estimation. In addition, the period of the pandemic by COVID-19 may have an additional effect on children’s mental health that could not be estimated or measured.

Declarations

Ethical Approval

Not applicable.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Funding

The authors did not receive support from any organization for the submitted work.

Availability of data and materials

All study data are available with the published article.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [RMSS], [MEOAG], [SAV] and [YJAN]. The first draft of the manuscript was written by [RMSS] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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6.4 Artigo 2

The associations between screen time and mental health in adolescents: A Systematic Review

Running head: Screen time and mental health in adolescents

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Abstract

Background: Adolescents have extensive use of screens and, they have common complains related to mental health. Here a systematic review was done to understand the association between screen time and adolescent's mental health. Method: This review was conducted in compliance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA. An update search was performed in January 2023 with the following keywords: "screen time," "adolescent," and "mental health" on PubMed, PsycINFO and Scopus databases. Results: 50 articles were included, most have found associations between screen exposure and mental health in adolescents. The most used device by adolescents was the smartphone and the use on weekdays was associated with diminished mental well-being. Social media use was negatively associated with mental well-being and, in girls, associated at higher risk for depression. Conclusion: Excessive screen time in adolescents seems associated with mental health problems. Given the profusion and disparity of the results, additional studies are needed to clarify elements such as the screen content or the interaction of adolescents with different screen devices. Systematic review registration: PROSPERO CRD42022302817
Keywords: screen time; mental health; adolescents; media

Introduction

Adolescence represents a phase of increased risk for the emergence of mental health problems [1,2]. According to the 2021 update of the World Health Organization (WHO) [3], it is estimated that 14% of young people between 10 and 19 years old have mental health problems, which represents, globally, 13% of all diseases that affect this population. Depression, anxiety, and behavioral disorders are among the leading causes of illness and disability in adolescents, and suicide is already the fourth leading cause of death among 15–19-year-olds [3].

The current generation of teenagers is growing up immersed in a world saturated with electronic media, they did not know the times before the internet and for this reason, they are called “digital natives” [4]. Media use of screen-based electronic devices is extensive, including television (TV) programs watching and using computers, tablets, and smartphones. In the last 10 years, the use of mobile Internet devices has increased exponentially, becoming part of everyday life [5].

The increased use of screens has been noticeable and amplified in the COVID-19 pandemic due to isolation and restrictions on other leisure activities [6]. The American Academy of Pediatrics (AAP) recommends that children over age five through adolescence be exposed to less than 2 hours of screen time (ST) per day. However, a large percentage of adolescents already exceed this recommendation [7]. In general, these media-related activities occupy about 6 to 9 hours of a young American's day, excluding housework and schoolwork [2,4].

Adolescents are particularly susceptible to the opportunities and risks of new technologies [8]. The development of socio-affective brain circuits can increase sensitivity to social information, impulsiveness toward rewards, as well as a preoccupation with peer evaluation [2]. The growing suggestion that excessive screen time is related to recent increases in mental health problems among young people has been the focus of research [9,10,11]. However, reviews of this nature were either restricted to children [9] or included several age groups [10,11,12]. In addition, the specific focus on a given symptom [9,12], or the concern with providing recommendations and strategies [10], reinforces the need for a more detailed investigation of this relationship among adolescents.

Results from previous reviews are mixed [13,14,15,16]. In the general population, research done during COVID-19 pandemic has found most evidence indicating negative effects of long screen time on mental health (MH) [10]. Among children, an association was found between screen time and internalizing and externalizing behavior problems [9]. In adolescents, the association between social media use and psychological well-being was negative but very small [17]. Together, adolescent children and young adults showed a small to very small association between screen time and depressive symptoms, varying between different devices and uses [11]. Furthermore, methodological issues such as cross-sectional design, sampling and measurements can weaken the evidence [17,18].

Accumulated evidence indicates that screen time may be associated with aspects of the adolescent's mental health. However, the direction of these associations is not yet clear, the literature still lacks comprehensive and detailed research. With this in mind, this review aims to contribute to the understanding of the effects that exposure to screens can promote on a wide range of the mental health aspects of adolescents, which were previously researched such as flourishing (synonymous with a high level of mental well-being), life satisfaction, self-efficacy, self -concept Physical, psychosocial difficulties, conduct problems, hyperactivity/inattention and pro-social behavior, symptoms of internalization and externalization, positive mental health, and mental well-being. In addition, this review included the various screen-based devices most used by this population. The goal was to raise evidence that could increase knowledge about the interactions that adolescents set with screens, which may have potential additive increase in exposure time and effect on the mental health of this population.

Method

This review was conducted in compliance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA [19] and was registered at PROSPERO, under number CRD42022302817. A search was performed on 12/27/2021 with the following question: Is there any association between screen time and mental health in adolescents? For this, the following keywords were used: “screen time,” “adolescent,” and “mental health,” combined with the operator AND on databases PubMed, PsycINFO, and Scopus. An additional search was performed to update the research on 01/18/2023, using the same strategy and the same databases, totaling six more studies included. Table 1 presents the search strategies (Additional file 1: Table 1)

(APÊNDICE F). The adopted strategy tried to increase the sensitivity of the searches, expanding the range of outcomes with the umbrella term mental health, and searching in all or any fields of the articles. In accordance with the PICO strategy, the study population will be composed of individuals in the adolescence phase and the intervention will be represented by exposure to screens. As outcomes, any aspects related to mental health will be considered, including measures related to mental well-being, like life satisfaction, and the control groups may be absent from the observational studies included. With the volume of data captured, considering previous reviews, the addition of records from the reference lists of the included articles was not considered.

Inclusion criteria: (1) articles that directly assessed associations between screen time [i.e., the amount of time spent using a device with a screen such as a smartphone, computer or video game console (active screen, screens that allow motor interaction and responsivity), or television (TV) and videos (passives screens), for entertainment or educational use] and mental health, that is, (mood, internalization or externalization problems, sleep disorders, aspects related to mental well-being such as satisfaction with life, self-esteem and self-efficacy, among others), with at least one variable evaluated; (2) studies that measured mental health outcomes through validated scales/instruments; (3) studies with adolescents, average age between 12 and 18 years; (4) articles in English, published in the last 10 years. Exclusion criteria: (1) studies carried out with adolescents diagnosed with problematic internet use, (2) sample composed of adolescents already diagnosed with mental health problems or being followed up in mental health/psychiatry outpatient clinics, (3) research that used screen-based devices to aid functionality and (4) case reports and case series.

The screening procedure was performed in pairs, including an initial independent search. After duplicate records were deleted, the titles and abstracts of each study were screened according to the inclusion and exclusion criteria. The articles eligible for full reading were selected and the two authors discussed the results and reached a consensus on articles to be included in the review. Any disagreements were resolved by consensus with the third author.

Data extraction

The following data were extracted according to a standard form that included: first author, date, country of publication, study design, sample characteristics and study objectives, mental health assessment, measures of screen time exposure, and main

associations found. The allocation of records in the form followed the year of publication, starting with more recent studies.

The term self-reported was used to indicate that screen time was the time spent on screen-based activities, reported by the participant in response to a question. When the study applied a validated instrument or performed an objective measurement of screen time, it was indicated in the form.

Quality Assessment

The methodological quality of the studies was assessed using the Newcastle-Ottawa Scale, based on criteria related to selection and comparability between cohorts and related to study outcomes. The methodological quality of the cross-sectional studies was performed using the adapted Newcastle Ottawa for cross-sectional studies [100]. The evaluation was performed in pairs, by four reviewers and discrepancies were resolved by consensus with a fifth reviewer. The maximum score (9 points) represents high methodological quality [20].

Results

In the first search carried out on 12/27/2021, 1,309 records were identified in the database through the search strategy. Four hundred and forty-two duplicates were removed and 867 articles were screened by title and abstract. After screening, 763 reports were excluded because they did not meet pre-established criteria. Thus, 104 articles were reviewed, of which 44 were included in this review. These 44 articles were added to the most recent search, carried out on 01/18/2023, totaling 50 articles reviewed in this study. Both selection processes are described in detail in two PRISMA Flowcharts (Additional File 2: Figure 1 and Figure 2) (APÊNDICE G).

Study characteristics

Of the 50 studies, published between 2011-2023, 38 were cross-sectional and 12 longitudinal, with a total of 1,900,447 adolescents. Table 2 (Additional file 1: Table 2) (APÊNDICE H), presents the distribution of this sample.

Data extracted from the included studies are summarized in Table 3.

Table 3. Descriptive characteristics of the included studies.

Author, country, type of study	N / Age / Gender / Purposes	Mental Health (MH) – assessment	Screen Time (ST) measurements	Associations
Chen et al. [21] China Cross-Sectional	N: 1,331 M Age: 7–9 th grades 48,69% girls To investigate the associations between different types of (screen-based sedentary behavior - SSB) and anxiety symptoms.	Anxiety symptoms: Zung Self-Rating Anxiety Scale	Self-reported. SSB was categorized into television/movie time, video game time, and internet-surfing time	Video game time of 6 or more hours was positively associated with boys' anxiety symptoms ($p<.05$), with a large effect size (OR=5.12, 95% CI: 1.56–17.44). There were no associations between different types of SSBs and anxiety symptoms in girls.
Forte et al. [22] Ireland Cross-Sectional	N: 1,756 M Age: 15,2 56,7% girls To investigate the associations between screen time (ST) and physical activity (PA) level with depressive symptoms.	Depressive Symptoms Quick Inventory of Depressive Symptomatology	Self-reported weekly ST (TV, computer (PC), and phone use)	The most significant correlations with depressive symptoms were shown by higher levels of computer ($\beta=.106$, $p \leq .000$) and phone use ($\beta = 0.138$, $p \leq 0.000$), with a small effect size. Only correlations between phone use and depressive symptoms were moderated by PA level.
Kandola et al. [23] UK Longitudinal	N: 4,599 M Age: 14,0 55%girls To investigate how theoretically replacing different screen-uses with exercise might influence future adolescent emotional distress.	The outcome was emotional distress at age 17: Strengths and Difficulties Questionnaire, emotional symptoms subscale	Self-reported. Daily time-use variables were recorded by 24-hour time-use diaries completed over two randomly selected days, one in the week and the other at the weekend.	Substituting 60 min of television or social media use with team sports was associated with a decrement of 0.17 (95%CI, -0.31, -0.04) and 0.15 (95%CI, -0.29, -0.01) in emotional symptom scores, at 17, respectively. Small effect size.
Kjellenberg et al. [24] Sweden Cross-Sectional	N: 1,139 M Age: 13,4 51% girls To investigate the associations between physical activity pattern, sports participation, screen time and mental health.	Anxiety and health-related quality of life (HRQoL): short version of the Spence Children's Anxiety Scale and Kidscreen-10.	Self-reported: time spent with screens on a weekday and weekend, not including schoolwork.	Only the group of girls who reported ≥ 5 h ST on weekdays or weekends has shown significant associations. These groups had considerably higher anxiety rates compared with those who reported up to 2 h. When controlling for MVPA, this comparison held significant (B=3.39, 95% CI 1.33 to 5.46). Large effect size.
Kidokoro et al. [25] Japan Cross-Sectional	N: 7,847 M Age: 14,0 53% girls To investigate associations between different types of screen behavior and depression, considering sleep and exercise.	Depression symptoms were measured using a modified version of the depression questionnaire developed by the American Psychiatric Association	Self-reported: time spent on recreational (i.e., screen behavior outside of school) screen, in a week.	Longer time spent on newer sorts of screen behavior, including social media, and online games (among junior high school girls), was associated with a higher prevalence of depression, with a small effect size. Longer time was spent on TV correlation with a lower prevalence of depression

Marciano et al. [26] Switzerland Longitudinal	N: 674 M Age: 14,4 56,7% girls To investigate how changes in screen-media use from Spring 2019 (T1) influenced adolescents' mental health in (T2) Autumn 2020	Mental health: adapted version of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). Loneliness: 3-item version of the UCLA Loneliness Scale. Depression: seven items from the Center for Epidemiologic Studies Depression Scale.	Self-reported: Screen-media activities were measured at T1 and T2 as time spent in different online activities on "a typical school day" and on "a typical weekend day"	Worse mental health at T2 has only been significantly associated with increased time spent on social media ($\beta = 0.112$, $p = 0.016$), with medium effect size. Longer time dedicated to structured media activities as television viewing decreased rates of inattention ($\beta = -0.091$, $p = 0.021$) and anxiety ($\beta = -0.093$, $p = 0.014$).
Khan et al. [27] 42 European and North American countries. Cross-sectional	N: 577,475 M Age: 13.6 51.35% girls To examine the associations between the combination of ST and Physical Activity (PA) with mental well-being.	Satisfaction with life: Cantril Ladder Psychosomatic complaints: feeling low; irritability or bad mood; nervousness; difficulty falling asleep; dizziness; headaches; stomachaches; and back pain.	Self-reported use of all screen types and all purposes, excluding motion and fitness games.	In a dose-dependent manner, there was negative association between ST levels and life satisfaction and positive association between ST and psychosomatic complaints. Detrimental correlations between ST and mental well-being started when ST exceeded 60 min/d for girls and 75 min for boys ($p<.001$). Small to medium effect sizes.
McAllister et al. [28] UK Cross-sectional	N: 4,243 M Age: 13.7 55% girls To examine associations between depressive symptoms and self-harm by gender and screen types.	Depression: Short version of the Mood and Feelings Questions (SMFQ); Self-harm: reported whether they had engaged in self-harm in the past year	Self-reported: Time Use Diary (TUD) activities that involved screen media: texting/e-mailing, social media, internet use, gaming and "watching TV, DVDs, downloaded videos" (TV/videos).	More than 3h/d on social media (n=92) more likely to self-harm (29%) and less than 1h/d (n=852) less likely (19%) girls. For depressive symptoms the results were similar 31% vs 19%. Small effect sizes. Self-harm or depression among boys was not associated with media use. The correlation was not significant between MH and games or TV/video for boys and girls.
Sampasa-Kanyinga et al. [29] Canada Cross-sectional	N: 6,364 M Age: 15.1 56.7% girls To investigate associations between compliance with the Canadian 24H Movement Guidelines recommendations and psychological distress.	Psychic distress: 6-item Kessler Psychological Distress Scale (K6)	Self-reported: Time spent in the last 7 days on any screen device in free time.	ST was only associated with sleep duration when combined with anxiety and depression ($p<0.001$), with a small effect size. No direct correlation between ST and anxiety or depression was observed.
Ren et al. [30] China Cross-sectional	N: 1,771 M Age: 12 to 19 51.8% girls To examine the psychological impacts of the pandemic COVID-19 on the development of mood disorders.	Anxiety: General Anxiety Disorder-7 (GAD-7, Chinese version). Depression: Patient Health Questionnaire-9 (PHQ-9, Chinese version); Perceived Social Support: Multidimensional Scale of Perceived Social Support (MSPSS, Chinese version); Psychological resilience: Connor-Davidson Resilience Scale-10 (CD-RISC-10, Chinese version).	Self-reported: average time spent per day, in leisure and study, on electronic devices (TV, smartphones, tablets and computers).	Symptoms of anxiety and depression were 28.3% and 30.8%, respectively. The risk of anxiety/depression decreases with less ST ($P<0.05$). Between ages, the association between TS and depression and anxiety did not differ.

Brown et al. [31] Canada Longitudinal wave 1 (1994-1995) and wave 2 (1996)	N: 6,436 M Age: 16.03 52% girls To determine whether adherence to a movement behavior profile was associated with differences in depressive symptoms.	Depression: Center for Epidemiological Studies Depression Scale (CES-D)	Self-reported: 7-day recall Daily hours spent on TV/videos; computer games.	High profile AF and low ST reported minor depressive symptoms, and these differences were evident one year later
Brown & Kwan [32] Canada Cross-sectional	N: 1,118 M Age: 15.92 54.5% girls To examine the effects of reallocation/substitution of PA, ST, and sleep on mental well-being in adolescents.	Flourishing: Diener Flourishing Scale. Self-esteem: modified Rosenberg Self-Esteem Scale. Resilience: two articles from the Canadian Campus Well-Being Study.	Self-reported: standard 7-day recall. How many hours per day on average are spent watching TV, using the PC, tablet or smartphone during free time.	ST (combined with < 8h of sleep) is negatively associated with self-esteem, resilience, and flourishing. Replacing 60 min/d of ST with moderate/intense PA or sleep was associated with better self-esteem and resilience scores. For flourishing, benefits were observed when replacing ST with moderate/intense PA or sleep (in the group that slept less than 8h). Small effect size.
Gilchrist et al. [33] Canada Cross-sectional	N: 46,413 M Age: 9th to 12th grade 51.5% girls To examine the impact on MH when reallocating 15 min spent on one health behavior to 15 min spent on another behavior.	Depression: 10-item Center for Epidemiologic Studies Revised Depression Scale - 10 (CESD-R-10) Anxiety: (GAD-7) Generalized Anxiety Disorder 7-item scale Flourishing: Diener Flourishing Scale.	Self-reported. How much daily time is spent watching TV or movies, playing video/PC games, surfing the Internet, and texting/messaging/e-mailing.	Replacing ST with any behavior (homework, PA, or sleep) may be better for MH outcomes. Small effect size.
Khan & Burton [34] Australia Cross-sectional	N: 2,946 M Age: 16.9 49% girls To investigate associations between two common recreational screen activities and psychological well-being.	Psychological well-being: Strengths and Difficulties Questionnaire (SDQ).	Self-reported: Average daily time spent on electronic games and TV separately.	Playing electronic games was inversely associated with psychological well-being for male and female adolescents ($p<.001$), with medium and large effects size. Watching TV was inversely associated with psychological well-being for female adolescents ($p<.001$), with large effect size.
Nigg et al. [35] Germany Longitudinal	N: 686 M Age: wave 1 (T2) 11.85 years wave 2 (T3) 16.86 years 55.2% girls To investigate the relationships between PA, ST and MH.	MH status: Strengths and Difficulties Questionnaire (SDQ), subscales: emotional symptoms; conduct problems; hyperactivity/inattention; relationship problems; pro-social behavior	Self-reported: daily time spent on TV/video, PC/internet and PC games	In girls, TV time at T1 and T2 predicted emotional symptoms at T2 and T3, overall SDQ score and conduct problems, hyperactivity and inattention at T3; PC time at T1 predicted hyperactivity/inattention at T2 and conducted problems at T3; For boys, PC time at T1 predicts emotional symptoms at T2. Conduct problems, hyperactivity/inattention, peer relationship problems, and SDQ score at T2 predicted TV time and PC time at T3.

Twenge & Farley [36] UK Cross-sectional	N: 11,427 M Age: 13.77 50% girls To examine associations between different types of screen activities and MH indicators. And whether there are differences in these associations between genders.	Self-harm behaviors: "In the past year have you purposely hurt yourself in any way?" with response options of "yes" or "no"; Depression: Short form mood and feelings questionnaire; Self-Esteem: 5 questions based on Rosenberg's Self-Esteem Scale; Life Satisfaction: 6 questions based on scales that measure life satisfaction.	Self-reported: How much daily time, outside of school, is spent with all types of screen devices (smartphone, tablet, TV, internet, Digital Versatile Disk (DVD), video games, social media)	Among girls, the association of MH problems with social media and Internet use was more evident than for gaming and TV ($p<.001$). Boys: social media and Internet use are associated with self-harm behavior. Girls: MH impairment when ST ≥ 2h; for boys, only with > 5h of ST. In individuals who used social media for more than 5h, MH problems were more relevant for girls than for boys ($p<.05$). Small effect size.
Xiao et al. [37] China Cross-sectional	N: 1,680 M Age: 7th to 12th grade 48.7% girls To evaluate PA and ST during the COVID-19 pandemic, and also their associations with mood disorders and conflict with parents.	Mood State: Shortened Chinese version of the Mood States Profile (POMS). Conflict with parents: "Approximately how many times have you had a conflict with your parents in the last 7 days?"	Self-reported: Students reported the number of hours per day they spend studying online and other uses of ST.	More time studying online ($p<.05$) and other ST ($p<.001$) verified more conflict with parents. Girls had significantly higher mood disorder scores ($p<.01$). Other ST use was associated with mood disorders ($p<.01$). A 1h addition of ST was associated with a 1.6-to-1.8-point increase in mood.
Bang, et al. [38] Canada Cross-sectional	N: 1,477 M Age: 12 to 17 50.9% girls Correlations to adherence to the 24-Hour Movement and MH Guidelines.	Social difficulties: Strengths and Difficulties Questionnaire (SDQ); Stress: self-reported; MH: self-report	Self-reported: how much time on screen devices.	Adolescents who adhered to ST recommendations were more likely to have good psychosocial health (OR=2.64; 95% CI: 1.21-5.73) when compared to those who did not ($p<.05$). Mean effect size.
Barthorpe et al. [39] UK Cross-sectional	N: 4,032 M Age: 13 to 15 55.2% girls To investigate associations between time spent on social media and self-harm, depressive symptoms and self-esteem.	Self-mutilation: yes/no response to the question "In the past year, have you hurt yourself on purpose?" Depressive symptoms: Short Mood and Feelings Questionnaire. Self-esteem: short Rosenberg scale	ST on social media was recorded in time use diaries (TUD). Social media use was assessed through the activity 'browsing and updating on social networking sites, e.g., Twitter, Facebook, BBM, Snapchat'.	Significant associations in girls only. Increased time on social media increased the risk of: Automutilation on weekdays (OR=1.13, 95%CI 1.06 to 1.21). Depression on weekdays (OR=1.13, 95%CI 1.06 to 1.21). weekend use = 0.19, 95%CI 0.06 to 0.32). Lower levels of self-esteem on weekdays (adjusted OR by 30-min increase in social media use = 1.13, 95%CI 1.06 to 1.21). (adjusted β by 30-min increase in: weekday use = -0.12, 95%CI -0.20 to -0.04; weekend use = -0.12, 95%CI -0.18 to -0.07). Medium effect sizes.
Cao et al. [40] China Cross-sectional	N: 4,178 53.4% girls M Age: 14.2 To identify clustering patterns of health-related behavior and their association with depressive symptoms.	Depressive symptoms: Depression Scale of the Center for Epidemiologic Studies.	Self-reported: daily time spent using all kinds of screen devices.	ST >2 h/d higher risk of developing depressive symptoms 1,24 (1,06-1,45) ($p<.01$). Cluster of high ST pattern 4.83 ± 1.66 h/d, adolescents were 1.37 times (AOR=1.37, 95% CI: 1.08-1.73) more likely to develop depressive symptoms compared to Cluster <2h/d of ST ($p<.01$). Small effect size.
Coyne et al. [41] USA Longitudinal	N: 487 M Age: 13 to 20 51.6% girls To assess the correlation between time spent on social media, depression, and anxiety.	Depression: 20-item Depression Scale, Center for Epidemiological Studies (CES-DC). Anxiety: 6-item Spence Child Anxiety Inventory.	Self-reported: Time spent on social networking sites on a typical day.	Girls spend more time on social networking sites. Increased time spent on social networking sites was not associated with increased MH problems when examined for both genders.

Faria et al. [42] Brazil Cross-sectional	N: 217 M Age: 16.08 49.3% girls To identify PA-related lifestyles and sedentary behavior (SB) and their association with health outcomes.	Common Mental Disorders (CMD): General Health Questionnaire, 12-item version, validated in Brazil. Tobacco and alcohol use: short version of the Global School-Based Student Health Survey, validated for Brazilian adolescents.	Self-reported: daily time spent in front of any screen device.	Adolescents included in the "Inactive and Sedentary" class had higher CMD scores than those assigned to the "Active and Non-Sedentary" class ($p<.05$). Girls with signs of CMD were 9.20 (95% CI 1.17-71.52) more likely to be in the "Inactive and Sedentary" class than in the "Active and Non-Sedentary" class. Medium effect size.
Faulkner et al. [43] Canada Longitudinal	N: 2,292 M Age: 16.3 54% girls To examine whether changes in adherence to the Canadian 24h Movement Guidelines (PA, ST, and sleep) are associated with changes in flowering.	Flourishing: Diener Flourishing Scale. Depression: Center for Epidemiological Studies Depression Scale-(revised)-10 (CESD-R-10)	Self-reported: Daily time spent watching TV/movies, playing video/PC games, talking on the phone, surfing the Internet, and texting, messaging, or e-mailing.	The majority did not meet the guidelines for total recreation ST (90.5% of the girls and 94.3% of the boys). Meeting the ST guideline was not associated with flowering in both sexes. For girls and boys, meeting more guidelines was not associated with higher flourishing scores when controlling for depressive symptoms and other covariates ($p>.05$).
Kim et al. [44] Canada Cross-sectional	N: 2,320 M Age: 14.58 50.3% girls Quantify the strength of the association between passive and active forms of ST and adolescent major depressive episodes and anxiety disorders.	Major depressive episode, social phobia, generalized anxiety disorder and specific phobia: Mini International Neuropsychiatric Interview for Children and Adolescents, according to DSM-IV criteria.	Passive ST: Hours /day watch TV, movies, or videos, including YouTube?" Active screen: hours /day outside of school on average on a PC, laptop, tablet, or smartphone?"	Adolescents with 4h or more of passive ST p/day, compared to < 2h, were 3 times more likely to meet DSM-IV-TR criteria for major depressive episode [OR=3.28 (95% CI = 1.71) -6.28)], social phobia [OR=3.15 (95% CI = 1.57-6.30)], and generalized anxiety disorder [OR=2.92 (95% CI = 1.64-5.20)]. Passive ST use was associated with mood and anxiety disorders. Medium effect size.
Weatherson et al. [45] Canada Cross-sectional	N: 29,133 50.26 % girls M Age: 15.3 To examine whether complete MH status (CMHS) is associated with adherence to the guidelines for moderate to vigorous PA and recreational ST from the Canadian 24h Movement Guidelines.	Flourishing: Diener's Flourishing Scale Depression: Center for Epidemiologic Studies Revised 10-item Depression Scale (CESD-R-10). L: wasting F: flourishing -DS: low depressive symptoms +DS: high depressive symptomatology	Self-reported: daily time watching TV or movies, playing video/PC games, talking on the phone, surfing internet and text messaging, email messaging). To meet the guidelines the sum must be < 2h p/day of recreational ST.	Presence of DS in 53.85% and F in 50.46%. L/-DS individuals were 50% more likely to meet ST guidelines compared to L/+DS. F/+DS individuals were 87% more likely, and F/-DS were 112% more likely to meet ST guidelines ($p<.0001$). Lower SD scores and higher F scores were associated with meeting ST guidelines ($p<.0001$).
Zhang, et al. [46] China Cross-sectional	N: 7,200 M Age: 15.50 50% girls Estimate the combination of exercise time and ST to promote MH. Formulate a benchmark for these variables to prevent the development of psychological problems.	Psychological symptoms: Multidimensional Sub-health Questionnaire of Adolescents (MSQA)	Self-reported: daily time playing video games and watching TV/video programs?" Every type of ST was counted, from leisure to educational purposes. There were 4 options for teens to choose from: "less than 1h," "1-2h," "2-3h," and "more than 3h."	Detection rates for emotional and behavioral symptoms and social adjustment difficulties were higher among boys than among girls. ST > 2h/d is a risk factor for emotional, behavioral, psychological symptoms, and social adjustment difficulties, with medium effect size.

Orben & Przybylski [47] UK Cross-sectional	N: 355,358 M Age: 16 ± 1.24 50.5% girls Show that specification curve analysis (SCA) can be a more reliable way to show the relationship between well-being and ST.	Revaluation of data obtained from 3 samples of previous studies: Monitoring the Future (MTF); Youth Risk and Behavior Survey (YRBS); Millennium Cohort Study (MCS). Psychological Well-being: Strengths and Difficulties Questionnaire (SDQ); Rosenberg Self-Esteem; Moods and Feelings Scale; 4 items from the Center for Epidemiological Studies Depression Scale	Self-reported: Own computer; Weekday electronic games; Hours of social media use; Weekday TV; Mean technology; Use internet at home	Association between digital technology use and well-being is negative, with a 0.4% of variation in well-being. YRBS: When employing the electronic device, the effects were more negative; when including TV use, however, they were less negative. MTF: Watching TV only on the weekend, median positive association with well-being (β=.008); Using social media, median negative association with well-being (β= .031).
Khouja et al. [48] UK Longitudinal	N: 14,665 M Age: 16 to 18 51% girls Evaluate the association between ST for device types (watching TV, PC use, and texting), time (weekday or weekend), and anxiety and depression.	Anxiety and depression: computerized version of the Clinical Interview Schedule (CIS-R); Childhood covariates for further adjustment: IQ: Wechsler Intelligence Scale for Children (WISC-III UK); Parental conflict; Father's presence in the home; Number of people living in the home; Bullying; Early use of family TV.	Self-reported ST: watching TV, PC use and texting. Use during the week and at weekends.	More time spent using PC during the week was associated with a small increase in the risk of anxiety (p=.003). More time spent using the PC only on weekends was associated with a small increase in risk of anxiety and depression (p=.003). There was a small positive association between computer use at age 16 and anxiety and depression two years later.
Liu et al. [49] China Cross-sectional	N: 11,831 M Age: 15,0 50.9% girls To examine the association between the time of cell phone use and depressive symptoms.	Depression: The Center for Epidemiological Studies Depression Scale (CES-D) and the Chinese Youth Self-Report (YSR) of the Achenbach Child Behavior Checklist.	Self-reported: "On an average school day, how many hours have you used a smartphone in the past month?", "On an average weekend day, how many hours have you used a smartphone in the past month?"	Weekdays: depressive symptoms increased with ST ≥ 2h/day compared with ST < 1h/day (19.1% and 10.0% respectively). This association was small. Weekends: depressive symptoms increased with ST ≥ 5h/day compared with ST < 2h/day (18.3% and 8.6%, respectively). This association was medium.
Liu et al. [50] China Cross-sectional	N: 13,119 M Age: 15.18 49,5% girls Analyze moderate to vigorous PA (MVPA) and screen-based sedentary behavior (SSB) and their correlations with depression, anxiety, and self-injurious behavior.	Depression: Centers for Epidemiological Studies 20-item Depression Scale Anxiety: 39-item Multidimensional Anxiety Scale Self-injurious behavior: 5-item subscale, Health-Risk Behavior Inventory.	Self-reported. Average daily hours spent watching TV, playing video games, or using the PC on a typical school day. Clusters: 1 (high MVPA/low SSB), 2 (low MVPA/low SSB), 3 (low MVPA/high SSB), 4 (low MVPA/low SSB).	Boys: Depressive symptoms in class 3 > classes 1 and 2 (p<.001). Total anxiety in class 3 > classes 1 (p<.014) and > class 2 (P<.009). Self-injurious behaviors in class 4 > class 2 and class 3 > than classes 1 and 2 (p<.001). Girls: depressive symptoms in class 3 > than classes 1 (p<.001) and 2 (p<.005). Anxiety class 2 > class 1 (p<.042). Both sexes: self-injurious behavior is more severe in class 3.
Paulus et al. [51] USA Cross-sectional	N: 4,257 M Age: 120 months 47.5% girls To investigate associations between Screen Media Activity (SMA) and the psychopathology of internalizing and externalizing symptoms.	Psychological symptoms: Child Behavior Checklist CBCL. Usable structural neuroimaging and SMA data from the Adolescent Brain and Cognitive Development Study (ABCD).	Self-reported: frequency of screen use.	Youth with higher GFA 1 and 4 scores, i.e., had more significant levels of externalizing problems. Also, they had a thinner occipital cortex and a lower volume in the orbitofrontal areas, such as a thinner hippocampus and a lower inferior temporal cortical volume.

				Individuals with higher SMA-related GFA 1 (β=.059) and GFA 4 (β=.095) scores had significantly higher externalizing scores, with small effect sizes.
Perrino et al. [52] USA Longitudinal	N: 370 M Age: 14.65 47.6% girls To understand SB based on screen activity and examine the relationship with internalizing psychological symptoms.	Internalizing symptoms: internalizing subscale of the Youth Self-Report. The variable internalizing problems were created by summing three subscales: (a) anxious-depressed b) withdrawn c) somatic complaints	Physical Activity Questionnaire for Adolescents (PAQ-A) SB subscale. Self-report the amount of time spent in the previous week on TV; video games/PC games; texting; email; surfing the Internet and using the telephone.	Girls had more internalizing symptoms and used more internet, email, messaging and cell phones (p<.001). Boys spent more time with video games (p<.001). Positive association between internalizing symptoms and SB in the early phase (p=.01) and their trajectories (p<.001), in both genders (p=.50).
Hrafnkelsdo-ttir et al. [53] Iceland Cross-sectional	N: 244 M Age: 15.8 59% girls To examine separate and interactive associations of ST and physical activity level with MH.	MH problems (depression, anxiety and somatic symptoms): "22-item version of the Subscales of the Symptom Checklist 90". Self-esteem: Rosenberg Self-Esteem Scale. Life satisfaction: "Diener's Satisfaction with Life Scale".	Self-reported: how many h/d on average played PC games, watched TV/DVD/Internet material, used the Internet for web browsing/Facebook/email, and participated in "other" PC use. Participants were classified into high and low ST groups.	Less ST was associated with lower odds of reporting: Symptoms of depression (RR=0.33, 95% CI = 0.14-0.76) - p<0.001. Anxiety (RR=0.44, 95% CI = 0.23-0.84) - p<0.01. Low self-esteem (RR = 0.31, 95% CI = 0.15-0.66) - p<.005. Dissatisfaction with life (RR=0.38, 95% CI = 0.20-0.72) - p<.005. Associations with small effect size.
Gireesh et al. [54] UK Cross-sectional	N: 120,115 M Age: 15,0 52.42% girls To identify modifiable behavioral factors for mental well-being taking into account deprivation, ethnicity, and grouping.	MH: Warwick-Edinburgh Mental Well-Being Scale (WEMWBS).	Self-reported on weekdays, and weekends, time spent on TV, internet, smartphone and PC games. Categorized into '≥7 hours/day', 'about 5-6 hours/day', 'about 3-4 hours/day', 'about 2 hours/day', and '≤1h/day'.	Being physically inactive, having higher ST, and bullying were associated with decreased well-being in both genders, with the association being more significant in girls (p<.005) than in boys (p<.05). Well-being in both sexes decreased with higher ST in both sexes, starting at about 3h/d of exposure (p<.001). Associations with small to moderate effect sizes.
Khan et al. [55] Bangladesh Cross-sectional	N: 671 M Age: 14.3 49% girls To explore interactive associations of PA and ST with psychosocial difficulties.	Psychosocial difficulties: Parent-reported Strengths and Difficulties Questionnaire (SDQ)	Self-reported: Adolescent Sedentary Activity Questionnaire (ASAQ) for a typical school day and weekend. Total recreation ST was dichotomized as ≤ 2h/d ('low') or > 2h/d ('high').	Insufficient physical activity + high ST resulted in an 18% increase in total psychosocial difficulties scores, with small effect size. ST was not significantly associated with SDQ difficulties scores (model 2: p=.44).
Twenge et al. [56] USA Longitudinal	N: 506,820 M Age: 13 to 18 50.76% girls To examine cultural changes in 3 generations (GenX, Millennials, and iGen). Determine trends in depressive symptoms, suicide-related outcomes, and suicide rates and examine associations between MH, ST of new and older media, and non-screen activities.	Studies included: Monitoring the Future (MtF) and the Youth Risk Behavior Surveillance System (YRBSS) from 1991 and the Centers for Disease Control data from 1999. Depressive symptoms: MtF: 6 items from the Bentler Inventory of Medical and Psychological Functioning depression scale YRBSS: 4 items related to suicide.	Self-reported. Non-school activities only. 2009: TV, video games, PC games, and internet; 2011: Facebook; 2013 and 2015: smartphone and other social media. Homework. MtF asked, "About how many hours spend on average in a week on all their homework, including both in school and out of school..."	Since 2010, iGen teens have spent more time in new screen media activities and less time in non-screen activities. Teens who spent more time on screen activities were more likely to have high depressive symptoms. Social media use was correlated significantly with depressive symptoms among girls (p<.001). All suicide-related outcomes were significantly with electronic device use (p<.001). Associations with a small effect size.

Yan et al. [57] China Cross-sectional	N: 2,625 M Age: 13 to 18 46.9 % girls To determine time spent on screen activities, associations with adiposity, unhealthy eating behaviors, sleep, PA, academic performance, anxiety, self-esteem, and life satisfaction.	Anxiety: High School Student Mental Health Scale. Satisfaction with life: Satisfaction With Life Scale. Self-esteem: Rosenberg Self-esteem Scale.	Self-reported: Time spent watching TV, playing e-games, receiving news or study materials from electronic devices, using social media sites or apps, and watching videos on school and non-school days.	Watching TV during school days for 2 to 4 h was negatively associated with anxiety (p=.047) and self-esteem (p=.032). Receiving news via digital media or studying for 2 to 4h (p=.036) or > 4h (p=.002) on school days was positively associated with anxiety. Positive association of social media use with anxiety (p=.009). On school days, watching TV > 04h is negatively associated with life satisfaction (p=.012), with large to medium effect size.
Khan & Burton [58] Bangladesh Cross-sectional	N: 505 M Age: 14.3 53% girls Assess the association of moderate to vigorous PA (MVPA) with depressive symptoms in adolescents with recreational high ST.	Depression: Center for Epidemiological Studies Depression Scale (CESD 10)	Self-reported: recreational ST (watching TV, DVDs/videos, PC use for entertainment; use of social media - Facebook, Twitter), Adolescent Sedentary Activity Questionnaire (ASAQ).	Adolescents with high recreational ST: a quarter (24.6%) reported depression. A significant amount more girls with high ST than boys reported depression (29% vs 20%). There were no significant associations between meeting MVPA recommendations and depression for those with low recreational ST (<2h/d). Medium effect size.
Przybylski & Weinstein [59] UK Cross-sectional	N: 120,115 M Age: 15,0 Assess how ST is linked to mental well-being and empirically quantify a moderate activity level in digital activities.	Mental well-being: Warwick-Edinburgh Mental Well-Being Scale.	Self-reported: throughout the week, how much of your free time is spent on TV, console, and computer games, internet, email, smartphones, online chats and social networks.	Relationship to impaired mental well-being and watching movies/TV, playing games, and using the PC during the week. Small effect size. For smartphone use, this relationship was observed only on weekdays. Girls spent more time using smartphones, PC and watching videos, and boys spent more time on the PC and console games (p<.001).
Babic et al. [60] Australia Longitudinal	N: 322 M Age: 14.4 66% girls To examine associations between changes in ST (total and device-specific) and MH indicators (well-being and malaise).	Physical self-concept: Physical self-concept subscale from Marsh's Physical Self-Description Questionnaire. Psychological well-being: Diener and colleagues' Flourishing Scale. Psychological distress: Strength and Difficulties Questionnaire.	Self-reported: Adolescent Sedentary Activity Questionnaire ASAQ: Recreational time spent using screen devices (TV, PC, tablet/cellphone) each weekday and weekend. Non-recreational ST when a PC was used for homework.	Total recreational ST (p=.048) and tablet/cellphone use (p<.001) were negatively associated with physical self-concept. Total recreational ST (p=.001) and PC use (p=.003) were negatively associated with psychological well-being. There was a positive association between TV/DVD use and psychological difficulties (p=.015). Large effect size.
Goldfield et al. [61] Canada Cross-sectional	N: 358 M Age: 15.6 72.9% girls To examine the association between duration and types of ST and depressive symptomatology in overweight and obese adolescents.	Depressive symptoms: Childhood Depression Inventory (CDI)	Self-reported: How many hours a day spent watching TV, playing video games, and using the computer for recreational purposes. Computer games excluded.	ST is associated with more severe depressive symptomatology (p=.001). Playing video games and recreational PC use was associated with depression (p=.05 and p=.006) respectively, but watching TV showed no significant relationship (p=.09). ST may represent a risk factor for depressive symptomatology. Small effect size.

Gunnell et al. [62] Canada Longitudinal	N: 1,160 M Age: 13.54 60.5% girls To examine changes in PA and ST, depression, and anxiety. Bidirectional relationships between PA, ST, and depression and anxiety.	ST: Self-report questionnaire Depression: Children's Depression Inventory (CDI). Anxiety: Multidimensional Anxiety Scale for Children-10 (MASC-10).	Self-reported Questions: How many hours per day did the adolescents spend watching TV, playing video games, and using the computer on weekdays and weekends?	Symptoms of depression, anxiety, and ST increased significantly ($p<.05$) over time. Higher initial symptoms of anxiety are associated with initial symptoms of depression ($p<.05$) and higher ST ($p<.05$).
Hayward et al. [63] Australia Cross-sectional	N: 3,295 45.7% girls M Age: 15.14 To establish associations and relative contributions between diet, PA, ST behaviors, and depressive symptomatology.	Depressive symptomatology: Moods and Feelings Questionnaire - Short Form (SMFQ).	ST: Key Indicators and Measures from the Youth Health Survey. Questions: How many hours during the 07 days before the survey did adolescents have ST (less than 01h, 1-2h, 2-5h, and 5+h).	Achieving the recommended ST guidelines was associated with reduction in the likelihood of depressive symptoms (OR=0.90 and 95% CI= [0.87, 0.93] in girls. Small effect size.
Trinh et al. [64] Canada Cross-sectional	N: 2,660 52.5% girls M Age: 15.8 To examine the independent effects of PA and ST on MH, school connectedness, and academic performance, and to identify possible interactions between PA and ST in such associations.	Psychological stress: General Health Questionnaire (GHQ) Depressive symptoms: four items adapted from the Center for Epidemiologic Studies Depression (CES-D) Self-esteem: 6 items adapted from the Rosenberg Self-esteem Scale	Self-reported Question: "In the past seven days, how many hours per day did you spend watching TV, playing games, chatting on the computer, or surfing the Internet?"	ST was significantly associated with poor MH outcomes, including psychological distress ($p<.05$), low self-esteem ($p<.05$), and depressive symptoms ($p<.05$). Boys: greater screen time was associated with psychological distress ($p<.05$), low self-esteem ($p<.05$), and depressive symptoms ($p<.05$). Girls: greater ST was associated with low self-esteem ($p<.05$). Small effect size.
Maras et al. [65] Canada Cross-sectional	N: 2,482 M Age: 14.1 57.8% girls To examine the relationships between sedentary ST and symptoms of depression and anxiety.	Depression: The Children's Depression Inventory (CDI) (Self-related). Anxiety: Multidimensional Anxiety Scale for Children - 10 (MASC-10)	Leisure-Time Sedentary Activities 6-item questionnaire - measuring how many hours per day students spend on activities such as watching TV, playing video games, and using the PC.	Total ST is associated with depression ($p<.001$) and severity of anxiety ($p<.001$). ST related to video games and PC use was associated with more severe depression ($p<.001$). ST related to video games alone was associated with more severe anxiety ($p<.001$), with medium effect size.
Suchert et al. [66] Germany Cross-sectional	N: 1,296 M Age: 13.7 47% girls Examine the effects of sedentary behavior (SB) on mental well-being and the differences between screen-based SB (sSB) and non-screen-based SB (nSB).	Depression: German version of the Center for Epidemiological Studies Depression Scale for Children (CES-DC); General self-efficacy: 5 items from Schwarzer and Jerusalem's general self-efficacy scale; Self-esteem: KINDL-R. Physical attractiveness self-image: physical self-concept scales by Stiller, Würth, and Alfermann.	Self-reported: Time spent on activities involving screens during the last school day and on the last Sunday: watching TV/DVDs, playing video/PC games, and other leisure activities on PC/mobile phone, except active electronic games.	Girls: screen-based sedentary behavior (sSB) is associated with higher depression ($p=.032$), lower self-esteem ($p=.039$), lower self-concept for physical attractiveness ($p=.003$) and lower overall self-efficacy ($p=.002$). Boys: significant positive association between sSB and self-esteem ($p=.014$). Small effect sizes.
Nihill et al. [67] Australia Cross-sectional	N: 357 100% girls M Age: 13.2 To examine the association between SB and self-esteem among adolescent girls.	SB: Adolescent Sedentary Activity Questionnaire (ASAQ); Physical self-concept and self-esteem: Marsh's Physical Self-Description Questionnaire (PSDQ).	ST was created by adding time spent watching TV, videos, DVDs and using the PC for non-school purposes.	Multilevel models did not reveal any association. After corrections, there were inverse associations between time spent watching DVDs ($p<.05$), playing PC games ($p<.05$), and total ST ($p<.05$) and self-esteem. Small effect size.

Straker et al. [68] Australia Longitudinal	N: 643 M Age: 14,0 To examine the relationships between sedentary behavior (including ST) and self-esteem.	MH: Cowen's Perceived Self-Efficacy Scale. BDI for Youth CBCL - Youth Self-Report version of the Child Behavior Checklist.	Time spent watching TV, playing electronic games, video games and other different PC usages for graphics, text, email, internet and general gaming. Categories: C1 instrumental PC users; C2 multimodal electronic gamers; C3 PC e-gamers.	Instrumental PC users girls had higher self-efficacy than e-gamers girls (p = 0.028). Instrumental PC boys had lower depression scores than multimodal and e-gamers boys (p = 0.046), having also less symptoms. Small effect sizes.
Arbour-Nicitopoulos et al. [69] Canada Cross-sectional	N: 2,935 M Age: 15.9 49% girls Investigate the prevalence of psychological distress and its associations with health risk behaviors.	Stress: General Health Questionnaire (GHQ); Substance Use (alcohol, tobacco, and cannabis): Self-report	Self-reported: In the last 7 days, how many hours per day you spend in front of screens.	Students who did not comply with ST recommendations were at higher risk for psychological distress (p<.001). Girls are approximately 2 times more likely than boys to experience psychological distress (p<.001). Tobacco use was significantly associated with the risk of psychological distress (p<.001). Small effect sizes.
Cao et al. [70] China Cross-sectional	N: 5,003 47.9% girls M Age: 13.13 To test the association between ST, PA and psychological problems in adolescents.	Depression: 18-item version of the Self-Regulatory Depression Scale for Children (DSRSC); Anxiety: 41-item Screen for Child Anxiety Related Emotional Disturbances (SCARED); Satisfaction with school life: 12-item School Life Satisfaction Assessment Questionnaire for Adolescents.	Self-reported: How much time, on average, I spend on weekdays and weekends on sedentary activities, such as watching TV and using a PC.	Positive associations of ST with depression, anxiety, and dissatisfaction with school life (p<.001). High ST was a risk factor for: Depression (OR = 1.52 - 95%CI: 1.31-1.76); Anxiety (OR = 1.36, 95%CI : 1.18-1.57); Dissatisfaction with school life (OR = 2.07, 95% CI : 1.79-2.38). Small effect sizes.

Participants characteristics

Participants' ages ranged from 10 to 21 years, mean 14,85 standard deviation 1,14. Some studies presented data on the age of participants based on school grade [21,33,37]. In the pooled sample, there was a greater participation of girls, however, one study did not provide this data [59], and there was a study that evaluated only girls [67]. Of the studies that reported sample demographic data, the socioeconomic status was mostly medium and predominantly white ethnicity.

Screen time and mental health assessments

The measurements taken for both screen time and mental health were very heterogeneous. Most of the time, screen time was self-reported and aspects such as flourishing and resilience were considered in the mental health assessment. The data are described in detail in (Additional file 3) (APÊNDICE I).

Associations between screen time and mental health

Most studies have observed associations between screen time and adolescent mental health. Only a few studies found no unfavorable associations between screen time and overall mental health, or any of its aspects [21,25,26,28,37,41,47,56,57,60,66,67]. For the studies that found significant associations, most of the time, the findings were from just one survey, or congruent among a few studies, which did not allow performing a statistical analysis of the associations. A small number of studies showed an effect size from medium to large [34,57,65] or large [21,24,34,60]. Most made sizes were small [22,25,28,29,32,33,36,40,48,51,53,55,56,59,61,63,64, 66,68,69,70], or medium [26,27,38,39,42,44,46,47,49,57,58].

Cross-sectional associations

Types, contents, and usage habits of screens

According to a study, with a robust sample of adolescents in the United Kingdom, the screen activities with the highest levels of engagement were social media, games and TV/video [28]. Watching TV was positively associated with mood and anxiety disorders [44], impaired mental well-being [59], i.e., the more TV time, the higher scores for mood and anxiety disorders and greater impairment in mental well-being, and inversely associated with self-esteem and life satisfaction [57] and psychological well-being for girls [34]. Whereas in other studies, TV was negatively associated with anxiety [57], positively with mental well-being [47] and lower prevalence of depression [25]. Furthermore, one study [61] did not find associations between watching TV and depressive symptoms, and another [28] also found no associations with mental health.

While Kim et al. (2020) [44] did not find associations of active screen use with mood and anxiety disorders, and McAllister et al. (2021) [28] between mental health and gaming, other studies did. A relationship was observed between computer use (such as for internet, email, and games) with impairment of mental well-being [59], psychological well-being [34] and an increase in depressive symptoms [65,61]. Video games alone were associated with more severe anxiety symptoms [65]. And 6 hours or more of video gaming was positively associated with anxiety symptoms in boys [21]. Higher levels of computer use showed stronger association with depressive symptoms [22]. And online gaming (among high school girls) was associated with a higher prevalence of depression [25]. The studies do not specify the modality online or not of video gaming.

The smartphone was the device that adolescents report more time using, according to Przybylski & Weinstein (2017) [59]. A recent study observed that telephone use showed a stronger association with depressive symptoms among the girls [22], while in another study it represented impairment of mental well-being only on weekdays [59]. More time spent on new types of screen behavior, including social media, was associated with a higher prevalence of depression in one study [25]. Social media use also had a median negative association with well-being in another study [47]. Among girls, the positive association of mental health problems with social media and internet use was greater than for games and TV in the study by Twenge et al. (2021) [36]. In McAllister et al. (2021) [28], media use negatively impacted mental health, but was not significantly associated with self-harm or depression among boys.

Among adolescents with high recreational ST, about a quarter reported depressive symptoms in one study [58]. Girls who reported ≥5 hours of ST on weekdays or weekends had higher anxiety scores compared to those who reported up to 2 hours, even controlling for moderate to vigorous physical activity (MVPA), in a recent survey [24]. Time studying online was positively associated with anxiety in one study [57], but was not associated with mood disturbances in another [37], and in the latter, other ST uses were associated with mood disturbance [37].

Different mental health outcomes including well-being

Young people who met screen time recommendations were about 2.6 times more likely to have good psychosocial health outcomes compared to those who did not in one study [38]. Higher flourishing scores were associated with meeting ST guidelines of less than 2 hours daily in one study [45]. One study found that high ST (with < 8 hours of sleep) was negatively associated with self-esteem, resilience, and flourishing [32].

The study by Gireesh et al. (2018) [33] also addressed well-being, finding greater screen time, and suffering from bullying associated with decreased well-being in both sexes, with the strongest association in girls. Playing electronic games was inversely associated with psychological well-being for adolescents of both sexes. Watching television was also inversely associated with psychological well-being in girls in one study [34].

The association between the use of digital technology and adolescent well-being is negative, but small, representing less than 0.1% of the observed variability in well-being, according to the study by Orben and Przybylski (2019) [47]. Watching TV only on the weekend showed a median positive association with well-being. Social media use had a median negative association with well-being [47]. In a previous study, Przybylski et al. (2017) [59], observed a relationship with impaired mental well-being and watching movies/TV, playing games and using the computer throughout the week. As for smartphone use, this relationship was observed only on weekdays.

Longitudinal associations

Types, contents, and usage habits of screens

Social media use was significantly correlated with depressive symptoms among girls but not among boys, moreover, all suicide-related outcomes were correlated with electronic device use in Twenge et al. (2018) [56]. In the study by Coyne et al. (2020) [41], the increase in time spent on social media was not associated with an increase in mental health problems, when adolescents were examined at the individual level. In a recent study, more time spent in structured media activities, such as watching television, decreased levels of inattention and anxiety [26].

An 11-year study found that increased TV viewing and Personal Computer (PC) use was predictive of conduct problems, hyperactivity, and inattention in girls [35]. There was a small positive association between computer use at age 16 and anxiety and depression two years later in one study [48]. Boy computer instrumental users had lower depression scores and fewer internalizing behavior problems than "e-gamers" in one study [68].

Different mental health outcomes including well-being

In the study by Babic et al. (2017) [60], decrease in total recreational screen ST was negatively associated with physical self-concept and psychological well-being, and there was a positive association between television/DVD use and psychological difficulties. CP time positively predicted emotional symptoms in one study [35]. Girl instrumental computer users had higher self-efficacy compared to female computer e-gamers in one study [68].

In a recent study, increased time spent on social media was the only screen media activity significantly associated with worse mental health [26]. In another more recent study, the theoretical replacement of 60 minutes of television or social media use by team sports at age 14 years was associated with a reduction in emotional symptom scores at age 17 years, respectively [23].

Quality assessment of studies

The summary of the methodological evaluation of the articles included in this review are presented in Table 4, according to the items of the Newcastle-Ottawa scale for observational studies, (Additional file 4: Table 4) (APÊNDICE J). The quality assessment of the cross-sectional studies was carried out by adapting the Newcastle Ottawa for cross-sectional studies. Most studies had high methodological quality, with a total score above 6. Recurrent problems among studies were the lack of a group not exposed to screens, generating comparability only between factors such as gender, in addition to the lack of objective measurement of screen time.

Discussion

Although screen-based activities bring many benefits, such as communication and entertainment, most of the results of this study indicate that excessive exposure to screens is associated with effects on the mental condition of adolescents. Of the 50 studies reviewed, only 12 found no unfavorable associations between screen time and overall mental health, or any of its aspects [21,25,26,28,37,41,47,56,57,60,66,67]. It is also important to consider that some studies in this review were carried out during the COVID-19 pandemic and with social distancing, screen time may not significantly negatively interfere with well-being, since it is the only way to if you remain socially connected [10].

Screens and mental health: do device and content matter?

The current review is consistent with other reviews that concluded that the type, use and content of the screen influences the relationship between mental health problems and ST [11,13,71]. It seems that the impairment of mental health in adolescents is closely related to the purpose of screen use and not just the exposure time. For example, online study or non-recreational use of screens [37,60] does not seem associated with mental health. Currently, there is a suggestion that the term "screen time" is no longer a useful construct [72], since the devices and the social character of the media must be evaluated

separately, the nature of the content may be more relevant for mental health than the amount of time teenagers are exposed to screens [73,74,75]. In fact, in this review, watching TV did not show a significant relationship with depressive symptoms [25,61], self-esteem [67] or mental health [28], in some cross-sectional studies, it even decreased levels of inattention and anxiety longitudinally [26]. It was also observed in the literature that, over time, the relationship between screen time and depressive symptoms varied between different screen uses, with stronger relationships observed with cell phones and computer/internet, new forms of technology [11].

A very popular activity among teenagers is the use of social media such as Facebook, Instagram, and Twitter [76]. Here, social media use was associated with poor mental health and impaired mental well-being [23,25,26,36,47,59]. Our results involving social media agree with previously published reviews [15,18]. In fact, excessive use of social media can lead to the development of fear of missing out (FoMO). FoMO is defined by the fear that other people will have pleasurable experiences while the individual is away, felt as a need for constant contact with members of the social network [77]. It is true that in adolescence internalizing symptoms happens frequently [78] and here these symptoms were the most common. Thus, the association between social media use and internalizing symptoms may be complex. Social media can worsen depression and anxiety [79], however, adolescents having depression and anxiety symptoms may lean on technology to alleviate those feelings too. In this sense, our results and other revised longitudinal data agreed, that a stronger relationship was observed between greater exposure to screens and a subsequent increase in the depression score [11].

Regarding games, the results were mixed, in McAllister et al. (2021) [28] associations with mental health were not significant for boys and girls. Boers et al. (2019) [75] also did not find a significant association between the time spent playing video games with depression, these authors consider that video game players are not socially isolated, they play with friends, physically or online, which it has social and emotional benefits [80]. However, few studies had already observed a significant association between playing video games and worse mental health in adolescents [81,82].

In this review, non-recreational computer use for girls was associated with greater self-efficacy, while boys had lower depression scores and internalizing behaviors than those who used their computers only as a game console ("e-gamers") [68]. The authors

suggest that adolescents were acquiring more computer skills, which had already been associated with improved mental well-being in a previous study [83]. In this sense, our data are confirmed in studies over time in which depression did not increase at the intrapersonal level [74,75].

Smartphone and social media use has been associated with depression [22,23,25,26] and internalizing symptoms [52]. Twenge in 2017 [84] already raised the concern on whether smartphones were "destroying a generation". Odgers (2018) [85], however, concluded that this would be a misinterpretation of reality, as most adolescents are doing well in the digital age and that US and European numbers show academic improvement, a decrease in violence, abuse of alcohol, smoking, and teenage pregnancy [85,86]. Smartphone studies can have limitations, such as an often underestimate smartphone use, leading to low correlations between self-reported screen time data and data collected through the device app itself [87,88]. Considering screen time simply by counting frequency and duration may limit understanding of an adolescent's relationship with the smartphone and the consequences on mental well-being [89]. It would be important to obtain detailed information about the goals and how the adolescent uses their device [90].

Screens and mental health: mediators and confounding factors

In one study, significant associations between anxiety and depression appeared when screen time was combined with shorter sleep duration [29]. It is not yet established whether the act of looking at the screen interrupts sleep or whether the media content is responsible. Light-emitting diode (LED) screens on computers and phones emit a slow wave, blue light, which can interfere with the circadian rhythms that regulate sleep. Exposure to LED versus non-LED screens produces changes in melatonin levels and sleep quality, and this exposure decreases cognitive performance [91]. Sleep disturbances may also be related to excessive use of technological devices at night [92]. Sleep disorders is an umbrella term, according to the International Classification of Diseases 11th Revision (ICD-11), they belong to an overlapping area between mental health and neurological disorders, and according to WHO they are part of common mental health disorders [96,97,98]. Sleep disorders are often associated with depression and anxiety and often co-occur [95,97,99] or even antecede the disorders diagnosis. Currently, young people interact on social networks, sending messages and selfies, sometimes all night, a characteristic behavior that gave rise to the term "Vamping". This term relates to tech-

addicted teens who already have a disrupted circadian rhythm and who are at greater risk of declining school performance and loss of self-control [93]. In fact, in another study of this review [32], self-esteem, resilience and flourishing were negatively associated with ST in those adolescents who slept less than eight hours a night.

In addition to sleep, physical activity may also protect against the potentially harmful effect of interacting with social media in some adolescents [79]. From the records reviewed, some studies noted that replacing screen time with physical activity showed a positive effect on associations with mental health [23,32,33]. Insufficient physical activity and high ST was associated with increased psychosocial difficulties [55]. In fact, a review that investigated moderating variables of associations between ST and depression in youth found that physical activity can influence the magnitude of these associations [71].

Increased screen time was significantly associated with aspects of mental health. Few studies showed an effect size from medium to large [34,57,65] or large [21,24,34,60]. However, most studies observe small effect sizes [22,25,28,29,32,33,36,40,48,51,53,55,56,59,61,63,64,66,68,69,70], or medium [26,27,38,39,42,44,46,47,49,57,58]. Our findings are agreed with previous literature about the predominant small effect size, in addition to the large heterogeneity of the studies [9,94].

The results of this review suggest that interaction with screen-based devices may underlie the impairment of adolescent mental health over the last decade. However, other studies also agree that establishing causality and directionality can be difficult [17,47,72,90]. While research is still being conducted, care must be taken in interpreting data on the positive and negative effects of adolescents' interaction with digital technologies. However, even with possible benefits, it may not be healthy to suppress the other activities that our nature is qualified for, underutilizing our other senses, and looking at screens for most of the day.

Conclusion

This study contributes with data on the various mental health outcomes of adolescents, including aspects of positive mental health, in addition to considering exposure to all types of screens most used by this population. This review found some

evidence for the current research question, we highlight here that watching TV for 2 to 4 hours on school days was negatively associated with anxiety and self-esteem. The most time spent by adolescents was with the smartphone and use during the week was associated with diminished mental well-being. Screen exposure time was most positively associated with problems in teens' mental well-being. Social media use had a median negative association with mental well-being in adolescents and an increased risk of depression in girls. Furthermore, "screen time" may no longer be appropriate for investigations of the effects of exposure to screen-based devices and related mental health outcomes in adolescents. Most of the reviewed studies provided total measures of time spent in front of screens, however, the nature of the content offered on each device, as well as the interaction of adolescents with this content, is still unclear.

More detailed studies will be needed, seeking to understand the motivations of adolescents to engage with screen devices. Studies that consider issues related to the environment of adolescents may also help to clarify the varied emotional responses to screen stimuli. Longitudinal studies that pay attention to factors such as sleep, physical activity and socioeconomic status will also be important to establish mediators of associations between interaction with screens and mental health in this population.

Limitations

The current review has some limitations, which may impact the generalizability of the results. The first refers to the diversity and fragility of the methods applied in the data collection of the included studies. Self-reported screen time may provide inaccurate data due to adolescents' recall difficulties. Studies focusing on sedentary behavior that included screen time in this category may provide even coarser measures of this variable. The lack of measurement of adolescents' interaction time with each type of device and type of content leads to a superficial assessment of the associations between screen time and adolescents' mental well-being, especially considering the emotional particularities of this phase. The wide variety of instruments to assess mental health outcomes can also be a factor that makes it difficult to standardize results. The second limitation is related to studies that analyzed data from previous research. These studies, in addition to addressing many variables not reviewed in the present study, used old data with a reality different from that observed today. In addition, of the articles reviewed, only one study from Brazil and five from Australia represented the global south, it is necessary to

increase diversity. And finally, as adolescents' interactions with screens and their contents can vary depending on when they occur and for what purpose the screens are being used, the associations between screen time and mental health depend on intensity and context, such as the day of screen use in a week, for the purpose of use and whether the use is recreational or for study.

Abbreviations

AAP: American Academy of Pediatrics
ABCD: Adolescent Brain and Cognitive Development
ADHD: Attention Deficit Hyperactivity Disorder
AOR: Adjusted Odds Ratio
ASAQ: Adolescents' Sedentary Activities Questionnaire
BBM: Blackberry Messenger
CBCL: Child Behavior Checklist
CD-RISC-10: Connor-Davidson Resilience Scale-10
CDI: Childhood Depression Inventory
CES-D: Center for Epidemiological Studies Depression Scale
CESD-R-10: 10-Item Center for Epidemiologic Studies Depression Scale Revised-10
CES-DC: Children of the Center for Epidemiological Studies
CI: confidence interval
CMD: Common Mental Disorders
CP: Conduct Problems
DS: Depressive Symptoms
DSM IV: Diagnostic and Statistical Manual of Mental Disorders - Fourth Edition
DSRSC: Self-Regulatory Depression Scale for Children
DVD: Digital Versatile Disk
FoMO: Fear of Missing Out
GAD-7: General Anxiety Disorder-7
GFA: Group Factor Analysis
GHQ: General Health Questionnaire
IQ: Intelligent Quotient
K6: 6-item Kessler Psychological Distress Scale
LED: Light-Emitting Diode

MARCA: Multimedia Activity Recall for Children and Adolescents

MASC-10: Multidimensional Anxiety Scale for Children

MCS: Millennium Cohort Study

M: Mean

MH: Mental Health

MVPA: Moderate to Vigorous Physical Activity

N: Sample

NSB: Non-Screen-Based

PA: Physical Activity

PAQ-A: Adolescent Physical Activity Questionnaire - Sedentary Behavior Subscale

PC: Personal Computer

PHQ-9: Patient Health Questionnaire-9

PICO: Population, Intervention, Comparation and Outcome

POMS: Mood States Profile

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SAMHSA: Substance Abuse and Mental Health Services Administration

SB: Sedentary Behavior

SCA: Specification Curve Analysis

SCARED: Screen for Child Anxiety Related Emotional Disturbances

SDQ: Strengths and Difficulties Questionnaires

SMA: Screen Media Activity

SMFQ: Short Form of the Mood and Feelings Questionnaire

SSB: Screen-Based Sedentary Behavior

ST: Screen Time

TV: Television

TUD: Time Use Diary

UCLA: (University of California, Los Angeles) Loneliness Scale

UFMG: Universidade Federal de Minas Gerais (Federal University of Minas Gerais)

USA: United States of America

UK: United Kingdom

WEMWBS: Warwick-Edinburgh Mental Well-Being Scale

WHO: World Health Organization

WISC-III UK: Wechsler Intelligence Scale for Children

YRBSS: Youth Risk Behavior Surveillance System

YRSB: Youth Risk and Behavior Survey

YSR: Youth Self-Report

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article

Competing interests

The authors report no conflict of interest.

Funding

Not applicable.

Authors' contributions

RS, CM, and GB were responsible for writing the protocol. All authors were involved in the conceptualization of the systematic search. RS and CM designed the search strategy. RS, and GB were responsible for the literature search. RS, GB, SV, and YN were responsible for study selection, data extraction, and quality assurance. All authors read and approved the final manuscript.

Acknowledgments

Not applicable.

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6.5 Artigo 3

The associations between screen time and mental health in adults: A Systematic Review

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Abstract

This review aimed to understand the association between screen time and mental health in adults. **Method**: The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses - PRISMA and registered in Prospero under number CRD42022335373. Defined according to the PICO strategy, a search was conducted in January 2023 with the following keywords: "screen time", "adults" and "mental health" combined with the AND operator in PubMed, PsycInfo and Scopus databases. **Results:** 1,695 articles were identified, and 90 papers were read in full, of which 32 were included in this review. There were 19 studies conducted before the COVID-19 Pandemic and 13 studies conducted in the context of the COVID-19 pandemic. Most studies found associations between excessive screen exposure and impact on aspects of mental health in adults. Before the pandemic, high screen times were associated with depression, anxiety, stress, burnout, and lower well-being. Watching TV was worse for mental health than computer or mobile device use. Replacing non-work time in a recent retirement with screen time is worse for mental health than replacing it with sleep or physical activity. Recreational screen time was associated with depression and screen time for schoolwork was not. During the pandemic, messaging app usage was associated with decreased feelings of loneliness. Screens and social media were associated risk of depression, anxiety, loneliness and FoMO. For in college adults, before

and during the pandemic, depression and anxiety were associated with screen use, especially for leisure. **Discussion:** Beyond screentime, excessive interaction with screen devices in adults, may be associated with mental health problems. Always-on mobile devices can increase interruptions to activities, weaken time management, and decrease the quality of time spent with children.
Keywords: screen time, mental health, adults, media

1. Introduction

In recent years, there has been growing recognition of the importance of mental health in achieving global development goals. Mental health is a state of well-being that allows the individual to cope with the normal stresses of life and to function productively (World Health Organization - WHO, 2001; Manwell et al., 2015; Fusar-Poli et al., 2020). A mental disorder is characterized by a clinically significant disturbance in cognition, emotion regulation or behavior associated with significant distress, impaired functioning, or risk of self-harm (WHO, 2022a). In 2019, one in eight people worldwide were living with a mental disorder, commonly anxiety and depressive disorders (WHO, 2022a). In 2020, the number of people living with anxiety disorders and depression increased significantly due to the COVID-19 pandemic (WHO, 2022b).

The COVID-19 pandemic, which changed daily routine for more than 3 years, has altered the functioning of countries around the world, increasing internet usage and screen time (Wang, Xu, & Xie, 2022; Wiciak, Shazley, & Santhosh, 2022). Currently, Internet-based media, the use of electronic screen devices, such as computers and smartphones, are part of people's daily lives (Small et al., 2020; Qiu et al., 2021). According to the 2020 Canadian 24 Hour Movement Guidelines, recreational screen time for adults should not exceed 3 hours per day (Ross et al., 2020). However, the average daily screen time of adults is increasing worldwide, in 2019 it averaged 11 h/day and the COVID-19 Pandemic accelerated this increase (Liu, Coulter, Sui, Nuss, & Rhodes, 2023). Although it may have positive aspects in some brain functions, frequent use of digital technology has been associated with unfavorable outcomes, such as increased symptoms of attention deficit hyperactivity disorder (ADHD), interference with emotional and social features, sleep, addictions, social isolation and mental health (Small, et al., 2020; Kjellenberg, Ekblom, Ahlen, Helgadóttir, & Nyberg, 2022; Nakshine, Thute, Khatib, & Sarkar, 2022; Wiciak, Shazley. & Santhosh, 2022).

Studies suggest that electronic media use may be a risk factor for mental health problems, such as anxiety and depression in adulthood (Adamczewska-Chmiel, Dudzic, Chmiela, & Gorzkowska, 2022; Silva et al., 2022). Adulthood is the longest phase of human development and it is when the individual already accumulates skills, abilities and plays family and professional roles, which mark the end of adolescence (Gonçalves, 2016). Parents who have minors living at home are rapidly adopting new technologies (Sanders, Parent, Forehand, Sullivan, & Jones, 2016). With parents immersed in the digital age, it is difficult to provide a technology-free environment for children (Ishtiaq, Ashraf, Iftikhar, & Baig-Ansari, 2021). Furthermore, parents use smartphones a significant proportion of the time in everyday family situations, which affects parent-child interaction (Konrad et al., 2021).

In fact, previous investigations have already warned of the unfavorable effects of screen time on mental health (Yoon, Kleinman, Mertz, & Brannick, 2019). However, available evidence about correlations between screen time and mental health in adults is not specific. They include associations of screen time with physical health aspects (Nakshine, Thute, Khatib, & Sarkar, 2022), other age groups (Runacres et al., 2021; Manwell, Tadros, Ciccarelli, & Eikelboom, 2022), with addiction (Park, King, Wilkinson-Meyers & Rodda, 2022), or specific populations such as students (Kaur, Balakrishnan, Chen, & Periasamy, 2022). Faced with the need to intensify care with mental health, it is important to understand the effects of excessive screen exposure among adults, so this review seeks to inventory and discuss the associations between screen exposure and mental health outcomes in this population.

2. Method

The search strategy for this review was initially developed by a series of discussions among investigators and preliminary searches. This review was performed in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA (Shamseer et al., 2015) and was registered in PROSPERO, under number CRD42022335373. A search was carried out in January 2023 with the guiding question: Is there an association between screen time and mental health in adults? For this, the following keywords were used: “screen time”, “adult” and “mental health”, combined with the AND operator in PubMed, PsycINFO and Scopus databases. The intent of the search was to cover as many studies as possible, using more general search terms, as

adulthood was not being addressed much in the domain of screen time and specific mental health outcomes. Therefore, the group opted to carry out the search with terms that did not just describe one or another symptom or a mental disorder and that covered all screen devices. According to the PICO strategy, the study population will be composed of individuals in adulthood and the intervention will be represented by exposure to screens. All aspects related to mental health will be considered as outcomes if they are properly evaluated. Observational studies may not have a control group.

Inclusion criteria: (1) articles that directly assessed associations between screen time [i.e., the amount of time spent using a device with a screen such as a television (TV), personal computer (PC), a smartphone, or console video game for entertainment or educational use] and mental health (ie, at least one dependent variable assessed); (2) studies that measured mental health outcomes through validated scales/instruments; (3) studies with adults (18 to 65 years); (4) articles in English, published in the last 10 years. Exclusion criteria: (1) studies carried out with adults previously diagnosed with problematic internet use, (2) sample composed of adults already diagnosed with mental health problems or who are being followed up in mental health/psychiatry outpatient clinics (the reasoning was due to the have an understanding related to exposure to screen, the intent of these criterion was to standardize the sample in terms of prior mental condition, to increase the strength of the study with respect to the risks found for general population), (3) research who used screen-based devices to aid functionality and (4) case reports and case series.

The screening procedure was performed in pairs, including an initial independent search. After excluding duplicate records, the studies were selected by title and abstract, according to the previously established inclusion criteria. Articles eligible for full reading were selected and the two authors discussed the results and reached a consensus, after applying the exclusion criteria, on the articles to remain in the review. Any disagreements were resolved by consensus with the third author.

2.1. Data extraction

The following data were extracted in alphabetical order, according to a standard form that included: first author, date, country of publication, study design, sample characteristics and study objectives, mental health assessment, measures of screen time exposure and main associations found. Data from studies conducted in the context of the

COVID-19 pandemic will be extracted separately. The description of the results of the associations will also be covered in topics, with the studies conducted during the COVID -19 pandemic presented separately. Similarly, there will be a section devoted to describing the associations from studies conducted with university students.

2.2. Quality Assessment

The Cochrane Collaboration's risk of bias tool (Higgins et al., 2011) was used by the same review authors, to assess the risk of bias in the RCT's included. The methodological quality of the other types of studies, that is, observational cross-sectional and longitudinal studies, was assessed by the Joanna Briggs Institute (JBI) Critical Appraisal Tools (Moola et al., 2020).

3. Results

A total of 1.695 records were identified in the databases through the search strategy. Four hundred and thirty-six duplicates were removed, and 1.259 articles were evaluated by title and abstract. After screening, 1.169 articles were excluded as they did not meet the predetermined criteria. Thus, 90 articles were reviewed, of which 28 were selected to compose the present study. Through a manual search in the references, 4 studies were selected, totaling 32 articles included in the review. An additional file shows in more detail the selection of articles via the PRISMA Diagram [see Supplementary File 1: Fig 1] (APÊNDICE K).

3.1. Study characteristics

Of the 32 studies published between 2014-2022, there were a total of 77.219 adult participants. The age range of the participants was between 18 and 64 years, heterogeneously distributed among the studies, and females were predominant. Of the 19 studies conducted before the COVID-19 pandemic, 46,914 individuals were allocated into 8 studies from China. There were 1,948 participants from 2 Australian studies and 1,048 participants from 2 studies from the United States of America. One study from each location below has the remain sample: 5,090 from Finland; 2,813 from Taiwan; 1,156 from Canada; 1,140 from Bangladesh; 1,038 from Brazil; 114 from the Netherlands and 78 from the United Arab Emirates. Regarding the design of the studies, 14 were cross-sectional, 3 were longitudinal, and 2 were randomized clinical trials (RCTs). Of the 32 articles included, 13 were studies conducted in the context of COVID-19, including

15,827 participants. During COVID-19, one study was from Iran with a sample size of 350, a Japanese with 484 participants, England with 154, one study included sample from Argentina, Italy, and the UK with 334, Mexican with 1,116, four American with 5,510, and four from China with 7,900 participants. Regarding study design, there were 1 RCT, 8 cross-sectional studies, and 4 longitudinal studies. Table 1 summarized the included studies performed before the pandemic COVID-19, in alphabetical order. Table 2 summarized the included studies conducted in the context of COVID-19, in alphabetical order.

Table 1. Descriptive characteristics of the studies conducted before the pandemic COVID-19

Reference, Country, Type of Study	N / Age / Gender / Purposes	Mental Health- Assessment	Screen Time Measurements	Main Associations
Dennis et al., 2022 Canada Cross-sectional	N = 1,156 Age: 34,3 years 83,1% female To establish the level and correlates of problematic internet use in parents.	Depression: PHQ-9 Anxiety: General Anxiety Disorder Scale-7 (GAD-7) Stress: 10-item Perceived Stress Scale (PSS)	Young's Internet Addictions Test (IAT)	Perceived stress ($p<0.001$) and depressive symptoms ($p=0.017$) were associated with higher scores of IAT, with small effect size.
Feng et al., 2014 China Cross-sectional	N = 1,106 Age: 18,9 years 42,6% female To investigate the independent and interactive associations of physical activity (PA) and screen time (ST) with depression, anxiety and sleep quality.	Depression: Self-rating Depression Scale (SDS) Anxiety: Self-rating Anxiety Scale (SAS) Sleep quality: Pittsburgh Sleep Quality Index (PSQI)	Self-reported: activities including computer (PC) and internet use, watching TV/video programs and playing games both on weekdays and weekends.	The only significant and isolated association between variables of interest was that a ST of ≤ 2h/day predicted lower risks of depression ($p<0.05$). Small effect size.
Gao et al., 2021 China Cross-sectional	N = 278 Age: 19,4 years 36% female To examine the link between recreational ST and student-athletes pre-competition and competition anxiety.	Three validated psychometrics scales were used: Athlete Trait Anxiety Scale and Athlete State Anxiety Scale (before and during competition)	Self-reported: subjects reported their average daily recreational screen time in the previous week from doing the questionnaire	In comparison with the non-recreational ST group, student athletes had higher levels of anxiety in general ($p<.005$). Also, student athletes with ≥3h/day of recreational ST reported significantly higher levels of pre-competition anxiety than those with no recreational ST ($p<.005$).
Ge et al., 2020 China Cross-sectional	N = 1,137 Age: 19,9 years 65,5% female To investigate independent and combined associations between ST, PA and perceived stress among college students.	Perceived stress: Long Form and the Chinese Perceived Stress Scale (CPSS)	Self-reported: participants were asked to report the number of hours per day they spent on personal PC, smartphones, and tablets on weekdays and weekends.	Female students who reported high amounts of ST were more likely to experience stress ($p=.007$). When combined with varying levels of PA, female students who reported high levels of ST were more likely to experience stress, compared to those low levels of ST ($p\leq.005$). For males, no significant associations were observed. Small effect size.

Griffioen et al., 2021 Netherlands Cross-sectional	N = 114 Age: 21,3 years 84,8% female To answer questions regarding youths' use of smartphones and its relationship with their wellbeing.	21-items Depression, Anxiety and Stress Scale (DASS-21) Cognitive Emotion Regulation Questionnaire Short (CERQ-short) State-Trait Anxiety Index—Trait part (STAI-T). Self-Compassion Scale (SCS) Rejection Sensitivity Questionnaire for Adults (A-RSQ)	Self-reported: recording and assisted recall protocol	High scores on depression symptoms were negatively associated with positive feelings about social media use (p=.009). High stress (p=.011) and anxiety (p<.028) scores were negatively related to less positive feelings about social media use in general. Greater sensitivity to rejection was related to less messaging activities (p=.014). Higher rejection sensitivity scores were also related to less positive feeling during social media use in general (p=.003). Self-compassion was positively related to number of messaging activities (p=.047) and use of social media (p=.023). Small effect sizes.
Hossain et al., 2019 Bangladesh Longitudinal	N = 1,140 Age: 19,49 years 42% female To investigate the impacts of sociocultural environment and lifestyle on the psychological health of university students.	Depression: PHQ-9 Anxiety: General Anxiety Disorder-7 (GAD-7) Psychological health: self-reported	Self-reported	High recreational screen time was strong correlates for depression and anxiety (p<0.05), yet it was more evident for depression symptoms. Small effect sizes.
Hunt et al., 2018 USA Randomized Controlled Trials (RCT)	N = 143 Age: was not informed 75,5% female To assess whether the use of multiple Social Networking Sites (SNS) platforms impacts well-being in a sample of undergraduates at the University of Pennsylvania.	FoMO: FoMO Scale Anxiety: Spielberger State-Trait Anxiety Inventory (STAI-S) Depression: BDI-II Self-Esteem: Rosenberg Self-Esteem Scale (RSES) Autonomy and Self-Acceptance: Ryff Psychological Well-Being Scale (PWB) Loneliness: UCLA Loneliness Scale Social Support: Interpersonal Support and Evaluation List	Self-monitoring apps provided objective data about social media usage on devices. The control group was instructed to continue to use social media as usual, while the intervention group was told to limit their usage on Facebook, Instagram and Snapchat to 10 minutes per platform per day.	Subjects in the experimental group scored significantly lower on the UCLA Loneliness Scale at the end of the intervention (p=0.01). Individuals in the experimental group saw clinically significant declines in depressive symptoms (p<0.05). Also, a statistically significant decline in fear of missing out appeared in both groups (p<0.05) Similarly, a slight decline in anxiety appeared in both groups (p < 0.05). Small effect sizes.
Olds et al., 2018 Australia Longitudinal	N = 105 Age: 63,4 years 51,4% female To describe changes in time use across retirement transition; to determine whether these changes were associated with changes in MH; and to describe the effects of replacing work time with PA, sleep and ST.	Depression, Anxiety and Stress: DASS-21 Well-being: SWEMWBS. Life satisfaction: Australian Unity Personal Well-being Index (AUPWI). Self-esteem: Rosenberg Self-Esteem Scale.	Self-reported: participants recalled time use with the Multimedia Activity Recall for Children and Adults (MARCA).	The change in overall activity composition was significantly related to changes in DASS-21 total score (p=0.006), in depression (p=0.03), anxiety (p=0.26), stress (p=0.02), and self-esteem (p=0.02). Unfavorable substitutions showed lower effect sizes and usually involved replacing work with screen time or social.

Rebar et al., 2014 Australia Cross-sectional	N = 1,843 Age: 58 years 55% female To examine the association between sitting time in different contexts, such as leisure and laboring activities with depression, anxiety, and stress symptoms.	Depression, anxiety, and stress symptom: DASS-21	Sitting time: 10-item Workforce Sitting Questionnaire, comprised of other activities besides those involved with electronic devices	Sitting time showed a significant association with depression and anxiety symptoms ($p<0.05$), with small effect size.
Tamminen et al., 2020 Finland Cross-sectional	N = 5,090 Age: 55,5 years 55,6 % female To investigate whether diverse domains of PA and ST sitting were associated with positive MH using a large national population study.	Positive mental health: Warwick-Edinburgh Mental Well-being Scale (WEMWBS)	Self-reported	High screen time sitting at home was related to higher odds of low positive MH (OR = 1.51). Small effect size.
Tsou, 2022 Taiwan Cross-sectional	N = 2,813 Age: 32 years 89.2 % Female To examine the effects of prolonged Visual Display Terminal (VDT) working time on the physical and MH of healthcare workers.	Perceived stress: Self-reported Burnout: Chinese version of the Maslach Burnout Inventory—Health Services Survey test (MBI-HSS) MH: Brief Symptom Rating Scale-5 (BSRS-5)	Self-reported	The increase in VDT time caused a worsening of almost all the mental conditions measured in physicians and non-medical subjects ($p<0.05$). The only difference appeared in this second group, showing no significant associations between VDT time and burnout levels. Small effect size.
Vally & D'Souza, 2019 United Arab Emirates Randomi-zed Controlled Trials (RCT)	N = 78 52.6% female Middle age: 22,13 years To test the effect of abstaining from social media use on participants' well-being, perceived stress, and sense of loneliness.	Subjective Well-Being: Satisfaction with Life Scale (SWLS) Affective well-being: Positive and Negative Affect Schedule (PANAS) Loneliness: Social and Emotional Loneliness Scale for Adults—Short Form (SELSA) Stress: Perceived Stress Scale (PSS)	Social media usage data: 8-item Questionnaire. Group 1, an abstinence protocol was established, participants were asked to delete all social media apps from their mobile devices. Group 2 (control) continued to use social media as normal.	Compared with the control group, participants who abstained from social media use reported lower levels of subjective well-being ($P = 0.05$), a higher degree of negative affect ($P<0.05$) and substantially deeper experiences of loneliness during the period under examination ($P=0.005$). Medium effect sizes.
Vieira et al., 2021 Brazil Cross-sectional	N = 1,038 Age: 16 to 25 years 49% Female To estimate the prevalence of depressive symptoms in college students and its association with lifestyle-related behaviors.	Depression: Patient Health Questionnaire-9 (PHQ-9)	Self-administered questionnaire: concerning activities such as television, computers, and video games	Screen time ST was associated with symptoms of depression just for men, showing a higher prevalence of depressive symptoms among those reporting more than 4 hours per day of ST (aPR = 1.61, 95%CI: 1.18; 2.20).
Vizcaino et al., 2020 USA Cross-sectional	N = 926 Age: 34 years 55,1% female To examine whether extended use of a variety of screen-based devices was associated with poor dietary habits and other health-related characteristics and behaviors.	Psychological stress: 10-item version of the Perceived Stress Scale (PSS)	18-item questionnaire: an estimate of total time spent in hours and minutes using TV, TV-connected devices, laptops/computers, smartphones, and tablets	Heavy screen users reported the lowest self-rated health ($p=.000$) and the highest perceived stress scores ($p=.000$). Self-rated health was significantly lower for heavy users of TV, TV-connected devices, and smartphones ($p<.05$). Binge watching was significantly associated with and perceived stress ($p<.000$). Small effect sizes.

Wu et al., 2015 China Cross-sectional	N = 4,747 Age: 19,24 years 58,4% female To examine the associations of PA and screen time isolated and combined with Self-reported mental health and sleep quality among Chinese college students.	Depression: CES-D Anxiety: SAS Psychopathological symptoms: MSQA Sleep problems: PSQI	Self-reported.	ST correlates with anxiety, depression, psychopathological symptoms and poor sleep quality (p<.001). The risks were significantly lower in those with low PA and low ST (p<.05 for all of them). The participants with high PA and low ST had the lowest risks of psychopatho-logical symptoms and poor sleep (p<.05). Small effect sizes.
Wu et al., 2016 China Longitudinal	N = 2,521 Age: 18,43 years 52,9 % female To examine the relationships between ST and mental health problems and whether increased ST affects mental health progression.	Depression: CES-D Anxiety: SAS Psychopathological symptoms: Multidimensional Sub-health Questionnaire of Adolescents (MSQA).	Self-reported.	At baseline, even when adjusted for covariables, high ST was positively associated with anxiety, depression and psychopathological symptoms (p<0.05). Also, participants who increased their exposure to ST at follow-up exhibited higher ORs for progression or development of MH problems compared to baseline (p<0.05). Small effect sizes.
Yu et al., 2019 China Cross-sectional	N = 18,994 Age: 42,2 years 45,6% female To examine separately the association of computer/mobile device use and TV watching with depressive symptoms.	Depressive symptoms: Self-Rating Depression Scale (SDS).	Self-reported.	For PC and mobile use, in all analysis models, the ORs of the depressive symptoms decreased almost homogeneously across time levels (p<.0001). In contrast, the ORs of the depressive symptoms increased across the TV watching time levels with a clear dose-response relationship in all models (p<.0001). Small effect sizes.
Zhang et al., 2021 China Cross-sectional	N = 11,787 Age: 20,51 years 57,1% female To evaluate the associations between ST, PA, and depression symptoms.	Depressive symptoms: Patient Health Questionnaire (PHQ)	Self-reported: included using the computer and watching TV/video programs over the past 7 years	ST > 4 h/day was positively correlated with depressive symptoms (p<0.01). Also, there is an association between > 1 h/day of COVID-19 related ST and depressive symptoms (p<0.01). Medium effect sizes.
Zhang et al., 2022 China Cross-sectional	N = 7,121 in total (6,644 ranged our study age, 477 of this paper's sample were elderly individuals) Age: 38,04 years 67,3 % female To investigate the relationships between three types of ST, TV, PC use and cellphone/tablet use on weekdays and weekends and PTSD, depression, ADHD and Psychotic-Like Experiences (PLEs).	Posttraumatic Stress Disorder (PTSD): Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5) Depression symptoms: PHQ-9 ADHD: WHO Adult ADHD Self-Report Scale (ASRS) PLEs: MINI-International Neuropsychiatric Interview for Psychotic Disorders	Self-reported: screen time spent on TV, computer use and cell phone/tablet use both on weekdays and weekends	Using computers for at least 3 hours on weekends was associated with a higher likelihood of PTSD (p<0.001) and depression (p<0.05). Participants using cell phones/tablets at least 3 hours a day were at high risk of ADHD (p<0.001). Depression was correlated with greater use of cell phones/tablets (p<0.001). PLEs were related to spending more time watching TV (p<0.05) and less cell phone/tablet use (p<0.01). Small effect sizes.

Table 2. Descriptive characteristics of the studies conducted in the context of COVID-19

Reference, Country, Type of Study	N / Age / Gender / Purposes	Mental Health- Assessment	Screen Time Measurements	Main Associations
Aliverdi et al., 2022 Iran Cross-sectional	N: 350 Age 22,4 Gender: Not available To determine the predicted role of social networks and internet emotional relationships on students' mental health (MH).	Stress, anxiety and depression: Stress, anxiety, depression scale (DASS-21)	Self-reported	The DASS-21 score showed a positive and significant correlation with the average time of use of social networks ($r = 0.13$), with small effect size.
Fumagalli, Dolmatzian, & Shrum, 2021 Argentina, Italy and UK Longitudinal	N = 334 Age: 21,5 years 69,8% female To investigate associations between social networking apps, messaging and VoIP apps with loneliness, and Fear of Missing Out (FoMO) during the COVID-19 pandemic forced isolation.	Loneliness: 8-item short version of the revised UCLA Loneliness Scale Personality traits: 10-item Personality Inventory scale (TIPI) FoMO: 3-item measure adapted from the original scale 10-item scale (to reflect the COVID-19 period)	Comparative method: self-reporting was confronted with the data of the electronic devices.	There was an indirect association between social networking apps usage and loneliness mediated by COVID-19-related FoMo ($p<0.05$). Regarding messaging and VoIP apps usage, there was a negative direct association with Loneliness ($p<0.001$).
Gao et al., 2020 China Cross-sectional	N = 4,827 Age: 32,3 years 67,7% female To examine the associations between anxiety and depression disorders with social media exposure among the Chinese population during the COVID-19 outbreak.	Depression: Chinese version of WHO-Five Well-Being Index (WHO-5) Anxiety: Chinese version of generalized anxiety disorder scale (GAD-7)	Self-reported	Frequent social media exposure (SME) can increase the odds (OR = 1.72, 95%CI: 1.31–2.26) of anxiety compared with less SME. When in combination, SME can increase the adjusted odds (OR=1.91, 95%CI: 1.52–2.41) of depression and anxiety symptoms. Small effect sizes.
Giuntella et al., 2021 USA Longitudinal	N = 682 Age: 19,71 years. 68% female. To analyze disruptions in PA, sleep, and time use among young adults at the onset of the pandemic and examine the relationship between these disruptions and MH.	Depression: Center for Epidemiological Scale-Depression (CES-D) Anxiety: GAD-7 Resilience: Brief Resilience Scale Life Satisfaction: no objective and validated scale	Self-reported: includes time spent playing games, watching TV or surfing the Internet and does not include time spent working or studying on a device.	A longer recreational screen time had a significant association with the emergence of depression and anxiety during the COVID-19 pandemic ($p<0.01$), with large effect size.
Hu et al., 2020 China Cross-sectional	N = 1,033 Age: 18 to 60 years 48.2% female To explore perceived lifestyle changes after the outbreak of COVID-19 and their association with Subjective Well-Being (SWB).	SWB: Chinese adapted version of the General Wellbeing Schedule (GWS) Perceived Social Support (PSS): Perceived Social Support Scale (PSSS) Loneliness: short form of the University of California, Los Angeles (UCLA) Loneliness Scale (ULS-8)	Self-reported: ST related to watching TV/videos, internet use via smartphone or internet, playing on a computer or smartphone games, studying online, and using social platforms.	The distribution of GWS scores was not significantly different across the categories of leisure screen time ($P > 0.05$), showing that the association between ST with subjective well-being, perceived social support and loneliness is not significant in this study.

Jáuregui et al., 2022 Mexico Cross-sectional	N = 1,116 (32 of the original sample were elderly individuals) 77,6% female Age: 19 to 60 years To evaluate the association between changes in levels of physical activity LPA and Screen Time (LST) with symptoms of depression, anxiety, and stress during the early stages of COVID-19.	21-item Depression, Anxiety and Stress Scale (DASS-21)	Self-reported: data about frequency and duration of leisure screen time during a typical day, before and during the stay-at-home period.	High LST was associated with impairment on all mental health scales ($p \leq .05$). For depressive symptoms: $\beta = 4.92$; 95% CI, 2.95–6.89. For anxiety: $\beta = 3.94$; CI 95%: 2.00–5.88. For stress: $\beta = 4.80$; 95% CI, 2.61–6.98. Large effect sizes.
Lambert et al., 2022 UK RCT	N = 154 Age: 29,6 years 62% female To understand the impact of taking a 1-week break from social media on well-being, depression, and anxiety.	Well Being: Warwick-Edinburgh Mental Well-being Scale (WEMWBS) Anxiety: General Anxiety Disorder Scale-7 (GAD-7) Depression: PHQ-8	The intervention group stopped using social media platforms for 1 week, as evidenced by monitoring app. The control group continued their regular social media use during this period.	Improved well-being ($p<.001$), and reduced symptoms of depression ($p<.001$) and anxiety ($p<.01$) in the intervention group, with moderate effect sizes.
Meyer et al., 2020 USA Cross-sectional	N = 2,769 (805 of the original sample were elderly individuals) Age: 18 to 64 years 62% female To evaluate that self-reported MH would be associated with the degree of changes in PA, sitting time, and ST over the COVID-related public health restrictions period.	Stress: 4-item Perceived Stress Scale-4 Loneliness: 3-item Loneliness scale PMH: Short Warwick–Edinburgh Mental Wellbeing Scale Social engagement: 3-item form of the Lubben Social Network Scale-6 BDI-II and 21-item Beck Anxiety Inventory	Self-reported: before and after the restrictions	Compared to those who maintained low screen time, those who increased had higher depressive symptoms ($p < 0.001$), loneliness ($p < 0.001$), stress ($p < 0.001$), and lower Positive Mental Health -PMH ($p < 0.001$).
Meyer et al., 2021 USA Longitudinal	N = 1,654 (673 of the original sample were elderly individuals) Age: 18 to 64 years 63.8% female To investigate how changes in PA, sitting time, and ST in response to the COVID-19 pandemic were associated with changes in MH across time.	Anxiety: 21-item Beck Anxiety Inventory (BAI) Depression: 21-item Beck Depression Inventory-II (BDI-II) Positive MH (PMH): 7-item Short Warwick -Edinburgh Mental Well-begin Scale (SWEMWBS-7)	Self-reported	Depressive symptoms were higher in those viewing screens for 13 h compared to 4 h. But, in the third week, this difference was no longer apparent ($p<0.05$).
Sewall, Goldstein, & Rosen, 2021 USA Longitudinal	n = 384 Wave 1 Age: 24,5 years wave 1, 57% female To examine the associations between digital-technology use and psychological distress among young adults.	Anxiety and Depression: Patient-Reported Outcomes Measurement Information System (PROMIS)	Device reports from Apple's Screen Time application concerning ST in total, ST usage for social media and number of pickups.	Multilevel analyses revealed that none of the objectively measured digital technology use variables were positively associated with depression, anxiety, or suicidal ideation at the within- or between-person levels.

Tashiro et al., 2022 Japan Cross-sectional	N: 484 Age M: 21,7 years 61% female To investigate the association between sedentary behavior (SB) and depression in medical students during the COVID-19 pandemic.	Depressive symptoms: Patient Health Questionnaire 2 (PHQ-2)	Self-reported: ST (min/day) as two conditions: leisure and study	Negative associations between depression and leisure ST: crude model (β=0.001, p =0.002, OR=1.003, 95% CI 1.001 –1.005) and adjusted model (β = 0.003, p = 0.003, OR=1.003, CI 95% 1.001–1.005). Small effect sizes.
Xu et al., 2021 China Cross-sectional	N = 1,456 Age: 33,8 years 59.1% female To investigate the potential factors associated with MH outcomes among Chinese adults during the COVID-19 epidemic.	Depression: PHQ-2 Loneliness: 3-item UCLA Loneliness Scale (UCLA-3) Anxiety: GAD-2 Post-Traumatic Stress Disorder (PTSD): 2 questions from the Clinician-Administered PTSD Scale	Self-reported: average daily use time of the mobile phone, Internet, TV, and video games in the past two weeks.	Depressive symptoms and reported loneliness were positively associated with screen time ($p<0.05$). Small effect sizes.
Zhou et al., 2021 China Cross-sectional	N = 584 Age: Undergraduates in grades 1 to 3 40,2% female To analyze the association of depression with total and domain-specific SB and PA.	Depression: Nine-item Patient Health Questionnaire (PHQ-9)	Self-reported: data of recreational screen time over the last 7 days.	Individuals with higher amounts of recreational screen time were more likely to be detected with depression ($p = 0.035$), with small effect size.

3.2. Screen time assessment

Of the three RCTs in this review, two implemented total abstention from social media platforms for 1 week (Vally & D'Souza, 2019; Lambert, Barnstable, Minter, Cooper, & McEwan, 2022) and one of them reduced the use of a social media platform to 10 minutes a day. for 3 weeks (Hunt et al., 2018), in the experimental group, while controls maintained their usual use. Some studies that systematically evaluated cell phone use involved screenshots (Fumagalli, Dolmatzian, & Shrum, 2021), or the "Screen Time" app (which passively tracks device usage) (Sewall, Goldstein, & Rosen, 2021). Griffioen, Scholten, Lichtwarck-Aschoff, van Rooij, and Granic (2021), evaluated only general smartphone use, that is, for social media, applications, browsing the internet and messaging.

In most studies, the self-report of the daily hours spent in front of various screen devices such as personal computers (PC), television (TV), video games, mobile devices such as smartphones and tablets, during the week or weekends was considered (Feng, Zhang, Du, Ye, & He, 2014; Wu et al., 2016; Hossain, Anjum, Uddin, Rahman, & Hossain, 2019; Yu et al., 2019; Ge et al., 2020; Giuntella, Hyde, Saccardo, & Sadoff, 2021; Xu et al., 2021; Vieira et al., 2021; Aliverdi, Farajidana, & Tourzani, 2022; Zhang

et al., 2022), for study and leisure (Tashiro et al., 2022). One study measured screen time with the Children's and Adults' Multimedia Activity Recall Time Use Questionnaire (MARCA) (Olds et al., 2018).

While some studies did not specify types or content (Meyer et al., 2020; Meyer et al., 2021), one evaluated only recreational screens (Gao, Fu, Mao, & Shi, 2021), and another only recreational screens before and during isolation by Covid-19 (Jáuregui et al., 2022). Two studies punctually evaluated PC use without, however, specifying whether it was for school or work (Wu, Tao, Zhang, Zhang, & Tao, 2015; Zhang et al., 2021). Hu, Lin, Kaminga, & Xu (2020) included online study time and in Tsou (2022) screen time was the number of hours in front of screens at work, in a working day, including overtime.

Vizcaino, Buman, DesRoches, and Wharton (2020) explored the new phenomenon of binge-watching and Gao et al. (2020) the frequency of social media exposure to COVID-19 news. Internet and screen use was assessed using the Young's Internet Addictions Test (IAT) questionnaire (Dennis et al., 2022). Others considered screen time as sedentary time, in which participants remained seated in front of screens (Tamminen et al., 2020; Zhou et al., 2021). In the study by Rebar et al. (2014), the self-report of sedentary time was collected through the 10-item Workforce Sitting Questionnaire.

3.3. Mental health assessment

The aspects related to mental health most evaluated in the articles were depression (n=24), anxiety (n=19), stress (n=11), loneliness (n=5), well-being (n=4), positive mental health (n=4), post-traumatic stress (n=2) and self-esteem (n=2). Only one study evaluated suicidal ideation (Sewall et al., 2021), symptoms of attention deficit hyperactivity disorder (ADHD), psychotic disorders (Zhang et al., 2022), and Burnout (Tsou, 2022), an outcome of work-related exhaustion. Two studies assessed Fear of Missing Out (FoMO), an outcome closely related to social media use (Hunt et al., 2018; Fumagalli, et al., 2021). The most used scales include the Patient Health Questionnaire-9 (PHQ-9), the General Anxiety Disorder Scale-7 (GAD-7) and the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS). Other scales such as the Self-Rating Depression Scale (SDS) and Self-Rating Anxiety Scale (SAS), the Center for Epidemiological Studies Depression Scale (CES-D), the Perceived Stress Scale (PSS), the Depression, Anxiety and Stress Scale, 21-item (DASS-21), a University of California, Los Angeles (UCLA) Short Loneliness Scale (ULS-8), and the Fear of Missing Out Scale, were used in fewer studies.

3.4 Associations between screen time and mental health before the context of Pandemic by COVID-19

In the study investigating various smartphone uses, self-compassion was positively related to the number of messaging activities ($p = 0.047$) and social media use ($p = 0.023$) (Griffioen et al., 2021). Considering computers and mobile devices, the Odds Ratio (ORs) of depressive symptoms decreased as screen time increased, compared to the lowest screen time (<1 h/day) (Yu et al., 2019). On the other hand, however, some studies have found improvements in adult mental health through reductions in screen exposure time. Limiting social media use for three weeks showed significant reductions in loneliness scale ($p = 0.01$) and depression (mean BDI scores: 23 at the beginning to 14.5 at the end). In Hunt et al., (2018), there was a significant decline in FoMO at the intra-subject level ($p < 0.001$) and anxiety ($p < 0.016$) in both groups after the intervention. Psychotic-type experiences (PLEs), on the other hand, were shown to be related to less cell/pill use (1-3 vs ≥ 4: OR = 0.66, OR = 0.65, respectively), during the week and weekends (Zhang et al., 2022). All OR values with 95% CI.3.5.2.

High screen times were associated with stress ($P = 0.001$) in women (Ge et al., 2020) and with depressive symptoms (aPR = 1.61, 95% CI: 1.18; 2.20) in men (Vieira et al., 2021). Research by Zhang et al., (2022) found different results across device types and days of the week. Higher likelihood of post-traumatic stress disorder (PTSD) (OR = 1.81) and depression (OR = 1.33) was associated with computer use on weekends. Cell phone/tablet use for at least 3 hours per day was associated with high risk of ADHD both during the week (OR = 1.56) and on weekends (OR = 1.48), and depression on weekdays (OR = 1.38) and weekends (OR = 1.28). In addition, psychotic-type experiences (PLEs) were shown to be related to spending more time watching TV during the week (0 vs ≥ 4: OR = 1.76/ 1-3 vs ≥ 4: OR = 1.79) and weekends (0 vs ≥ 4: OR = 1.46 /1-3 vs ≥ 4: OR = 1.76).

Griffioen et al. (2021) conducted a study on various smartphone uses, such as messaging or social media use, and the associations with mental health. Social media use was positively associated with more depression ($p = 0.009$), stress ($p = 0.011$), and anxiety ($p = 0.018$). Greater sensitivity to rejection was related to less messaging activity ($p = 0.014$). This review included three RCTs, in that of Vally and D'Souza (2019) participants who abstained from social media use had lower levels of subjective well-being ($p = 0.05$)

and a higher degree of negative affectivity ($p < 0.05$), as well as deeper experiences of loneliness during the experimental period ($p = 0.005$).

Screen time was also considered as sitting time in some studies and was positively associated with symptoms of depression and anxiety (Rebar et al., 2014), as well as higher odds of PMH of poor positive mental health (OR = 1.51) (Tamminen et al., 2020). One study investigated individuals in recent retirement, looking for the effects of replacing time spent at work with other activities (such as sleep, physical activity, or screen time), on depression, anxiety, and stress. With retirement, there was a significant reduction in symptom scores, but substitutions from work to activities involving screen time were unfavorable and showed smaller effect sizes in reducing scores (Olds et al., 2018).

In healthcare services, the use of Visual Display Terminal (VDT) in the workflow is common. In this regard, Tsou (2022) examined the negative effects of prolonged VDT use on the physical and mental health of healthcare professionals during hospital work. Increased VDT time caused worsening stress ($p < 0.001$), Burnout ($p = 0.01$) and worse mental health ($p = 0.004$) in physicians. For non-medical professionals, the results were positively associated with stress ($p = 0.004$) and worse mental health ($p < 0.001$).

One study investigated the association of excessive internet use with mental health outcomes. The results showed that the greater the time management deficiency, the greater the stress and the socioemotional impairment ($p = 0.002$), and more symptoms of depression ($p=0.016$) (Dennis et al., 2022). One study explored the phenomenon of binge-watching, that is, when individuals indulge in "marathon" viewing of TV series or programs. The results showed that compulsive watching was significantly associated with perceived stress ($p < 0.000$) (Vizcaino et al., 2020). Another study also found a higher likelihood of depressive symptoms with increased levels of TV time, compared to less watching time (<1 h/day) (Yu et al., 2019).

3.4.1 No evident change

Some studies observe no associations between screen time and mental health variables. In Vally and D'Souza's (2019) RCT, no difference in stress scores was found in who abstained from social media or not ($P > 0.05$). No association were observed between screen time and stress in men (Ge et al., 2020), or with depressive symptoms in women (Vieira et al., 2021). In male college students prospectively evaluated, high and excessive ST was also not correlated with depression and anxiety (Hossain et al., 2019). In Feng et

al. (2014), college students showed no statistically significant associations between ST and anxiety. Among workers, no association was found between prolonged Visual Display Terminal (VDT) and Burnout in non-medical healthcare professionals (Tsou, 2022).

3.4.2 Associations between screen time and mental health in college students before the COVID-19 pandemic

Some investigations have been conducted directly with college students. In cross-sectional studies, a higher rate of depressive symptoms was found in students who reported longer screen time, i.e., compared to daily ST ≤ 2 h/day, ST > 4 h/day was positively correlated with depressive symptoms (β = 0.48, 95% CI 0.37-0.59) (Zhang et al., 2021). Less screen time was associated with lower risks of depression (OR: 0.67) and poor sleep quality (OR: 0.48) (Feng et al., 2014). For student athletes, excessive recreational screen time was a risk factor for mood anxiety, pre-competition anxiety, and anxiety during competition ($p < 0.005$) (Gao et al., 2021).

In college students, high screen time at baseline was positively associated with anxiety (OR=1.38), depression (OR=1.55), and psychopathological symptoms (OR=1.49). Increased ST exposure at follow-up showed higher ORs for mental health problems compared to baseline (Wu et al., 2016). In another study elevated ST was correlated with depression ($p = 0.004$) and anxiety ($p = 0.023$) only in women (Hossain et al., 2019).

3.5 Associations between screen time and mental health in studies conducted in the context of the pandemic by COVID-19

There was a negative association between messaging app use and participants' feelings of loneliness (b = -0.02, SE = 0.006, 95% CI [-0.035, -0.012]) (Fumagalli et al., 2021). The reduction of the amount of time spent using social media platforms during a week was associated with a significant improvement in well-being ($p < 0.001$) and reductions in symptoms of depression ($p < 0.001$) and anxiety ($p < 0.01$) (Lambert et al. 2022).

In the study by Meyer et al. (2020), screen time < 8 h/day was considered low and adults exposed to longer screen times had increased depressive symptoms ($p < 0.001$), loneliness ($p < 0.001$), and stress ($p < 0.001$), as well as lower positive mental health ($p < 0.001$). In this study, participants were categorized according to compliance with the

US Physical Activity Guidelines, reporting ≥8 h/day of sitting time or reporting ≥8 h/day of screen time. The study considered likely required increase in screen time to adhere to COVID-19 restrictions, with a large transition to virtual work or school environments.

A study investigating social media exposure, specifically for Covid-19 news, found a positive association with high odds of anxiety (OR = 1.72) and combination of depression and anxiety (OR = 1.91), compared to less exposure (Gao et al., 2020). In Jáuregui, et al. (2022), increasing or maintaining high levels of screen time for low and medium socioeconomic status was associated with higher scores of depression (β = 4.92; 95% CI, 2.95-6.89), anxiety (β = 3.94; 95% CI: 2.00-5.88), and stress (β = 4.80; 95% CI, 2.61-6.98). In the assessment of screen time, a positive association was found with depression ($p < 0.001$) and loneliness ($p < 0.05$) (Xu et al., 2021).

Consistent with the findings of Fumagalli et al. (2021), the direct relationship between social media use and loneliness was not significant, but social media use was positively related to FOMO, which was positively related to loneliness. The previous three weeks social media use was positively correlated with FOMO measured in the fourth week (b = 0.012, SE = 0.004, 95% CI [0.004, 0.020]) and the level of FOMO was positively correlated with their level of loneliness.

3.5.1 No evident change

Some studies have observed no associations between screen time and mental health variables, such as Sewall et al. (2021), who longitudinally surveyed depression, anxiety, and suicidal ideation at the intra- and interpersonal levels. Adults in general also did not differ in anxiety, depression, and positive mental health symptoms as a function of screen time, at onset or over time (Meyer et al., 2021). No association was found between screen time and anxiety or significant post-traumatic stress symptoms during COVID-19 (Xu et al., 2021). Leisure screen time was also analyzed and showed no statistical significance ($p > 0.05$) in association with subjective well-being, perceived social support, and loneliness (Hu et al., 2020).

3.5.2 Associations between screen time and mental health in college students in a COVID-19 context

Three studies noted problems with screens for entertainment. An association was found between depression and screen use for recreation (Tashiro et al., 2022). The more recreational screen time, the greater the propensity for depression (OR = 1.540, p = 0.035)

compared to screen time dedicated for schoolwork (OR = 0.658, p = 0.038) (Zhou et al., 2021). Anxiety was also positively associated with more time on social media (r=0.13) (Aliverdi et al., 2022).

3.6. Quality Assessment

Summaries of the RCT's 'Risk of Bias' assessment are shown in Figures 2 and 3 (Supplementary File 2: Fig 2 and Fig 3) (APÊNDICE L). The included RCTs, in general, did not meet all the quality criteria, presenting a moderate risk of bias. The summaries of the methodological evaluation of the observational studies are presented in Tables 2 and 3 (Supplementary File 2: Table 2 and Table 3) (APÊNDICE M), according to the items of the Critical Appraisal Tools of the Joanna Briggs Institute (JBI). Of the 29 observational studies evaluated, 14 answered more than 70% of the scale's questions, which represents 48% of the included studies with good methodological quality (Yung, Wong, Ho, & Molassiotis, 2021).

4. Discussion

This systematic review is an attempt to gather and provide compiled evidence on associations between screen time and mental health in the adult population. Screen-based activities are today the equivalent of a social and productive norm, which permeates the lives of adults and can be used to maintain or avoid social relationships (Antonucci, Ajrouch, & Manalel, 2017). Both screen exposure and time spent on screen-based activities were shown here to be associated with impaired mental health in the adult population. Although adulthood has been less investigated compared to other stages of the life cycle in relation to screen use and mental health (Pallavicini, Ferrari, & Mantovani, 2018). The studies reviewed corroborate to previous data where the effect sizes of screen time on mental health outcomes mostly range from small to medium (Li et al., 2022; Maurya, Muhammad, Maurya, & Dhillon, 2022).

Adequate amounts of screen time are not established for the adult population. The American Academy of Pediatrics set some healthy limits on daily screen use for children and teens in 2013. As adults, the long hours on screen emerge as potential damage to health, having musculoskeletal impacts, for example (Al Shahrani & Al Shehri, 2021). In this review, screen time of less than 8 hours a day was considered low (Meyer et al., 2020) and adults exposed to longer screen times showed an increase in depressive symptoms, loneliness, and stress. However, more than 6 hours of television viewing and computer

use has been associated with depression, in the same way that people with depressive symptoms are reported to spend more hours a day watching TV and using a computer (Madhav, Sherchand, & Sherchan, 2017).

In fact, several studies found mental health problems as overall screen time increased (Wu et al., 2015; Wu et al., 2016; Zhang et al., 2021). Interestingly, some studies reviewed here did not find significant results relating screen time and mental health in adults, such as depression in women (Vieira et al., 2021), depression and anxiety in men (Hossain et al., 2019), or depression and anxiety in both (Feng et al., 2014; Meyer et al., 2021; Sewall et al., 2021).

For adults, an important determinant of depression and anxiety is economic insecurity (Scheve et al., 2022). Here, we observed that high and increasing levels of screen time during the pandemic were associated with more depression, anxiety, and stress among participants of low or medium socioeconomic status (Jáuregui et al., 2022). The economic insecurity related with the context of the COVID-19 pandemic has been associated with the worsening of mental health, especially for socioeconomically disadvantaged people (Scheve et al., 2022). However, during the pandemic, regardless of socioeconomic conditions, there was also a positive association of screen use with depression and loneliness (Xu et al., 2021). Loneliness and social isolation are distinct constructs, but loneliness is often considered a result of social isolation. Loneliness is a subjective experience related to the subject's social or emotional connections. While, social isolation is an objective measure of the number of significant relationships or social contacts, that is, not everyone who is alone is socially isolated and not everyone who is socially isolated fells alone (Burns, Leavey, & O'Sullivan, 2022).

Loneliness has been increasing reported around the world (Doryab et al., 2019). According to the latest US Loneliness Index Report, nearly half of Americans report high levels of loneliness, particularly among young adults ages 18 to 22 (Doryab et al., 2019). Prior to the pandemic, image-based social media was understood as something able to alleviate loneliness, due to increased social presence (Pittman & Reich, 2016), which was surprising when young adults with high levels of interconnectedness were more loners than other age groups (Pittman & Reich, 2016). In our study, weaning adults away from social media use showed controversial results: it increased the experience of loneliness for some (Vally & D'Souza, 2019) and reduced it for others (Hunt et al., 2018). The relationship between loneliness and the use of social networks was also observed, but not

directly: the social network was associated with FoMO and FoMO was associated with loneliness (Fumagalli et al., 2021).

Much of what we know about FoMO is related to the social media context. The fact is that individuals have always missed out on enjoyable activities, but today, social media manages to make people aware that others are having better experiences (Holte & Ferraro, 2020). Ostracism, that is, the feeling of being excluded or ignored by others, is a common experience in various contexts, including social media (Schneider et al., 2017). Thus, it can be inferred that instead of worrying about missing a pleasant moment, people may fear that they are excluded from their social group. There is already a study even finding that the FoMO predicts how much a person feels ostracized (Holte, Fisher, & Ferraro, 2022). In addition to FoMO and loneliness, decreasing social media use has also been shown to decrease anxiety and depression (Hunt et al., 2018; Lambert et al., 2022). It is clear, however, that during the COVID-19 lockdown, screen time and digital engagements have skyrocketed, and that regardless of the benefits of social media, overuse has been a reason for increased depression and anxiety (Raza et al., 2021).

Currently, and even before the conditions of isolation, adults study or work in front of computers (Wang et al., 2019). During the productive age, free time on weekends is often also devoted to work. Of the work-related health conditions described in the active population of workers, mental distress ranks second, second only to musculoskeletal disorders (Moukarzel et al., 2019). Here, computer use on weekends was associated with an increased likelihood of PTSD, depression, and ADHD (Zhang et al., 2022). In addition, the increase in the use of visual terminals at work by health professionals has caused a worsening of the mental condition, including Burnout (Tsou, 2022). Although categorized as an occupational phenomenon rather than a medical condition, Burnout Syndrome is related to excessive workload and appears to be strongly associated with mental disorders such as depression and insomnia, and a possible underlying cause of substance abuse and dependence (Toth et al., 2021). Burnout is an increasingly prevalent syndrome and can be characterized by emotional exhaustion, depersonalization and reduced personal fulfillment. As also noted in this review, the most vulnerable people are those who work in human services, especially health professionals (Denning et al., 2021).

Retirement removes individuals from stressful work situations, on the other hand, empowering conditions that accompany work such as money, status, and bonds, also can be lost, with negative impacts on mental health (Stenholm & Vahtera, 2017). The period

of retirement can be stressful, especially for adults today, where working life is extended and retirement ages are increased, but most studies in this field have shown positive associations of retirement with mental health (Fleischmann, Xue, & Head, 2020). Individuals in early retirement were evaluated about replacing time spent at work with other activities would have any effect on depression, anxiety, and stress. With retirement, there was a significant reduction in symptom scores, but job substitutions for activities that involved screen use were less effective in reducing scores (Olds et al., 2018).

Another data, that can help to direct the reflection is the difference between screens that can be used for work and recreational use. Interestingly, the more recreational screen time, the greater the propensity for depression, compared to screen time for schoolwork (Zhou et al., 2021). For student athletes, excessive recreational screen time was a risk factor for anxiety (Gao et al., 2021). Apparently, there is a tendency for mobile devices and computers to exert less harm on mental health than simply watching TV (Yu et al., 2019), or spending time sitting in front of screens (Rebar et al., 2014; Tamminen et al., 2020).

Technology has changed the way people consume TV content (Castro, Rigby, Cabral, & Nisi, 2021). Nowadays, TV programming has been replaced by online videos or streaming channels, which can provide, without breaks, several seasons of a series (Alimoradi et al., 2022). This flexibility leads people to spend much of their time on TV, in binge-watching (Pittman & Steiner, 2021). Binge-watching behavior has become one of the most popular ways to spend free time, but even being a leisure activity, it can be linked to mental health problems (Starosta & Izydorczyk, 2020; Raza et al., 2021). The associations between binge-watching and mental health appear to be supported by the Uses and Gratification Theory, that is, people may binge-watch to satisfy their mental health needs (Starosta & Izydorczyk, 2020). In the Theory of Uses and Gratification, a person can feel gratified by an activity, especially if it is planned. Thus, if binge-watching is not in the plans, and the person is unable to stop watching, it can result in regret and aggravation of mental health problems (Pittman & Steiner, 2021). Binge-watching was previously associated with stress perception (Vizcaino et al., 2020).

Currently, people no longer need to be at home to access movie and series platforms, they can access from their smartphones. The technological evolution of cell phones has made the smartphone a social tool, leading some users to experience discomfort and anxiety when they cannot access it (Kaviani, Robards, Young, & Koppel,

2020). Here, we find little evidence of improvements in mental health related to smartphone use, in the studies of (Fumagalli et al., 2021; Griffioen et al., 2021). In addition, there is growing concern about the vicious use of this device in adults. Smartphone addiction has been associated with insomnia, depression, and ADHD (Alageel et al., 2021). Smartphone addiction is generally conceptualized as a behavioral addiction (Ratan, Parrish, Zaman, Alotaibi, & Hosseinzadeh, 2021). In the context of technologies, addiction has been considered a controversial term, difficult to conceptualize, however, with a definition linked to dependence on a substance or activity (Ratan et al., 2021).

The investigation related to excessive internet consumption in this review found an outcome very relevant to the routine of adults: time management. The greater the time management deficiency, the greater the stress (Dennis et al., 2022). An additional explanation for the lack of time control is the gambling habit, reports indicate that this is already a daily activity for a consistent percentage of the adult population (Kemp et al., 2021). This excessive use of internet-connected devices, especially smartphone, has been distracting parents, who are less receptive and sensitive in interaction with their children (Kildare & Middlemiss, 2017). In fact, parental screen time has been associated with children's screen time (Sigmundová et al., 2016; Garriguet, Colley, & Bushnik, 2017). The literature even suggests that parents with high ST are likely to influence their children's ST increase (Nwankwo, Shin, Al-Habaibeh, & Massoud, 2019).

5. Conclusion

This review brings together evidence of the influence of screen time on mental health in the adult population. Important data were found on the interaction of adults with screen devices, it may help to guide care for this population. To date, there is no consensus on healthy screen time per day for adults. In general, adults perceive negative impacts from the use of devices when they have health compromise such as musculoskeletal problems. Smartphones can contribute to influences on the mental health of adults, among other causes, due to FoMO, binge-watching and addiction problems. Replacing work activities with screen-based activities was not effective as other activities in decreasing depression and anxiety. Poor time management is one of the reasons adults can stress out when they spend more time on screens. Parent-child interactions might be compromised by mobile screen devices impacting children's development and behavior.

6. Limitations and future directions

Large age range of included population and self-reported time adds certain frailty to the studies, since the outcomes metric is susceptible to difficulty of remembering daily use of screens, and the problems might differ in different ages. Sedentary behavior, or sitting time, was the benchmark for screen time in some studies, decreasing the sensitivity of the data. For future investigations, it would be important to determine appropriate screen exposure limits and to characterize how adults use digital devices. In addition, to consider moderating factors, such as sleep and physical activity, since they can consistently interfere with functionality and, consequently, with mental well-being scores in adults.

7. Abbreviations

A-RSQ, Rejection Sensitivity Questionnaire for Adults;
AAP, American Academy of Pediatrics;
ADHD, Attention Deficit Hyperactivity Disorder;
ASRS, Adult Self-Report Scale;
AUPWI, Australian Unity Personal Well-being Index;
BAI, Beck Anxiety Inventory;
BDI-II, Beck Depression Inventory-II;
BSRS-5, Brief Symptom Rating Scale-5;
CDA, Combination of Depression and Anxiety;
CERQ-short, Cognitive Emotion Regulation Questionnaire Short;
CES-D, Center for Epidemiologic Studies Depression Scale;
COVID-19, Coronavirus Disease 2019;
CPSS, Chinese Perceived Stress Scale;
DASS-21, 21-item Depression, Anxiety and Stress Scales;
FoMO, Fear of Missing Out;
GAD-7, General Anxiety Disorder Scale-7;
GWS, General Wellbeing Schedule;
HCWs, Healthcare Workers;
IAT, Young's Internet Addictions Test;
LST, Leisure Screen Time;
MARCA, Multimedia Activity Recall for Children and Adults;

MBI-HSS, Maslach Burnout Inventory—Health Services Survey test;

MH, Mental Health;

MSQA, Multidimensional Sub-health Questionnaire of Adolescents;

ORs, Odds Ratio;

PA, Physical Activity;

PANAS, Positive and Negative Affect Schedule;

PC, Personal Computer;

PCL-5, Posttraumatic Stress Disorder Checklist for DSM-5;

PHQ-8, Patient Health Questionnaire-8;

PLEs, Psychotic-Like Experiences;

PMH, Positive Mental Health;

PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses;

PROMIS, Patient-Reported Outcomes Measurement Information System;

PSQI, Pittsburgh Sleep Quality Index;

PSS, Perceived Stress Scale;

PSSS, Perceived Social Support Scale;

PTSD, Post-Traumatic Stress Disorder;

PWB, Psychological Well-Being Scale;

RCT, Randomized Clinical Trials;

RSES, Rosenberg Self-Esteem Scale;

SAS, Self-Rating Anxiety Scale;

SB, Sedentary Behavior;

SCS, Self-Compassion Scale;

SDS, Self-Rating Depression Scale;

SE, Mean;

SELSA, Social and Emotional Loneliness Scale for Adults;

SES, Socioeconomic Status;

SME, Social Media Exposure;

ST, Screen Time;

STAI-S, Spielberger State-Trait Anxiety Inventory;

STAI-T, State-Trait Anxiety Index—Trait part;

SWB, Subjective Well-Being;

SWEMWBS, Short Warwick-Edinburgh Mental Well-being Scale;

SWLS, Satisfaction with Life Scale;

TIPI, 10-item Personality Inventory scale;
TV, Television;
UCLA, University of California, Los Angeles;
UK, United Kingdom;
ULS-8, Short form of the UCLA Loneliness Scale;
USA, United States of America;
VDT, Visual Display Terminal;
WEMWBS, Warwick-Edinburgh Mental Well-being Scale;
WHO, World Health Organization.

8. Data Availability Statement

All data supporting the findings of this study are available within the paper and its Supplementary Information.

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6.6 Artigo 4

The associations between screen time and mental health in the elderly: a systematic review

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Abstract

Background: There are an increasing number of seniors using screen devices and it is important to know the possible consequences of this exposure on the mental health of this population. This systematic review aimed to raise evidence of the influence of excessive use of screen-based devices on mental health in the elderly. Method: This study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and registered in PROSPERO under CRD number 42022363354. The search was conducted in September 2022, using the keywords: "screen time", "elderly" "aged" and "mental health", combined with the AND operator in the PubMed, PsycINFO and Scopus databases. Results: 17 articles were included, most found associations between screen exposure and mental health in the elderly: Watching TV or DVD was positively associated with psychological distress; seniors who reported less time sitting in front of screens on the weekend had better quality of life scores related to mental health; a negative association was found between smartphone use and loneliness. Limitations: self-reported screen time can generate some weakness in the evidence raised; screen time included in sitting time may also decrease the accuracy of this variable. Conclusion: TV was the screen device most associated with worsening mental health in the elderly, and the smartphones can minimize loneliness. This research raises a set of

relevant data, which can direct the eye in mental health care for the elderly. More studies are needed that can establish healthy times of the elderly's interaction with screens.

Keywords: screen time; mental health; elderly; aged; media

Word count: 12.119

1. Introduction

The proportion of elderly in the population is growing in all countries of the world, today most people can expect to live up to sixty years or more (World Health Organization, 2022). Although population aging has started in high-income countries, economically less advantaged countries are already experiencing this shift in population distribution. It is expected that, by 2050, 22% of the world's population will be people aged 60 or over (Carrasco et al., 2022; World Health Organization, 2022).

From a biological point of view, aging results from the interaction between molecular and cellular conditions, and a variety of stressors over time (Guo et al., 2022). This phase of life is commonly marked by the decrease in physical and psychological capacities, which increases the risk of diseases and checks people's resilience (Colloca et al., 2020). Maintaining healthy behaviors throughout life can improve these capacities and delay dependence on care. The increase in life expectancy offers the chance to seek new activities, but this reality depends largely on the health factor (World Health Organization, 2022).

In addition to health issues, most variations in the elderly are due to the physical and social environment of the individual (World Health Organization, 2022). Staying connected has currently been linked to the concept of healthy aging, increasing the number of older people involved with digital technologies (Kebede et al., 2022; Sixsmith et al., 2022). Even before the COVID-19 pandemic, the use of technology by older people was already growing (Nimrod, 2020). However, the physical distancing measures related to control the spread of the SARS-Cov-2 virus facilitate the use of screen-based devices in the elder population (Vargo et al., 2021).

Extended hours of screen time are no longer exclusive to children and teenagers. The number of elderly people proficient in the use of various electronic devices has increased (Zhang et al., 2021). Screens contribute to the entertainment and make life

easier, including for medical monitoring in cases of chronic diseases and care of the elderly (Hu et al., 2020; Ollevier et al., 2020; Zhao et al., 2020).

However, increased screen time can contribute to undesirable consequences. Most often associated with sedentary behavior, screen time becomes a risk factor for negative mental health outcomes (Zhang et al., 2021). Additionally, the aging process itself makes the elderly more vulnerable to situations that impact mental health. Older people can experience common life stressors but are also particularly susceptible to the significant ongoing loss of skills, events such as bereavement, or a drop in socioeconomic status with retirement. Currently, they are also subject to digital challenges such as fake news online (Kusumota et al., 2022; Moore and Hancock, 2022). All these stressors can result in isolation, loneliness, or mental distress (World Health Organization, 2017).

Approximately 15% of people aged 60 years or older suffer from a mental disorder (World Health Organization, 2017). Depression and anxiety are the most common mental disorders in this age group, affecting approximately 7% and 3.8% of the world's elderly population, respectively (Janiri et al., 2022; World Health Organization, 2017). Depression can also lead to impaired functioning in daily life, just as mental health problems can largely impact the quality of life (Alexopoulos, 2005; Shu and Woo, 2020). In the context of population aging and increased exposure to screens, this research may provide an opportunity to advance our understanding of the influence of excessive use of screen-based devices on the mental health of the elderly.

2. Method

The development of the search strategy for the present review relied on preliminary searches and discussions among the investigators. This review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA (Shamseer et al., 2015) and was registered in PROSPERO, under number CRD 42022363354. The search was carried out in September 2022 with the aim of to answer the question: Is there an association between screen time and mental health in older people? To reach this aim, the following keywords were used: "screen time", "elderly" "aged" and "mental health", combined with the AND operator in three relevant databases PubMed, PsycINFO and Scopus databases. In accordance with the PICO strategy, the study population includes studies dedicated to the elderly population, and the intervention will be represented by exposure to screens. All aspects related to mental

health will be considered as outcomes, including measures related to mental well-being, like life satisfaction, provided they are properly evaluated. Inclusion Criteria were (1) Articles that directly assessed potential effects related to screen time [i.e., the amount of time spent using a device with a screen, such as a television (TV), personal computer (PC), smartphone, or video game console for entertainment or educational use] and mental health (ie, at least one dependent variable assessed); (2) studies that measured mental health outcomes; (3) studies with older people (60 years or more); (4) articles in English, published in the last 10 years to have a more recent view about screen use. While the exclusion criteria were: (1) studies carried out with elderly people previously diagnosed with problematic internet use, (2) sample composed of elderly people already diagnosed with mental health problems or being followed up in mental health/psychiatry outpatient clinics, (3) research that screen-based were used to aid functionality and (4) case reports and case series.

The search and sorting procedure were performed in pairs, independently. The articles eligible for full reading were selected, the authors applied the exclusion criteria, discussed the results, and reached a consensus on which articles would remain in the review. Any disagreements were resolved by consensus with a third author.

2.1. Data extraction

An extraction table was created containing data such as: first author, date, country of publication, study design, sample characteristics and study objectives, mental health assessment, measures of screen exposure time, and main associations.

2.2. Quality Assessment

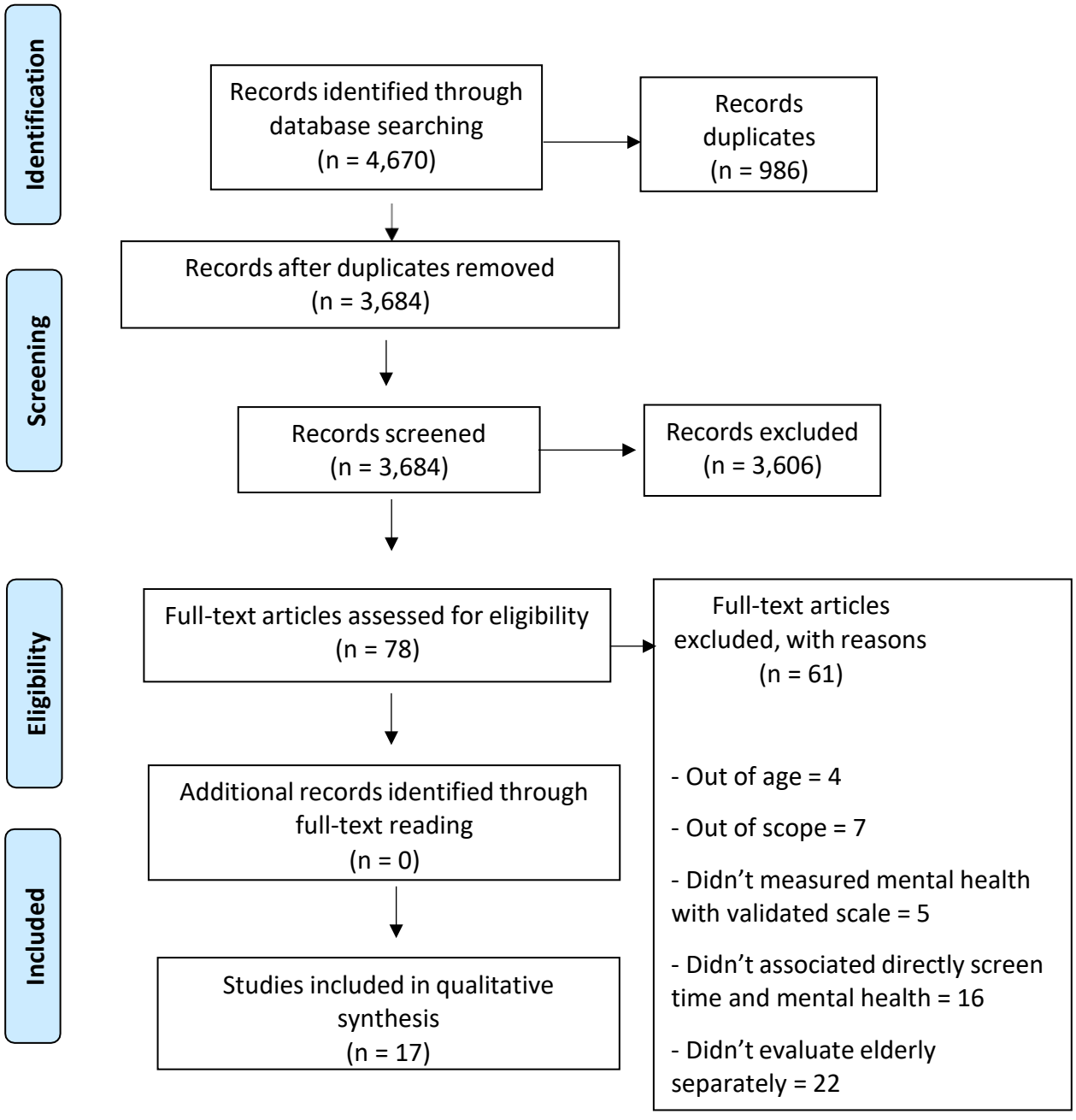
The quality of prospective cohort studies was assessed using the Newcastle-Ottawa Scale (Wells et al., 2021). For cross-sectional studies, the adapted Newcastle-Ottawa Scale was used (Herzog et al., 2013). The evaluation was performed in pairs and discrepancies were resolved by consensus with the third reviewer. The maximum score (9 points) represents high methodological quality (Herzog et al., 2013).

3. Results

A total of 4,670 records were identified in the databases through the search strategy. Nine hundred eighty-six duplicates were removed, and 3,684 articles were screened by title and abstract. After the screening, 3,606 articles were excluded for not

meeting the pre-established criteria. Thus, 78 articles were read in full, of which 17 fully met the criteria (Figure 1).

Fig. 1. PRISMA Flowchart.



3.1. Study characteristics

The 17 included studies were published between 2013 and 2022, with a total of 33,911 participants. This sample was distributed as follows: 5,504 in 3 studies in China, 2,828 in 3 studies in Japan, 1,001 in 3 studies in Australia, and 9,645 in 2 studies in

England. The remaining participants were distributed in only one study from each location below: 11,177 in the study from Brazil, 1,202 from Scotland, 810 from Croatia, 696 from Belgium, 673 from the United States of America (USA) and 375 participants in the study from Canada. Representing the global south, only 4 studies were reviewed. As for the study design, 4 were longitudinal and 13 were cross-sectional. Table 1 summarized the articles included.

Table 1. Descriptive characteristics of the included studies.

Author, year, country, type of study	N / Age / Gender / Purposes	Mental Health assessment	Screen Time measurements	Main associations
Compernolle et al., 2021 Belgium Cross-sectional	N = 696 Age = mean 74,2 years 74.6% women Identify sex-specific typologies of sedentary behavior (SB) in the elderly. Examine the association between sex-specific typologies and health outcomes.	Quality of life (QoL) related to physical and mental health: SF-12.	Self-report of the number of days that a particular SB (television time - TV, personal computer time - PC) was performed in the past 7 days and the average time the participant engaged in that SB on that day. Self-report of how much time participants generally spent on one of the SB during the past 7 days on a weekday and on a weekend day.	No overall significant difference found between mental health (MH)-related QoL and typologies encompassing screen time (ST) (PC and TV) in men (p=.270). Typologies characterized by high TV time seem to be related to more negative health outcomes, such as lower QoL related to MH. Men highly engaged in PC use had a higher MH-related QoL score (p=.09).
Gardner et al., 2014 England Longitudinal	N = 6,090 Age = mean 64.9 years 54,8% women To describe changes in TV viewing over a two-year follow-up period and to model sociodemographic, behavioral, and health factors associated with observed changes in viewing time.	Depressive symptoms: 8-item Centre of Epidemiological Studies Depression (CES-D) scale	Self-reported: "How many hours of TV do you watch on a normal weekday or evening, on the weekend, and in total. Average daily TV viewing data were classified into 4 categories (<2 h/d, 2 < 4 h/d, 4 < 6 h/d, ≥6 h/d).	Participants in the higher TV categories reported more depressive symptoms (p<.001). Participants with depressive symptoms increased TV viewing more than those without (B=0.43 [0.12, 0.74], p=.007). Medium effect sizes
Guo et al., 2021 China Cross-sectional	N = 47 Age ≥ 65 years 56,5% women Examine the associations of time spent on general and specific screen-based activities with problematic smartphone use (PSU) and its addiction symptoms.	Short Version of the ten-item Smartphone Dependence Scale (SAS-SV). Patient Health Questionnaire (PHQ-4)	Screen time was self-reported as the average hours per day spent on the Internet, online book/newspaper/magazine, online video, and social networking sites (SNS).	Positive association of SNS time with PSU severity (adjusted β = 2.87, 95% CI 0.95, 4.80; p<0.01). Large effect size

Jackson et al., 2019 England Cross sectional	N = 3,555 Age = mean 68.3 years 66,4 % women To analyze the association between sedentary behavior (operationalized as daily TV viewing time, a proxy for total sedentary time and hair cortisol concentration using data from a large population-based sample of older adults.	Stress: A lock of hair at least 2 cm long and weighing at least 10 mg was collected from the participants' posterior vertex, cut as close to the scalp as possible. The steroid washing and extraction procedure was performed using high-performance liquid chromatography-mass spectrometry, as described by Assuming an average hair growth of approximately 1 cm per month, the closest hair segment to the scalp of 2 cm represents an average cortisol accumulated over an approximate time period of 2 months prior to sampling. Depression: CES-D	TV viewing time was assessed with two questions: "How many hours of television do you watch on an ordinary day or evening, that is, Monday to Friday?" and "How many hours of TV do you normally watch in total over the weekend, that is, Saturday and Sunday?" Average daily time spent watching TV was calculated as [(weekday TV time x 5) + (weekend TV time)]/7. Daily TV time was categorized into four groups (<2 h/day; 2 to < 4 h/day; 4 to < 6 h/day; ≥6 h/day), as has been done in previous investigations.	In the unadjusted analysis, there was a small, but not significant, difference in hair cortisol concentration between groups, with hair cortisol increasing with increasing TV viewing time (p=.088). The mean hair cortisol concentration of the group watching ≥6 h/day (0.934 log pg/mg) was 8.4% higher than that of the watching <2 h/day group (0.862 log pg/mg). No significant difference in mean hair cortisol concentration between the groups watching less vs. more TV per day (p=.663).
Kaviani et al., 2020 Australia Cross-sectional	N = 772 Age ≥ 60 years 52,9% women To explore the relationship between nomophobia and PSU to determine if the fear of being without one's phone can predict problematic behavior such as dangerous, prohibited and dependent use.	Problematic Mobile Phone Use: The PMPUQ-R is a 16-item Severity of nomophobia, or psychological attachment: Nomophobia Questionnaire (NMP-Q)	Daily time spent using a smartphone use was measured by asking participants how many hours per day, on average, they spent using their smartphone.	Age was strongly negatively correlated with problematic and dependent cellphone use (p=.001), with large effect size. All degrees of nomophobia were significant predictors of dependent smartphone use, with small effect size Participants over the age of 60 were less likely to experience moderate (39.2%) or severe (5.4%) levels of nomophobia (p<.001), with small effect size. Seniors were 91% less likely to engage in prohibited smartphone use and 70% less likely to engage in hazardous smartphone use (p=.001), with small effect size.
Khin et al., 2021 Japan Cross-sectional	N = 653 Age ≥ 65 years 39,8% women The aim of this study was to determine the association between work and non-work Visual Display Terminals (VDT) usage time and self-rated health and psychological distress among office workers during the COVID-19 pandemic.	For psychological distress, we used the validated Japanese version of the K6 psychological screening tool for anxiety and mood disorder.	The VDT usage from June to September 2020 was categorized as less than 1, 1–3, 4–9, and 10 h or more per day.	For ages > 65 years there was no association between VDT use for < 9 h per day with psychological distress and for ≥ 10 hrs daily use was not demonstrated.

Kikuchi et al., 2014 Japan Cross-sectional	N = 1,580 Age = mean 69.5 years 47,7% women To identify categories of leisure time sedentary behaviors (LTSBs), and to examine their separate associations with indices of health and well-being.	Psychological distress was measured using the K6 scale	Leisure time sedentary behaviors (LTSBs) were determined from participants' self-reported frequency and average duration (minutes/day) over the past 7 days. Participants were asked about five types of LTSBs—TV viewing, PC use, reading books or newspapers, listening or talking while sitting, and sitting around.	Higher passive sedentary time (TV or DVD viewing) was associated with a higher likelihood of being in greater psychological distress ($p<.01$). However, the association between higher passive sedentary time and psychological distress became non-significant after adjusting for Moderate to Vigorous Physical Activity (MVPA) (OR=1.53; 95% CI=0.99-2.36). Small effect size.
Meyer et al., 2021 USA Longitudinal	N = 673 Age ≥ 65 years 63,8% women To evaluate the associations between behavioral changes and changes in MH over time during the initial phase of the initial wave of the pandemic.	Beck Anxiety Inventory (BAI) Beck Depression Inventory-II (BDI-II) Warwick-Edinburgh Short Mental Well-Being Scale (SWEMWBS-7)	Self-reported current daily average minutes of screen time.	Screen time was negatively associated with positive MH (MHP) and positively associated with depressive and anxious symptoms ($p<.05$), with small, large and large effect sizes, respectively.
Nguyen et al., 2022 Japan Cross-sectional	N Subsample ≥ 65 = 595 17,1% women N Total = 2630 Age = 22 to 87 years Understanding the correlation between smartphone use and loneliness under the effects of the COVID-19 pandemic.	Loneliness measured by the UCLA scale	Smartphone use was measured in min/day by asking survey participants a question.	Negative association between smartphone use and loneliness ($p<.01$), with small effect size.
Olds et al., 2018 Australia Longitudinal	N = 105 Age = mean 62.3 years 51,4% women To describe changes in time use across the retirement transition; to determine whether these changes were associated with changes in MH; and to describe the relative effects of replacing work time with time from other activity domains, such as PA, sleep and ST.	Depression, Anxiety and Stress Scales (DASS21) Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS) Australian Unity Personal Well-being Index (AUPWI) Rosenberg Self-Esteem Scale	Participants recalled the use of ST with Multimedia Activity Recall for Children and Adults (MARCA)	With retirement, reductions in work and commuting time were offset by significant increases in ST ($p<.0001$). MH improved, with significant reductions in DASS-21 total score, depression and stress ($p\leq.0001$) and improvements in well-being ($p<.0001$) and self-esteem ($p=.01$). Substitution of work time with ST showed smaller effect size than sleep or PA in improving MH. Medium effect sizes.

Olds et al., 2016 Australia Longitudinal	N = 124 Age = mean 62 years 50,8% women To explore the associations between time use and momentary hedonic affect ('pleasure') in adults in the peri-retirement period.	UCLA Loneliness Scale, Australian Unity Wellbeing Index. Participants were asked how much they enjoyed each activity using a scale ranging from 0 ('I hated it!') to 10 ('I loved it!') and a pleasure index was generated for the sets of activities. Sleep quality measured with a 4-point scale.	Use of the Multimedia Activity Recall for Children and Adults (MARCA), a 24-hour computer-assisted time use recall, to capture activity profiles. The adult version of the MARCA has test-retest reliability in adults for major domains such as sleep, physical activity (PA), and ST.	Changes in the overall Pleasure Index between pre-retirement and 12 months after retirement were not related to loneliness, well-being, or sleep quality at baseline. For ST (TV and video games), there was no significant change in the Activity Pleasure Index before and after retirement. For PC use for work, there was significant change with increased enjoyment index after retirement ($p<.0001$). Small effect sizes.
Štefan et al., 2019 Croatia Cross-sectional	N = 810 Age ≥ 85 years 83,7% women To explore the association between domain-specific SB (ST, SB at leisure and transportation) and total SB (sum of all indicators) with "high" psychological distress in the elderly.	Kessler's 6-item scale (K6) for assessing the level of psychological distress.	Sedentary Behavior Questionnaire Measure of Older Adults' Sedentary Time to assess time spent in a specific domain of sedentary behavior (screen time)	Psychological distress and screen time negatively associated with each other ($r = -0.14$, $p<.001$). Small effect size.
Sun et al., 2022 China Cross-Sectional	N = 4,700 Age ≥ 65 years 56,1% women Distinguish the association between different levels of ST at night and sleep quality in different age groups.	Sleep quality: Pittsburgh Sleep Quality Index (PSQI).	Averaged Evening screen time (AEST). All participants were asked if they used electronics in the evening hours. They were asked about the average time per day that they used electronic products	In the 65+ age group, AEST of more than 2 h/day was associated with poor sleep quality ($p<.001$). ≤3 h/day ($\beta=0.92$, $p<.001$) and > 3 h/day ($\beta=1.90$, $p<.001$) were at higher risk for poor sleep quality compared to participants who used screen ≤ 1 h/day at night. Small effect size.
Tomaz et al., 2021 Scotland Cross-Sectional	N = 1,202 Age ≥ 60 years 77% women Examine the impact of social withdrawal during the pandemic on loneliness and well-being.	Loneliness: Short form of the UCLA loneliness scale, the ULS-6. Well-being: EQ5D-3L Perceived social support: brief perceived social support questionnaire (BPSSQ), 6-item scale.	Screen time was reported as an average time per day over the past seven days.	Screen time showed no significant relationships with mean loneliness score (UCLA) and with well-being and perceived social support.

Vallance et al., 2013 Canada Cross-sectional	N = 375 Age = mean 65.3 years 100% older men. To determine associations of total sitting time with Health-related quality of life (HRQoL) across both weekdays and weekend days among a sample of older men. To describe the domain-specific sitting behaviors (watching TV, using a PC at home) across both weekdays and weekend days among a sample of older men.	HRQoL: was assessed using the four-week version of the Health Status Inventory (RAND-12) which provides a mental health component scale (MHC), a physical health component scale (PHC), and a global health score (GHC).	Sitting was assessed using a total and domain specific measure of sitting that included five items assessing time spent sitting (hours and minutes) each day in the following domains: a) while traveling to and from places, b) while at work, c) while watching television, d) while using a computer at home, and e) at leisure not including watching television, on a weekday and a weekend day.	Sitting while watching TV on the weekend compared to the weekday (p<.001). Sitting while using the PC on the weekday compared to the weekend (p<.01). For day of the week, all three adjusted HRQoL models (physical, mental, and global health) indicated no significant differences in HRQoL scores across weekday sitting time quartiles (all p's > .36). Less sitting time on the weekend showed better HRQoL scores related to MH (p<.05) and global health (p<.05).
Werneck et al., 2018 Brazil Cross-sectional	N = 11,177 Age ≥ 60 years 59,2% women Examine the relationship between symptoms of depression and time spent watching TV.	Depression was assessed using the nine items of the Patient Health Questionnaire-9 (PHQ-9)	TV viewing was estimated using the question: "How many hrs a day do you usually spend watching TV? The time in hours was classified into categories: 6 non-collapsed and 3 collapsed.	Women: there was no significant association between TV viewing and MH indicators. Men: risk of depression with less than 1 and 2 hrs, and from 2 to 4 hrs of TV p/day (p<.05). Suicidal feelings from 4 to 5 hrs of TV p/day (p<.05). Small effect sizes.
Xie et al., 2020 China Cross-sectional	N (45-64 years) = 561 57% women N (≥ 65) = 196 52,5% women N Total = 1,500 Understand the characteristics of TV viewing, PC use, and cellphone use, and examine their roles in predicting variations in sleep quality.	Sleep: Pittsburgh Sleep Quality Index (PSQI)	Respondents were asked how many days they spent watching TV or using a PC and mobile phone in 1 week and the duration they spent on TV viewing and PC and mobile phone usage on a typical day (minutes or hours/day). Minutes were converted to hours and recorded to the nearest 0.1 hours.	Those with 1.5-2.5 h of TV (P<.001) and 2.0-2.4 h of PC use (p=.009) had the lowest PSQI scores. No significant difference was observed between PSQI scores and cell phone users (p=.23), among the different age groups. Significant negative associations of sleep quality with the durations of TV (p=.003) and PC (p<.001) use, but not cellphone (p=.12) use.

3.2. Participants characteristics

To gather as much data as possible, studies that included populations of other ages were included, but only data about the elderly were included. In study Nguyen et al., (2022), there was a large age range among the 2,630 participants from 22 to 87 years old, so only the subsample of 595 participants aged over 65 years was considered for this review. Only in 4 studies were men the majority (Khin et al., 2021; Kikuchi et al., 2014; Nguyen et al., 2022; Qu et al., 2022) and the study (Vallance et al., 2013) was performed only with elderly men.

3.3. Screen time assessment

Screen time was considered as TV watching and all other screen-based activities (Meyer et al., 2021; Tomaz et al., 2021), or restricted it to watching TV only (Gardner et al., 2014; Jackson et al., 2019; Werneck et al., 2018), TV and computer use (Compernolle et al., 2021; Kikuchi et al., 2014; Vallance et al., 2013) or mixed hours using TV, or computer and cell phone use (Xie et al., 2020). To recall time spent on screens, some studies used the Measure of Older Adults' Sedentary Time (Štefan et al., 2019), a self-report questionnaire to assess time spent with screen devices, and the Multimedia Activity Recall for Children and Adults (MARCA), which is computer-assisted and profiles activities (Olds et al., 2018; Olds et al., 2016). Screen time was represented by the self-reported daily time spent using the smartphone (Kaviani et al., 2020; Nguyen et al., 2022), or by the daily hours spent on the internet, videos, and social networks (Guo et al., 2021). There was a study that evaluated only the prospective use of the Visual Display Terminal (VDT) (Khin et al., 2021) and another that addressed the use of electronic devices specifically at night, in addition to the hours spent on screens during the day (Sun et al., 2022).

3.4. Mental health assessment

The mental health outcomes that received the most attention in the reviewed studies were depressive symptoms (Gardner et al., 2014; Meyer et al., 2021; Olds et al., 2018; Werneck et al., 2018), loneliness (Nguyen et al., 2022; Olds et al 2016; Tomaz et al., 2021) quality of sleep (Olds et al., 2016; Sun et al., 2022; Xie et al., 2020), psychological distress (Khin et al., 2021; Kikuchi et al., 2014; Štefan et al., 2019) anxiety (Meyer et al., 2021; Olds et al., 2018) and stress (Jackson et al., 2019; Olds et al., 2018). Some studies explored aspects related to mental well-being (Compernolle et al., 2021; Meyer et al., 2021; Olds et al., 2018; Olds et al., 2016; Tomaz et al., 2021) and two studies evaluated problematic smartphone use (Guo et al., 2021; Kaviani et al., 2020), and in the study of 55 the severity of nomophobia was also evaluated. About assessment, only loneliness and psychological distress were uniformly assessed across studies using the University of California, Los Angeles (UCLA) Loneliness Scale and the 6-item Kessler Scale (K6), respectively. Depression was assessed using different scales, among the reviewed studies, such as the Center for Epidemiological Studies Depression Scale (CES-D), Beck Depression Inventory II, Patient Health Questionnaire-9 (PHQ-9) and Anxiety and Stress 21-item scale (DASS-21). Anxiety was measured by K6 and the Beck Anxiety Inventory and stress was assessed by (DASS-21) and objectively by capillary cortisol

(Jackson et al., 2019). Regarding aspects of positive mental health, the scales of quality of life related to physical and mental health SF-12, Warwick-Edinburgh Mental Well-Being Scale (WEMWBS), Self Steem Scale Rosenberg, Australian Unity Personal Wellbeing Index (AUPWI). About problematic smartphone use, the scales used were Problematic Mobile Phone Use (PMPUQR), Nomophobia Questionnaire (NMP-Q) and short version of Smartphone Addiction Scale (SAS-SV) were used.

3.5. Associations between screen time and mental health

3.5.1. When no changes were identified

In this review, screen time was sometimes included in the concept of sedentary lifestyle, that is, considered as sitting time, or sedentary behavior. Within the scope of the results that did not show markedly positive or negative evidence for mental health, it was observed that for the day of the week, mental health did not show differences in the quartiles of sitting time (all p's > .36) (Vallance et al., 2013). In another study, the association between higher passive sedentary time and psychological distress became non-significant after adjustment for moderate to vigorous physical activity (OR=1.53; 95% CI=0.99 –2.36) (Kikuchi et al., 2014). No significant difference was found in the results of QoL related to mental health among the five types of activities identified, also in one study (Compernolle et al., 2021).

In the study by Werneck et al. (2018), there was no significant association between TV viewing and mental health indicators in women. Jackson et al. (2019) investigated the influence of TV viewing on stress levels, measured by capillary cortisol. No difference in the mean concentration of capillary cortisol was observed between the groups that watched less vs. more TV a day (p=0.663) (Jackson et al., 2019).

One study investigated the influence of using display terminals at work on different age groups. For the elderly population, no association was found between psychological distress within 9 hours of using the VDT. However, when the researchers analyzed the use of terminals for non-work activities, adjusting for hours already worked, they found a positive association between the use of these terminals and psychological distress (p=0.04) (Khin et al., 2021).

About possible changes in the pleasure index when performing screen-based activities, between pre-retirement and 12 months after, no significant changes were found in the activity pleasure index before and after one year of retirement (Olds et al., 2016).

In one study, the screen time did not show significant relationships with loneliness or well-being (Tomaz et al., 2021), and no significant difference was observed between sleep quality scores in cellphone users, in one study ($p=0.23$) (Xie et al., 2020).

When mental health showed worsening

In Kikuchi et al. (2014), watching TV or DVD was considered as passive sedentary time, and longer time was associated with a greater probability of greater psychological difficulty. A study that evaluated only older men found a significant difference between screen time during the week and weekends, both for TV ($p<0.001$) and for computer ($p<0.01$). Those who reported less time sitting on the weekend had better quality of life indices related to mental health ($p<0.05$) and overall health ($p<0.05$), compared to older men with longer sitting times (Vallance et al., 2013). Typologies of activities characterized by high television viewing seem to be related to more negative health outcomes, such as lower quality of life related to physical and mental health (Compernolle et al., 2021).

In research by Werneck et al. (2018), associations between screen time hours and mental health were evident among men. They showed an increase in the risk of depression from less than 1 h (1.87/1.04-3.36) to 4 h of TV per day (0.50/0.32-0.80), with between 4 and 5 h of TV per day also coursing with suicidal feelings (0.32/0.11-0.90), (95% CI). Another study that addressed TV viewing was by Gardner et al. (2014), participants classified as in higher TV times categories report more depressive symptoms ($p<0.001$) and participants with depressive symptoms increased more TV viewing than those without symptoms (B=0.43 [0.12, 0.74], $p=0.007$). The Xie et al., 2020 study found significant negative associations between sleep quality and duration of TV ($p=0.003$) and computer use ($p<0.001$).

Some studies did not distinguish between devices, considering only the total screen time. Replacing work time with screen time showed a smaller effect size than sleep or physical activity in improving mental health (Olds et al., 2018). In the age group of 65 years and older, averaged evening screen time (average night screen time) AEST of more than 2 h/day was associated with poor sleep quality ($p<0.001$). ≤3 h/day ($\beta=0.92$, $p<0.001$) and > 3 h/day ($\beta=1.90$, $p<0.001$) were at greater risk of poor sleep quality compared to participants who used screen ≤ 1 h/day at night (Sun et al., 2022). Screen time was negatively associated with mental health positive (MHP) and positively associated with depressive and anxious symptoms ($p<0.05$) (Meyer et al., 2021).

In an investigation on the use of cell phones and social networking sites, nomophobia was a significant predictor of dependency on smartphone use. The greater the nomophobia, the greater the probability of occurrence of problematic dependent behaviors (Kaviani et al., 2020). Nomophobia is a psychological condition of discomfort and anxiety, caused by the fear of being disconnected from others through smartphones (Guimarães et al., 2022). Association of social networking sites (SNS) time with the severity of smartphone use (PSU) $p<0.01$. adjusted $\beta=2.87$, 95% CI 0.95, 4.80 (Guo et al., 2021).

3.5.2. When mental health showed improvement

There are results in which screen time was associated with positive aspects of mental health. In the study by Štefan et al. (2019), psychological distress and screen time were negatively associated ($r= -0.14$ / $p<0.001$), meaning that the more time spent in front of screens (television and computer/tablet), the lower the levels of psychological distress. They also found a significant increase in the pleasure index in using the computer for work after retirement ($p<0.0001$) (Olds et al., 2016). With retirement, Olds et al. (2018) found that reductions in working time and transportation were offset by a significant increase in screen timing ($p<0.0001$). In addition, they also found improvements in mental health, with significant reductions in depression and stress scores ($p\leq0.0001$) and improvements in well-being ($p<0.0001$) and self-esteem ($p=0.01$) (Olds et al., 2018).

Loneliness and problematic cell phone use were also investigated in the elderly. In one study, age was strongly negatively correlated with problematic and dependent cell phone use ($p=0.009$). Participants over age 60 were less likely to experience moderate (39.2%) or severe (5.4%) levels of nomophobia ($p<0.001$), and older adults were less likely to engage in problematic drug use. smartphones ($p=0.001$) (Kaviani et al., 2020). Another study found a negative association between smartphone use and loneliness ($p<0.01$) (Nguyen et al., 2022).

3.6. Quality Assessment

The summary of the methodological evaluation of the articles included in this review is presented in Table 2, according to the items of the Newcastle-Ottawa scale for observational studies. Most studies had high methodological quality, with a total score above 7. Recurrent problems among studies were the lack of a group not exposed to

screens, the lack of representative samples in cohort studies, in addition to the lack of objective measurement of screen time.

Table 2. Methodological evaluation by Newcastle-Ottawa Scale for observational studies.

References	Design	Selection	Comparability	Outcome	Total
Compernolle et al., 2021	Cross-sectional	4	2	3	9
Gardner et al., 2014	Prospective Cohort	2	2	3	7
Guo et al., 2021	Cross-sectional	2	2	3	7
Jackson et al., 2019	Cross-sectional	3	2	3	8
Kaviani et al., 2020	Cross-sectional	3	2	3	8
Khin et al., 2021	Cross-sectional	3	2	3	8
Kikuchi et al., 2014	Cross-sectional	4	2	3	9
Meyer et al., 2021	Prospective Cohort	2	2	3	7
Nguyen et al., 2022	Cross-sectional	3	2	3	8
Olds et al., 2018	Prospective Cohort	2	2	3	7
Olds et al., 2016	Prospective Cohort	2	2	3	7
Štefan et al., 2019	Cross-sectional	2	2	3	7
Sun et al., 2022	Cross-sectional	3	2	3	8
Tomaz et al., 2021	Cross-sectional	3	2	3	8
Vallance et al., 2013	Cross-sectional	3	2	3	8
Werneck et al., 2018	Cross-sectional	3	2	3	8
Xie et al., 2020	Cross-sectional	3	2	3	8

Strong evidence: high quality studies 6/9; Moderate evidence: low-quality studies and/or one high quality study 4-5/9; Limited evidence: lower quality study < 4.

4. Discussion

The increasing use of screens increased exposure to content and time spent raises concerns. The aim of this review was to gather and examine evidence about associations between screen exposure and mental health in older people. We observed that the terms screen time and sitting time were recurrently used interchangeably (Compernolle et al., 2021; Jackson et al., 2019; Kikuchi et al., 2014; Štefan et al., 2019; Vallance et al., 2013). In the elderly population, there is great concern about sedentary time and its associations,

first with physical health, and less robustly with mental health (Stubbs, et al., 2018). It must be considered, however, that this is an important concern. Even if the elderly person meets the guidelines for daily physical activity, they can spend up to 90% of their remaining waking hours in a sitting position (Dunstan, et al., 2021). So, screen time has been considered sedentary time, as it is linked to the sitting position or very low energy expenditure and its implications (Tremblay et al., 2017). Sedentary time is positively associated with mental health problems, which supports the concern with levels of movement in this population (Hamer and Stamatakis, 2014; Vancampfort et al., 2020). Recently two coin sides must be addressed, a decrease in movement levels, and an increase in screen time and how long it stands (Hall et al., 2021).

4.1. *Screens and mental health: negative aspects*

A larger number of investigations found unfavorable associations between screen time and the mental health of the elderly (Compernolle et al., 2021; Gardner et al., 2014; Guo et al., 2021; Kaviani et al., 2020; Kikuchi et al., 2014; Meyer et al., 2021; Olds et al., 2018; Sun et al., 2022; Vallance et al., 2013; Werneck et al., 2018; Xie et al., 2020). Screen time as passive sedentary time was associated with greater psychological difficulty (Kikuchi et al., 2014), worse quality of life related to mental health (Compernolle et al., 2021; Compernolle et al. al., 2013; Vallance et al., 2013), depressive and anxious symptoms, and lower positive mental health (Meyer et al., 2021). Indeed, there is a growing body of evidence of the deleterious effects of screen time on mental health, particularly related to prolonged passive sedentary behavior and an increased risk of depressive symptoms (Hamer and Stamatakis, 2014; Wang et al., 2022a).

It remains unclear whether all types of sedentary behaviors increase the risk of depression (Wang et al., 2022a). It appears that cognitively stimulating sedentary behavior is associated with better mental health (Hamer and Stamatakis, 2014). A possible basis for this difference lies in the fact that watching TV is associated with the perception of loneliness and screen devices with internet access represent greater possibilities for social interactions, which can minimize loneliness (Fingerman et al., 2022; Kusumota et al., 2022). Besides some controversial findings, most studies show the positive effect of technologies on loneliness and well-being (Khosravi et al., 2016; Noone et al., 2020; Pandya and Lodha, 2021; Tomaz et al., 2021). As a legacy of social distancing, however, it is possible that screen time does not negatively interfere so significantly with mental

well-being, since it emerges as a way to remain socially connected (Pandya and Lodha, 2021).

Interestingly, when Werneck et al. (2018) investigated the effects of hours in front of the TV, only men were at risk of depression, including also report suicidal feelings, after 4 hours of TV a day. More time older men spent in front of screens was related to worse quality of life (Vallance et al., 2013). These data were more consistent among men, perhaps due to women's multitasking skills (Szameitat et al., 2015) that is, engaging in active sedentary behavior while watching TV may have been a protective factor in this case (Hamer and Stamatakis, 2014; Wang et al., 2022b). In addition, depending on the culture in which women are inserted, it seems that being a multitasking woman can represent happiness, depending on religion (Rosli et al., 2020).

Multitasking is part of people's daily lives, for example when we talk while driving a car (Bock et al., 2019). But performance generally declines with aging, both for cognitive and motor reasons (Mack et al., 2022). The reasons why women are more multitask may be related to evolutionary advantages, due to the management of children and home and/or family and work (Szameitat et al., 2015). However, justifications based on gender are not unanimous (Hirsch et al., 2019). Additionally, it is possible that anxious or depressed people use various electronic media devices as a strategy to avoid experiencing negative emotional states (Becker et al., 2013). Currently, older adults, who already are using new forms of communication technology, such as smartphones, might be using a strategy to add pleasure, focus and productivity to their activities, as well as helping to manage loneliness (Brasel and Gips, 2011; Kononova et al., 2019).

When it comes to screens, sleep also becomes a concern among the elderly (Gyasi et al., 2022; Nakshine et al., 2022). The use of screen-based devices before bed is growing, negatively impacting the quality of sleep (Zhang et al., 2021). The use of devices such as TV and computers, especially at night are related to compromise at the sleep quality (Sun et al., 2022; Xie et al., 2020). Chronic sleep deficiency can occur due to primary sleep disorders or induced by some behavior (Dong et al., 2022; Mader et al., 2022; Pandya and Lodha, 2021). Our findings also showed that replacing work time with screen time in retirement led to a smaller effect size than sleep in improving mental health (Olds et al., 2018).

In addition to sleep problems, the literature has also shown associations between increasing use of social media in bed and mood dysfunction (Bhat et al., 2018). As they are small, the use of smartphones in bed is quickly becoming common (Kheirinejad et al., 2022). Here, the few negative data involving smartphones in this population pointed to the possible development of problematic use behaviors (Guo et al., 2021; Kaviani et al., 2020). Nomophobia was a significant predictor of dependent smartphone use, the greater the nomophobia, the greater the probability of occurrence of problematic dependent behaviors (Kaviani et al., 2020). In addition, there was also an association between time on social networking sites and the severity of problematic smartphone use (Guo et al., 2021). Problematic smartphone use is characterized by a desire to use the smartphone, recurrent and difficult to control, which impairs the individual's daily functioning (Busch et al., 2021). While how seniors engage with their smartphones is still being studied, it is important to note that it can also lead to more serious consequences such as dangerous driving and psychopathologies (Abdon et al., 2022; Busch and McCarthy, 2021).

While most studies encourage the use of smartphones as a path to positive results in the mental health of the elderly (Li et al., 2022; Sagong and Yoon, 2022), we detected that it can be a double-edged sword, increasing the chances of dependence on these devices (Busch et al., 2021) and health compromise (Guo et al., 2021; Kaviani et al., 2020).

4.2. *Screens and mental health: positive aspects*

It is already established that interaction with screens can bring benefits to the mental health of the elderly (Cotten et al., 2014; Teng, 2022), even more significant than for physical health (Fu and Xie, 2021). In this review, more screen time also minimized psychological distress (Štefan et al., 2019). After retirement, when the elderly were able to replace work time with screen time, there was a significant increase in the pleasure index in using the computer for work (Olds et al., 2016), in addition to significant reductions in depression, stress and depression scores. improvements in well-being and self-esteem (Olds et al., 2018). In fact, working in old age can positively impact mental health, because work is a symbol of identity and personal status (Xie et al., 2021). Furthermore, people over 65 years old are less likely to develop mental health problems compared to adults between 20 and 35 years old (Madhav et al., 2017). Additionally, it appears that cognitively stimulating sedentary behavior is associated with better mental health (Hamer and Stamatakis, 2014). In fact, pleasure in screen time has already been

linked to positive emotions (Wang and Vella-Brodrick, 2018). The pleasure in interacting with screens can perhaps be explained because the “baby-boomers” generation, born in the 1960s, that is, not digital natives, are enjoying retirement, free from the pressure of schedules and goals to meet (Xie et al., 2021).

Although the widespread use of smartphones suggests the risk of developing dependence, it seems that among the elderly this use has not yet been considered problematic (Busch et al., 2021). Studies have shown that the intense use of smartphones alone does not negatively impact well-being, especially in old age (Katevas et al., 2018; Bertocchi et al., 2022). Here, Kaviani et al. (2020), investigated problematic cell phone use and concluded that older adults are less likely to experience nomophobia and problematic and dependent cell phone use. High smartphone use does not necessarily mean that a person engages in USP, that is, the self-control characteristic of older people can influence the level of engagement in problematic technology use (Busch et al., 2021). It is also argued that the recurring visualization of the cell phone may only be about solving everyday problems (Busch and McCarthy, 2021). It was further found that people who use their smartphones to read the news are less likely to engage in USP than those who use them for entertainment (Lin et al., 2017). Other positive results in the mental health of the elderly were found: owning a smartphone showed positive effects on life satisfaction compared to the group without cell phones (Sagong and Yoon, 2022). Reduced level of depression with internet use (Yang et al., 2022). The greater importance of the smartphone in life correlated with less depressive symptoms and less loneliness (Bertocchi et al., 2022).

Likewise, the intensity of cell phone use, especially for social media, is positive in terms of reducing social isolation and loneliness among the elderly (Khosravi et al., 2016). Loneliness can be defined as the feeling of being alone, while social isolation is objectively the lack of social connections with other people (Thangavel et al., 2022). In fact, in that review there was a negative association between smartphone use and loneliness (Nguyen et al., 2022). Old age is a phase in which the individual is particularly subject to feelings of loneliness, as in the empty nest syndrome (when children leave their parents' home) and widowhood (Wang et al., 2021c). And in this context, information and communication technologies can offer social support, contributing to the mental well-being of the elderly (Ashaari et al., 2022). Children and grandchildren themselves often encourage the elderly to adopt different technologies (Busch et al., 2021).

4.3. *Screens and mental health: no changes*

From the brief data set that did not identify a significant change in the mental health of the elderly, we observed that, even evaluating different devices, some aspects of mental health do not seem to be influenced only by screen time (Jackson et al., 2019; Khin et al., 2021; Olds et al., 2016; Tomaz et al., 2021; Vallance et al., 2013; Xie et al., 2020). Recently reported data also did not identify differences in symptoms of depression, anxiety or stress, quality of life, sleep disturbances or loneliness (Bertocchi et al., 2022).

The elder population is not digitally native exposed, for most this exposition isn't natural. They might transient from living totally away from any screens to individuals with extensive and beneficial exposition to many media (Vaportzis et al., 2017). The elderly represents the most digitally divided age group (Ball et al., 2019). The explanation for the gaps observed in the use of digital technologies, at this stage of life, encompass complex issues in a dynamic process. In addition to simple access to technology, it has been a matter of psychological and emotional repercussions resulting from the lack of contact with such technologies (Dijk and Hacker, 2003; Ball et al., 2019). Furthermore, for skill reasons, an individual with substantial technology experience may use the internet for capital-generating activities, while less experience may lead to internet use only to watch videos (Ball et al., 2019).

Watching TV is the most frequent screen-based activity among the elderly and is the device that most closely relates sedentary behavior in the elderly with screen time (Wang et al., 2022b; Fingerman et al., 2022). Watching TV was defined as a passive sedentary behavior, while internet use, reading and social sedentary behaviors, for example, communication between people and playing chess, were defined as mentally active sedentary behaviors (Wang et al., 2022a). Among the reviewed studies, Werneck et al. (2018) found no significant association between TV viewing and mental health indicators in women. It is known that mentally active sedentary behaviors, mainly of a social nature, can reduce the risk of depression (Wang et al., 2022a). This would partially explain the findings of Werneck et al. (2018) if we consider that women are more involved in maintaining the social connections of family and friends than men (Thomas et al., 2017).

Perhaps the ease of interaction can be an explanation why the TV is still the device most used by the elderly, avoiding the stress of getting involved with devices that are more complicated to use and that require a lot of attention. Here, stress measured through

cortisol did not show a significant difference between the elderly who watched more TV or less (Jackson et al., 2019). This data had already been observed (Teychenne et al., 2019; Teychenne et al., 2018). Apparently, screen time has affected the elderly in a secondary way (Yuan et al., 2016). They experience negative emotions such as frustration, disrespect, and isolation when they are in face-to-face interactions or family gatherings, where people finish their meals and literally "get into their cell phones" (Ball et al., 2019). Although adoption rates and use of screen- and internet-based devices by older adults have increased lately (Kononova et al., 2019), it appears that older adults still prefer face-to-face interaction with their social ties more than others (Yuan et al., 2016).

5. Conclusions

To the best of our knowledge, this is the first review to gather evidence of the influence of screen time on mental health, exclusively among the elderly. Important data were found to broaden the understanding about the interaction of the elderly with screen devices. In 11 studies worsening of some mental health outcomes were found, in 5 studies improvements in some mental health outcomes were found, and in 9 studies some aspect of mental health analyzed showed no change. With what we know so far, there is still no consensus on healthy screen time per day for this population. In general, the elderly have screen time included in their sitting time. TV was the screen device most associated with worsening mental health in the elderly. Smartphones can minimize loneliness and seniors are at less risk for problematic use. This is research that raises a set of relevant data, which can direct the eye in mental health care for the elderly. Further, more robust studies are needed that can establish healthy times of the elderly's interaction with screens.

6. Limitations

The data inventoried here also have some limitations. Self-reported screen time can generate some weakness in the evidence raised, due to the difficulty of reliably remembering the time spent in front of the screens. Screen time included in sedentary behaviors or sitting time may also decrease the accuracy of this variable. Another limitation is related to the lack of sample diversity. Additionally, we have the small effect sizes of the associations found, requiring complementary robust studies.

7. Declarations

7.1. Conflict of interest

The authors report no conflict of interest.

7.2. Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

7.3. Acknowledgments

None.

8. References

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7. DISCUSSÃO

Esta pesquisa em torno da influência do tempo de tela na saúde mental no ciclo vital, reuniu evidências importantes. Além da presença da ansiedade e da depressão, em cada fase do desenvolvimento foi encontrado um conjunto de outros desfechos de saúde mental relacionado. Nas crianças, o tempo de tela influenciou especialmente os comportamentos relacionados ao TDAH, problemas de conduta e de socialização, nos adolescentes o bem-estar mental, a autoestima e a autoagressão, nos adultos o estresse e nos idosos a nomofobia e a solidão. De fato, foram observadas mudanças nos perfis de resposta de saúde mental ao tempo de tela, nas diferentes fases da vida. De forma curiosa, foi encontrada nomofobia entre os idosos e altas taxas de depressão entre as crianças. Idosos fortemente apegados aos seus smartphones e crianças depressivas, de fato causam algum estranhamento. O desenvolvimento humano não se restringe à infância e adolescência, mas continua ativo na idade adulta e na velhice e é diferencialmente impactado. É necessário desenvolver habilidades que o auxiliem em sua capacidade adaptativa (Baltes, 1987).

A perspectiva de ciclo vital apresenta implicações importantes no estudo da saúde mental. Uma delas está relacionada ao atual avanço da compreensão sobre o início e sobre o curso inicial da maioria dos problemas de saúde mental, é comum que o conhecimento na fase avançada da vida, em geral, seja limitado (Videler, Hutsebaut, Schulkens, Sobczak, & van Alphen, 2019). Nesse sentido, o desenvolvimento de instrumentos de avaliação específicos para a idade ou instrumentos neutros para a idade, ou seja, que não sofreriam a interferência da idade (Debast, Rossi, & Van Alphen, 2018), poderia contribuir na concepção de modelos que expliquem o desenvolvimento e possivelmente o curso crônico de problemas de saúde mental ao longo da vida (Videler et al., 2019).

É verdade que nem todas as mudanças do desenvolvimento estão ligadas à idade (Neri, 1995). A aquisição, a manutenção, o aperfeiçoamento e a extinção de comportamentos são processos que podem originar-se em qualquer etapa da vida. Além da influência do contexto, há ainda a importância da plasticidade, ou seja, o potencial de flexibilidade do indivíduo para lidar com novas situações (Staudinger, Marsiske, & Baltes, 1993). Ao longo da vida, o indivíduo pode apresentar capacidade de criar ativamente e reagir aos contextos biológicos, psicológicos e sociais que melhoram ou restringem seu desenvolvimento em uma interação dinâmica com seus recursos disponíveis (Neri, 2007). De fato, segundo o modelo SOC, o potencial desenvolvimental de cada um é alcançado selecionando, buscando e adaptando seus objetivos e metas em resposta às mudanças biopsicossociais ao longo do ciclo vital (Heckhausen & Wrosch, 2010).

Assim, frente à perdas em plasticidade, em adaptabilidade ou em recursos, ou mesmo quando ocorre uma redução nas metas significativas alcançadas, o indivíduo deve acionar processos substitutivos para manter um bom nível de funcionamento em determinado domínio. Dessa forma, quando capacidades comportamentais específicas são perdidas ou encontram-se abaixo do padrão requerido para o funcionamento adequado, a seleção e a otimização tornam-se operativas (Baltes & Baltes, 1991). Esse pode ser um dos mecanismos subjacentes à influência da exposição excessiva às telas no bem estar mental das pessoas. Dependendo, sobretudo, do conteúdo a que se está exposto e da relação de dependência estabelecida com o dispositivo de tela. O que a tecnologia acrescentou em recursos de viabilidade para operacionalizar o cotidiano, pode também ter reduzido em recursos de socialização e otimização das competências exigidas para convívio, como o desenvolvimento da tolerância e da resiliência, que podem ser consideradas evidências de plasticidade que favoreceriam a compensação. O mesmo poderia ser aplicado às metas

e objetivos, com a velocidade da evolução tecnológica e o poder dos algoritmos desenvolvidos, o indivíduo pode ficar envolvido em uma vida virtual com muitas possibilidades, e não conseguir perceber que na vida real sua rotina está cada vez mais restrita.

As interações pessoa-ambiente podem gerar experiências de sucesso, que ajudam a manter os níveis de competência e a desenvolver outros, e podem gerar os fracassos, com potencial para minar as competências existentes. Dessa forma, desenvolvimento de mecanismos de compensação são necessários para proteger o indivíduo das ameaças decorrentes dos fracassos (Baltes, Staudinger & Lindeenberger, 1999). O ambiente é, de fato, uma influência importante. Nessa revisão, a presença das telas mostrou seu impacto. Estamos envolvidos com telas para trabalho, entretenimento e resolução de tarefas da vida diária. O tempo para atividades mais ricas em estímulos de socialização e convivência começou a ficar em segundo plano. As demandas ambientais (incluindo funções e responsabilidades educacionais, ocupacionais, financeiras, familiares e sociais) aumentam em número, escopo e complexidade com a idade, enquanto os recursos de suporte diminuem (Young et al., 2020; Turgay et al., 2012; Videler et al., 2019). Diante dessa realidade, um aspecto importante da otimização é o monitoramento dos efeitos das estratégias aplicadas. O feedback sobre o próprio desempenho é central para o alcance de metas e ajuste dos próprios meios e circunstâncias (Freund, Li & Baltes, 1998). De fato, dada as associações encontradas entre exposição às telas e prejuízos ao bem estar mental, é possível que seja necessário desenvolver habilidades individuais de avaliação do próprio desempenho na vida fora das telas, para desenvolver os ajustes necessários. Essa talvez seja uma estratégia para se conviver de forma mais adequada com o mundo digital.

8. CONSIDERAÇÕES FINAIS

Os resultados confirmaram as hipóteses norteadoras da pesquisa. Na maioria dos artigos analisados foram observados, mais proeminentemente, prejuízos que benefícios à saúde mental. Foram encontradas associações positivas entre tempo de tela e desfechos que demonstram piora da saúde mental e associações negativas entre tempo de tela e desfechos que apontam para melhora da saúde mental. De fato, hoje o termo “tempo de tela” pode não ser o mais adequado para balizar as análises, contudo, a pesquisa alerta para um olhar atento aos conteúdos veiculados com as telas, além da interação dos indivíduos com os dispositivos. Redes sociais podem elicitar emoções prejudiciais à

saúde mental. Smartphones podem ser fator de risco para desenvolvimento de comportamento aditivo, sobretudo em adolescentes e adultos, principalmente pela portabilidade quase vestível dos aparelhos e substituição de outros dispositivos com maiores possibilidades de socialização, como a tela do cinema.

A hipótese de que as respostas à influência do tempo de tela na saúde mental seriam diferentes em cada fase do ciclo vital, também foi confirmada. Além das oscilações observadas na ansiedade e na depressão nas quatro fases, adolescentes apresentaram mais autoagressão, adultos mais estresse, idosos mais nomofobia, já as crianças apresentaram mais problemas de comportamentos. Conhecer os efeitos de exposições ambientais em cada fase da vida, no mesmo corte temporal, provê maiores possibilidades do desenvolvimento de estratégias eficazes para o manejo em cada população. A direção a seguir em pesquisas futuras deve estar alinhada com a ideia de que nos encontramos irremediavelmente envolvidos pelas telas e resta descobrir maneiras de se conviver de forma saudável com essa nova realidade.

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10. ANEXOS

ANEXO I – Newcastle-Ottawa Quality Assessment Form for Cohort Studies

Newcastle-Ottawa Quality Assessment Form for Cohort Studies

Note: A study can be given a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability.

Selection

1) Representativeness of the exposed cohort
   a) Truly representative ***(one star)***
   b) Somewhat representative ***(one star)***
   c) Selected group
   d) No description of the derivation of the cohort
2) Selection of the non-exposed cohort
   a) Drawn from the same community as the exposed cohort ***(one star)***
   b) Drawn from a different source
   c) No description of the derivation of the non exposed cohort
3) Ascertainment of exposure
   a) Secure record (e.g., surgical record) ***(one star)***
   b) Structured interview ***(one star)***
   c) Written self report
   d) No description
   e) Other
4) Demonstration that outcome of interest was not present at start of study
   a) Yes ***(one star)***
   b) No

Comparability

1) Comparability of cohorts on the basis of the design or analysis controlled for confounders
   a) The study controls for age, sex and marital status ***(one star)***
   b) Study controls for other factors (list) _____ ***(one star)***
   c) Cohorts are not comparable on the basis of the design or analysis controlled for confounders

Outcome

1) Assessment of outcome
   a) Independent blind assessment ***(one star)***
   b) Record linkage ***(one star)***
   c) Self report
   d) No description
   e) Other
2) Was follow-up long enough for outcomes to occur
   a) Yes ***(one star)***
   b) No

Indicate the median duration of follow-up and a brief rationale for the assessment above:_____

3) Adequacy of follow-up of cohorts
   a) Complete follow up- all subject accounted for ***(one star)***
   b) Subjects lost to follow up unlikely to introduce bias- number lost less than or equal to 20% or description of those lost suggested no different from those followed. ***(one star)***
   c) Follow up rate less than 80% and no description of those lost
   d) No statement

ANEXO II – Newcastle-Ottawa Scale Adapted for Cross-Sectional Studies

Newcastle-Ottawa Scale adapted for cross-sectional studies

Selection: (Maximum 5 stars)

1) Representativeness of the sample:
a) Truly representative of the average in the target population. * (all subjects or random sampling)
b) Somewhat representative of the average in the target population. * (non-random sampling)
c) Selected group of users.
d) No description of the sampling strategy.

2) Sample size:
a) Justified and satisfactory. *
b) Not justified.

3) Non-respondents:
a) Comparability between respondents and non-respondents characteristics is established, and the response rate is satisfactory. *
b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory.
c) No description of the response rate or the characteristics of the responders and the non-responders.

4) Ascertainment of the exposure (risk factor):
a) Validated measurement tool. **
b) Non-validated measurement tool, but the tool is available or described.*
c) No description of the measurement tool.

Comparability: (Maximum 2 stars)

1) The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled.
a) The study controls for the most important factor (select one). *
b) The study control for any additional factor. *

Outcome: (Maximum 3 stars)

1) Assessment of the outcome:
a) Independent blind assessment. **
b) Record linkage. **
c) Self report. *
d) No description.

2) Statistical test:
a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value). *
b) The statistical test is not appropriate, not described or incomplete.

ANEXO III - Ferramenta avaliação de Risco de Viés Colaboração Cochrane em Ensaios Randomizados - RoB.

Domínio	Suporte para o julgamento	Julgamento do autor da revisão e critérios para julgamento
Viés de seleção 1. Geração da sequência aleatória	Descrever em detalhe o método utilizado para gerar a sequência aleatória, para permitir avaliar se foi possível produzir grupos comparáveis.	**Baixo risco de viés:** Tabela de números randômicos; Geração de números randômicos por computador; Arremesso de moeda; Embaralhamento de cartões ou envelopes; Jogando dados; Sorteio; Minimização. **Alto risco de viés:** Sequência gerada por data par ou ímpar de nascimento; Sequência gerada por alguma regra com base na data (ou dia) de admissão; Sequência gerada por alguma regra baseada no número do prontuário do hospital ou clínica; Alocação pelo julgamento do profissional; Alocação pela preferência do participante; Alocação baseada em resultados de exames ou testes prévios; Alocação pela disponibilidade da intervenção. **Risco de viés incerto:** Informação insuficiente sobre o processo de geração da sequência aleatória para permitir julgamento.
Viés de seleção **2. Ocultação de alocação**	Descrever em detalhes o método utilizado para ocultar a sequência aleatória, para determinarmos se a alocação das intervenções pôde ser prevista antes ou durante o recrutamento dos participantes.	**Baixo risco de viés:** Ocultação de alocação por uma central; Recipientes de drogas numerados de forma sequencial com aparência idêntica; Envelopes sequenciais numerados, opacos e selados. **Alto risco de viés:** Utilizando um processo aberto de randomização (exemplo: lista randômica de números); Envelopes sem critérios de segurança (exemplo: envelopes não selados, ou que não sejam opacos ou que não sejam numerados sequencialmente); Alternância ou rotação; Data de nascimento; Número de prontuário; Qualquer outro procedimento que não oculte a alocação. **Risco de viés incerto:** Informação insuficiente sobre o processo de geração da sequência aleatória para permitir julgamento. Este é o caso se estiver descrito que a ocultação foi realizada utilizando envelopes, mas não estiver claro se foram selados, opacos e numerados sequencialmente.
Viés de performance **3. Cegamento de participantes e profissionais** Avaliação deve ser feita para cada desfecho principal (ou classes de desfechos)	Descrever todas as medidas utilizadas para cegar participantes e profissionais envolvidos em relação a qual intervenção foi dada ao participante. Fornecer informações se realmente o cegamento foi efetivo.	**Baixo risco de viés:** Estudo não cego ou cegamento incompleto, mas os autores da revisão julgam que o desfecho não se altera pela falta de cegamento; Cegamento de participantes e profissionais assegurado, e é improvável que o cegamento tenha sido quebrado. **Alto risco de viés:** Estudo não cego ou cegamento incompleto, e o desfecho é susceptível de ser influenciado pela falta de cegamento; Tentativa de cegamento dos participantes e profissionais, mas é provável que o cegamento tenha sido quebrado, e o desfecho é influenciado pela falta de cegamento. **Risco de viés incerto:** Informação insuficiente para julgar como alto risco e baixo risco de viés; O estudo não relata esta informação.

Ferramenta avaliação de Risco de Viés Colaboração Cochrane em ensaios randomizados- RoB.

Viés de detecção **4. Cegamento de avaliadores de desfecho** Avaliação deve ser feita para cada desfecho principal (ou classes de desfechos)	Descrever todas as medidas utilizadas para cegar os avaliadores de desfecho em relação ao conhecimento da intervenção fornecida a cada participante. Fornecer informações se o cegamento pretendido foi efetivo.	**Baixo risco de viés:** Não cegamento da avaliação dos desfechos, mas os autores da revisão julgam que o desfecho não pode ser influenciado pela falta de cegamento; Cegamento da avaliação dos desfechos foi realizado, e é improvável que o cegamento tenha sido quebrado. **Alto risco de viés:** Não houve avaliação cega dos desfechos, e os desfechos avaliados são influenciáveis pela falta de cegamento; Os avaliadores de desfechos foram cegos, mas é provável que o cegamento tenha sido quebrado, e o desfecho mensurado pode ter sido influenciado pela falta de cegamento. **Risco de viés incerto:** Informação insuficiente para julgar como alto risco e baixo risco de viés; O estudo não relata esta informação.
Viés de atrito **5. Desfechos incompletos** Avaliação deve ser feita para cada desfecho principal (ou classes de desfechos)	Descrever se os dados relacionados aos desfechos estão completos para cada desfecho principal, incluindo perdas e exclusão da análise. Descrever se as perdas e exclusões foram informadas no estudo, assim como suas respectivas razões. Descreve se houve reinclusão de algum participante.	**Baixo risco de viés:** Não houve perda de dados dos desfechos; Razões para perdas de dados não estão relacionadas ao desfecho de interesse; Perda de dados foi balanceada entre os grupos, com razões semelhantes para perda dos dados entre os grupos; Para dados dicotômicos, a proporção de dados perdidos comparados com o risco observado do evento não é capaz de induzir viés clinicamente relevante na estimativa de efeito; Para desfechos contínuos, estimativa de efeito plausível (diferença média ou diferença média padronizada) nos desfechos perdidos não é capaz de induzir viés clinicamente relevante no tamanho de efeito observado; Dados perdidos foram imputados utilizando-se métodos apropriados. **Alto risco de viés:** Razões para perda de dados pode estar relacionada ao desfecho investigado, com desequilíbrio na quantidade de pacientes ou razões para perdas entre os grupos de intervenção; Para dados dicotômicos, a proporção de dados perdidos comparada com o risco observado do evento é capaz de induzir viés clinicamente relevante na estimativa de efeito; Para desfechos contínuos, estimativa de efeito plausível (diferença média ou diferença média padronizada) nos desfechos perdidos, capaz de induzir viés clinicamente relevante no tamanho de efeito observado. *"As-treated"* análise, feita com desvio substancial da intervenção recebida em relação à que foi randomizada; Imputação simples dos dados feita de forma inapropriada. **Risco de viés incerto:** Relato insuficiente das perdas e exclusões para permitir julgamento (exemplo: número randomizado não relatado, as razões para perdas não foram descritas).

Ferramenta avaliação de Risco de Viés Colaboração Cochrane em ensaios randomizados - RoB.

Viés de relato **6. Relato de desfecho seletivo**	Indicar a possibilidade de os ensaios clínicos randomizados terem selecionado os desfechos ao descrever os resultados do estudo e o que foi identificado.	**Baixo risco de viés:**
		O protocolo do estudo está disponível e todos os desfechos primários e secundários pré-especificados que são de interesse da revisão foram reportados de acordo com o que foi proposto;
		O protocolo do estudo não está disponível, mas está claro que o estudo publicado incluiu todos os desfechos desejados.
		Alto risco de viés:
		Nem todos os desfechos primários pré-especificados foram reportados;
		Um ou mais desfechos primários foram reportados utilizando mensuração, método de análise ou subconjunto de dados que não foram pré-especificados;
		Um ou mais desfechos primários reportados não foram pré-especificados (a não ser que uma justificativa clara seja fornecida para o relato daquele desfecho, como o surgimento de um efeito adverso inesperado);
		Um ou mais desfechos de interesse da revisão foram reportados incompletos, e não podem entrar na metanálise;
		O estudo não incluiu resultados de desfechos importantes que seriam esperados neste tipo de estudo.
		Risco de viés incerto:
		Informação insuficiente para permitir julgamento. É provável que a maioria dos estudos caia nesta categoria.
Outros vieses **7. Outras fontes de viés**	Declarar outro viés que não se enquadra em outro domínio prévio da ferramenta. Se em protocolos de revisões forem pré-especificadas questões neste domínio, cada questão deve ser respondida.	**Baixo risco de viés:**
		O estudo parece estar livre de outras fontes de viés.
		Alto risco de viés:
		Alto risco relacionado ao delineamento específico do estudo; ou
		Foi alegado como fraudulento;
		Teve algum outro problema.
		Risco de viés incerto:
		Informação insuficiente para avaliar se um importante risco de viés existe; ou
		Base lógica insuficiente de que um problema identificado possa introduzir viés.

Referência: Carvalho, A. P. V; Silva, V; Grande, A. J. (2013). Avaliação Do Risco De Viés De Ensaios Clínicos Randomizados Pela Ferramenta Da Colaboração Cochrane. *Diagn Tratamento*, V. *18*, N. 1, P. 38-44. https://Pesquisa.Bvsalud.Org/Portal/Resource/Pt/Lil-670595

ANEXO IV – Joana Briggs Institute-JBI Critical Appraisal Checklist for Cohort Studies

Reviewer_____Date_____

Author _____Year_____Record Number_____

	Yes	No	Unclear	Not applicable
1. 1. Os dois grupos eram semelhantes e foram recrutados na mesma população?	☐	☐	☐	☐
2. 2. As exposições foram medidas de forma semelhante para atribuir as pessoas a grupos expostos e não expostos?	☐	☐	☐	☐
3. 3. A exposição foi medida de forma válida e confiável?	☐	☐	☐	☐
4. 4. Foram identificados fatores de confusão?	☐	☐	☐	☐
5. 5. Foram declaradas estratégias para lidar com fatores de confusão?	☐	☐	☐	☐
6. 6. Os grupos/participantes estavam livres do desfecho no início do estudo (ou no momento da exposição)?	☐	☐	☐	☐
7. 7. Os resultados foram medidos de forma válida e confiável?	☐	☐	☐	☐
8. 8. O tempo de acompanhamento foi relatado e suficiente para que os resultados ocorressem?	☐	☐	☐	☐
9. 9. O acompanhamento foi completo e, caso contrário, os motivos da perda do acompanhamento foram descritos e explorados?	☐	☐	☐	☐
10. 10. Foram utilizadas estratégias para abordar o acompanhamento incompleto?	☐	☐	☐	☐
11. 11. Foi utilizada análise estatística adequada?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

_____

_____

ANEXO V - Joana Briggs Institute JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies

Reviewer_____Date_____

Author_____Year_____Record Number_____

	Yes	No	Unclear	Not applicable
1. 1. Os critérios de inclusão na amostra foram claramente definidos?	☐	☐	☐	☐
2. 2. Os sujeitos do estudo e o ambiente foram descritos detalhadamente?	☐	☐	☐	☐
3. 3. A exposição foi medida de forma válida e confiável?	☐	☐	☐	☐
4. 4. Foram utilizados critérios objetivos e padronizados para medição da condição?	☐	☐	☐	☐
5. 5. Foram identificados fatores de confusão?	☐	☐	☐	☐
6. 6. Foram declaradas estratégias para lidar com fatores de confusão?	☐	☐	☐	☐
7. 7. Os resultados foram medidos de forma válida e confiável?	☐	☐	☐	☐
8. 8. Foi utilizada análise estatística adequada?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

_____

_____

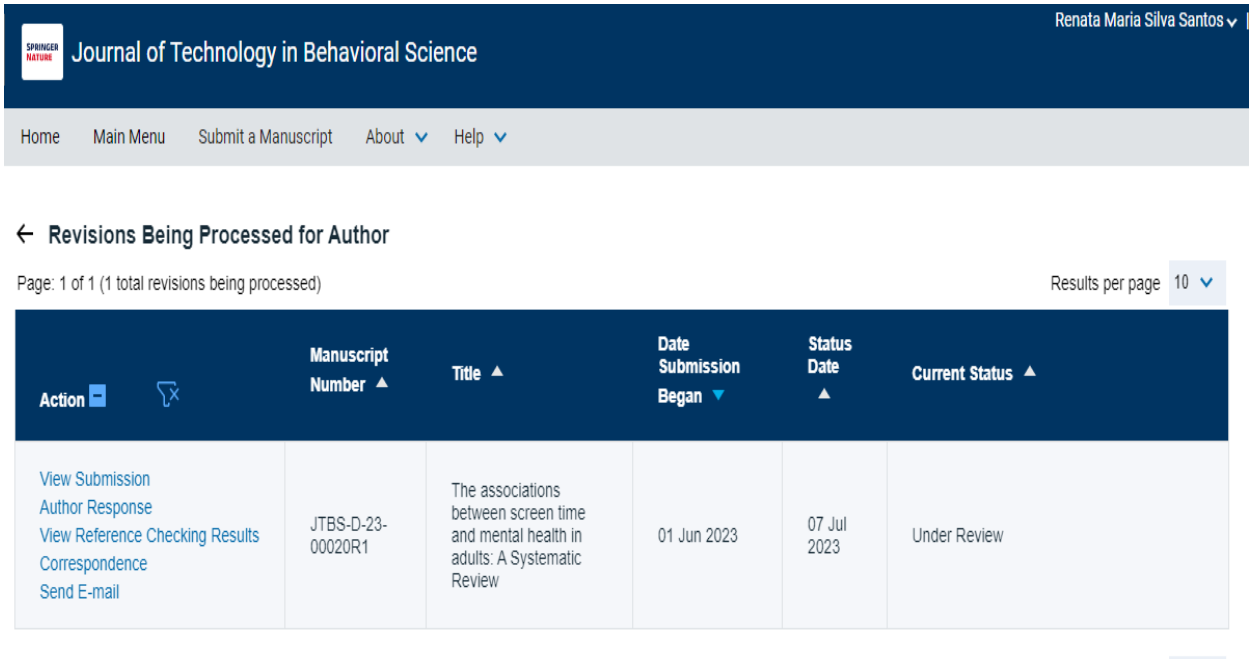
_____

11. APÊNDICES

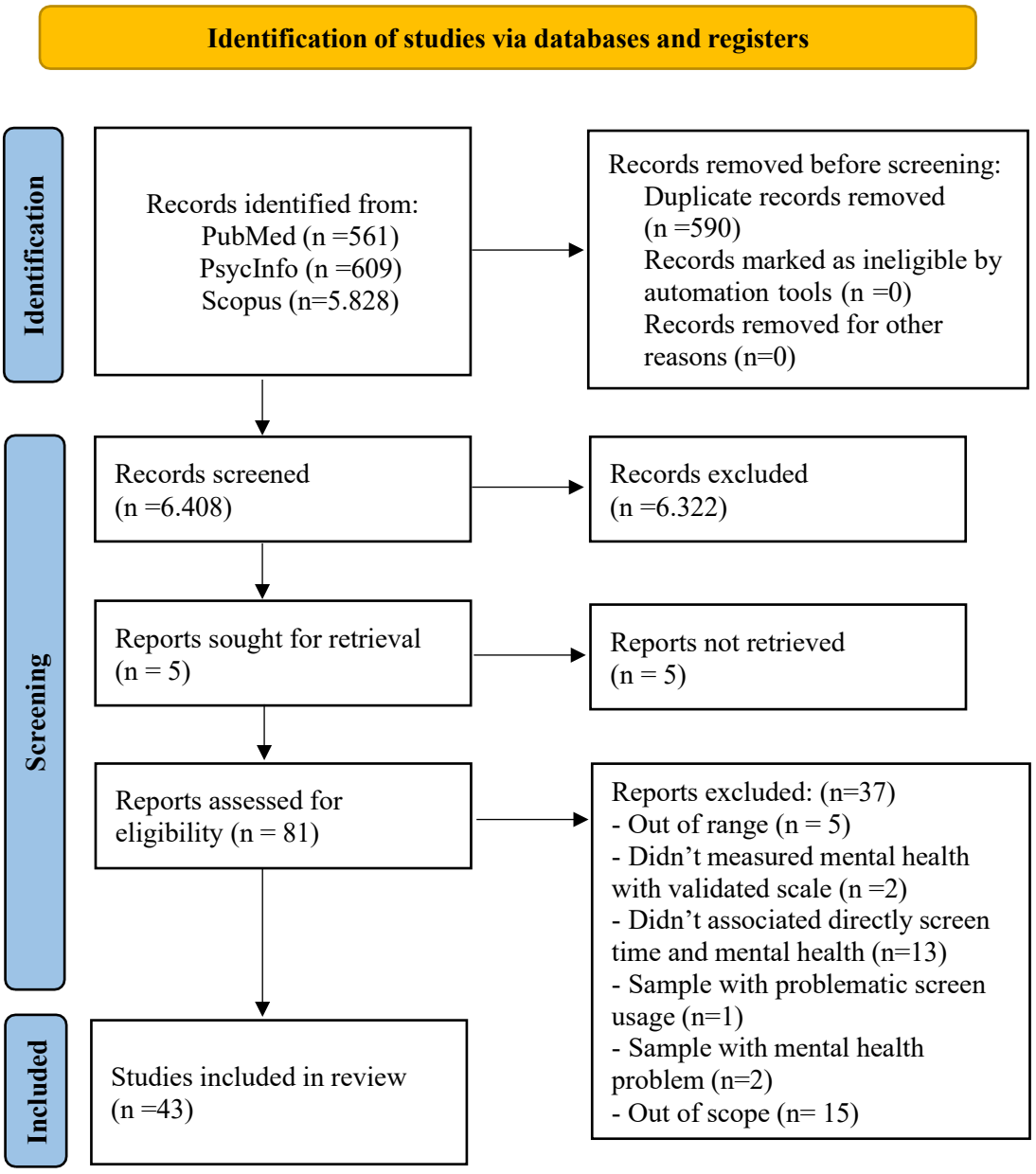
APÊNDICE A - Comprovantes de Submissão dos Artigos

The associations between screen time and mental health in children: a systematic review

Journal:	*Developmental Neuropsychology*
Manuscript ID	HDVN-2023-0043
Manuscript Type:	Review
Keywords:	screen time, mental health, children, media



APÊNDICE B - Artigo 1 - PRISMA Flowchart (Additional File 1)



APÊNDICE C - Artigo 1 - Distribution of sample (Additional file 2: Table 1)

Country	Number of studies	Total participants
United States of America (USA)	8	69,155
China	5	35,951
Japan	4	96,319
Canada	3	15,895
Netherlands	2	3,480
Italy	2	645
Turkey	2	430
Belgium	1	13,871
United Kingdom (UK)	1	11,014
Ireland	1	10,172
Spanish	1	4,073
Finland	1	699
Croatia	1	655
Egypt	1	564
England	1	520
France	1	432
South Korea	1	331
Thailand	1	200
Portugal	1	193
Israel	1	145
Switzerland	1	118
Hungary	1	98
Lithuania	1	78
Indonesia	1	70

APÊNDICE D - Artigo 1 - Table 3 Quality assessment (Additional File 3)

References	Design	Selection	Comparibility	Outcome	Total
Ahmed et al., 2022	Cross-sectional	2	2	3	7
Ayu et al., 2020	Cross-sectional	2	0	3	5
Bagaric et al., 2022	Cross-sectional	2	0	2	4
Bruggeman et al., 2019	Cross-sectional	3	1	3	7
Cardoso-Leite et al., 2021	Cross-sectional	2	2	3	7
Cartanyà-Hueso et al., 2022	Cross-sectional	3	2	3	8
Chen et al., 2020	Longitudinal	4	2	2	8
Choi et al., 2021	Cross-sectional	2	0	3	5
Chu et al., 2022	Longitudinal	3	2	2	7
De Pasquale et al., 2021	Cross-sectional	2	1	3	6
Dennison-Farris et al., 2017	Cross-sectional	1	2	3	6
Fors & Barch, 2019	Cross-sectional	3	1	3	7
Guerrero et al., 2019	Cross-sectional	3	2	3	8
Guxens et al., 2019	Cross-sectional	3	2	3	8
Hosokawa & Katsura, 2018	Cross-sectional	3	2	3	8
Janiri et al., 2020	Cross-sectional	4	2	2	8
Kahn et al., 2021	Cross-sectional	3	2	2	7
Kidokoro et al., 2022	Cross-sectional	3	2	3	8
Konok, 2022	Longitudinal	2	2	2	6
Kostyrka-Allchorne et al., 2020	Cross-sectional	3	2	3	8
Kushima et al., 2022	Longitudinal	3	1	3	7
Li et al., 2022a	Cross-sectional	3	2	2	7
Li et al., 2021	Longitudinal	3	2	3	8
Lin et al., 2020	Cross-sectional	4	2	3	9
Liu et al., 2021	Longitudinal	3	2	2	7
Lobel et al., 2017	Longitudinal	2	2	2	6

McArthur et al., 2022	Cross-sectional	4	2	3	9
Monteiro et al., 2021	Cross-sectional	2	2	3	7
Moulin et al., 2022	Cross-sectional	2	2	2	6
Nagata et al., 2022	Longitudinal	3	1	3	7
Neville et al., 2021	Longitudinal	3	1	1	5
Nicolì et al., 2022	Cross-sectional	1	0	1	2
Niiranen et al., 2020	Longitudinal	2	2	1	5
Okada et al., 2021	Cross-sectional	4	2	2	8
Parkes et al., 2013	Longitudinal	3	2	1	6
Rakickienė et al., 2021	Longitudinal	3	2	2	7
Roberston et al., 2022	Cross-sectional	3	2	2	7
Tansriratanawong et al., 2017	Cross-sectional	3	1	2	6
Tezol et al., 2022a	Cross-sectional	4	2	2	8
Tezol et al., 2022b	Cross-sectional	4	2	2	8
Xie et al., 2020	Cross-sectional	3	2	2	7
Zhang et al., 2022	Cross-sectional	2	1	2	5
Zhao et al., 2022a	Cross-sectional	3	2	3	8

APÊNDICE E - Artigo 1 - Screen time and mental health assessments (Additional file 4)

Mental health assessments

The mental health outcomes that were most prevalent in the studies included in this review were internalizing symptoms (n=4), such as depression (n=8), anxiety (n=7), psychological distress (Cardoso-Leite et al., 2021), and mood symptoms (Lin et al., 2020) and overall mental health (Ayu et al., 2020). Some research explored aspects related to emotional problems (n=19). Other studies assessed externalizing symptoms (n=3), such as irritability (Li et al., 2021), aggression (n=2), self-esteem (n=2), social interaction difficulties (Tezol et al., 2022b), conduct (n=3) and oppositional (Nagata et al., 2022). In addition, behaviors considered suicidal (n=2), similar to those of autistics (Chen et al., 2020), and behavior in general (n=17) have also received attention. Some investigations have looked at Attention Deficit Hyperactivity Disorder (ADHD) (n=8) and Autistic Spectrum Disorder (ASD) (Kushima et al., 2022). In addition, sleep issues (n=6) and psychosocial health (n=4) were of great interest in some studies.

Regarding the assessment of mental health outcomes, depression was measured by several tools, such as the Depression Inventory for Children, a questionnaire developed by the American Psychiatric Association (APA), Test of Anxiety and Depression (TAD), Child Behavior Checklist (CBCL), and the Depression Self-Rating Scale for Children (DSRSC). Anxiety was measured by the Social Anxiety Scale for Children (SASC), Children's Anxiety Meter-State (CAM-S), CBCL and TAD. While for self-esteem and psychological distress only one scale was used: Rosenberg Self-Esteem Scale and K-6 Stress Scale, respectively. For emotional and behavioral problems, we used the Checklist of Pediatric Symptoms in Infants (BPSC), Five-to-Fifteen Questionnaires (FTF), Kiddie Schedule for Affective Disorders and Schizophrenia for DSM-5 (KSADS-5), SDQ, and CBCL.

Some specific emotional problems received attention through the Child Alexithymia Measure (CAM), Positive and Negative Affect Schedule for children, 9 questions derived from the Swanson Nolan and Pelham (SNAP-IV), and 2 questions to investigate happiness. ADHD was analyzed using Conners' Teacher Rating Scale, Conners' Parent Rating Scale, CBCL, and SDQ. As for ASD, instruments such as the

Autism Behavior Checklist (ABC) and the 5-Age and Stages Questionnaire (ASQ-3) were used. Sleep was investigated using the Children's Sleep Habits Questionnaire (CSHQ-A), Personalized Sleep Questionnaire, Parental Sleep Disorders Scale for Children, Sleep Disorders Scale for Children (SDSC) and Actigraph Mini-Motionlogger. While mental health and psychosocial health, in general, were assessed only by the Mental Health Problems Questionnaire and SDQ, respectively.

Screen time assessments

In the reviewed studies, ST was considered as time in front of mobile devices (Ayu et al., 2020), such as smartphone (n=22), tablet (n=20) and laptop (n=4). Other devices such as TV (n=28), PC (n=16), DVD (n=7) and video game (n=22) were also investigated. In addition, time spent playing electronic games (n=7), watching videos (n=8) and movies (n=5), texting (n=5), video chatting (n=7), studying (Li et al., 2021; Tansriratanawong et al., 2017) and entertaining (Tansriratanawong et al., 2017) moments, and accessing social media (n=11), across screens was assessed. However, some research did not specify how they considered screen exposure (Bagaric et al., 2022; Janiri et al., 2020; Rakickienė et al., 2021).

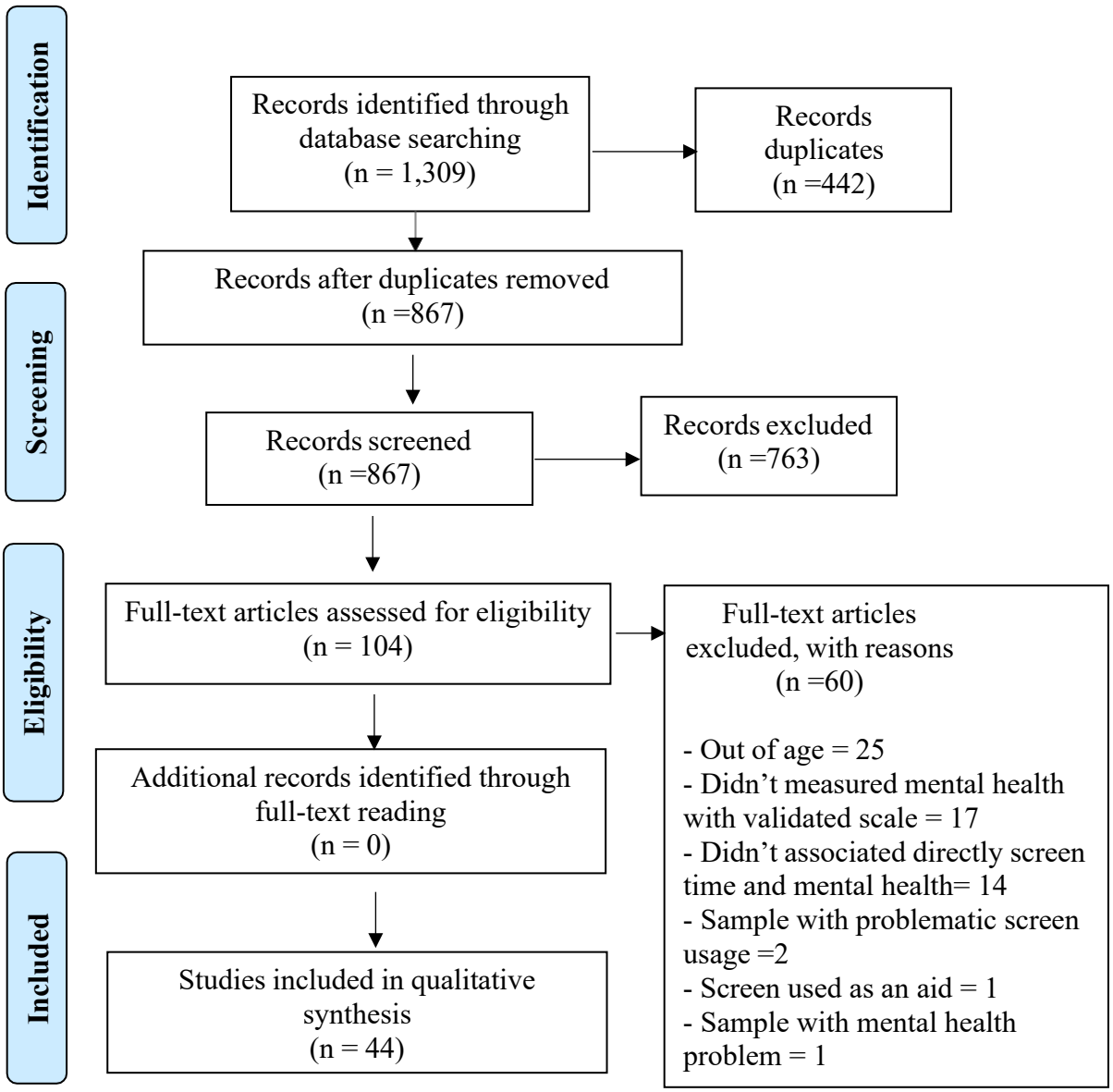
With regard to measuring ST, parents reported via self-report questionnaires the hours per day their children are in front of screens (n=18) and how they use them (Ayu et al., 2020). Some research assessed by hours alone (n=3), and others by the Digital Kids Questionnaire (Konok, 2022), Nutrition Screening Tool for Every Preschooler (NutriSTEPTM) (McArthur et al., 2022), Video Game Addiction Scale for Children (VASC) (De Pasquale et al., 2021) and different and short Screen Time Survey (STQ) (Fors & Barch, 2019). In some studies, children who reported by questionnaire, how often they use screens (n=11), reasons for using, types of social contacts (Bruggeman et al., 2019). Tools such as the Media Multitasking Inventory and Video Game Questionnaire (Cardoso-Leite et al., 2021), questions based on the Facebook Intensity Scale (Bruggeman et al., 2019), ABCD Youth Screen Time Survey (n=5) were also used.

APÊNDICE F - Artigo 2 - Table 1 Search Strategies (Additional file 1: Table 1)

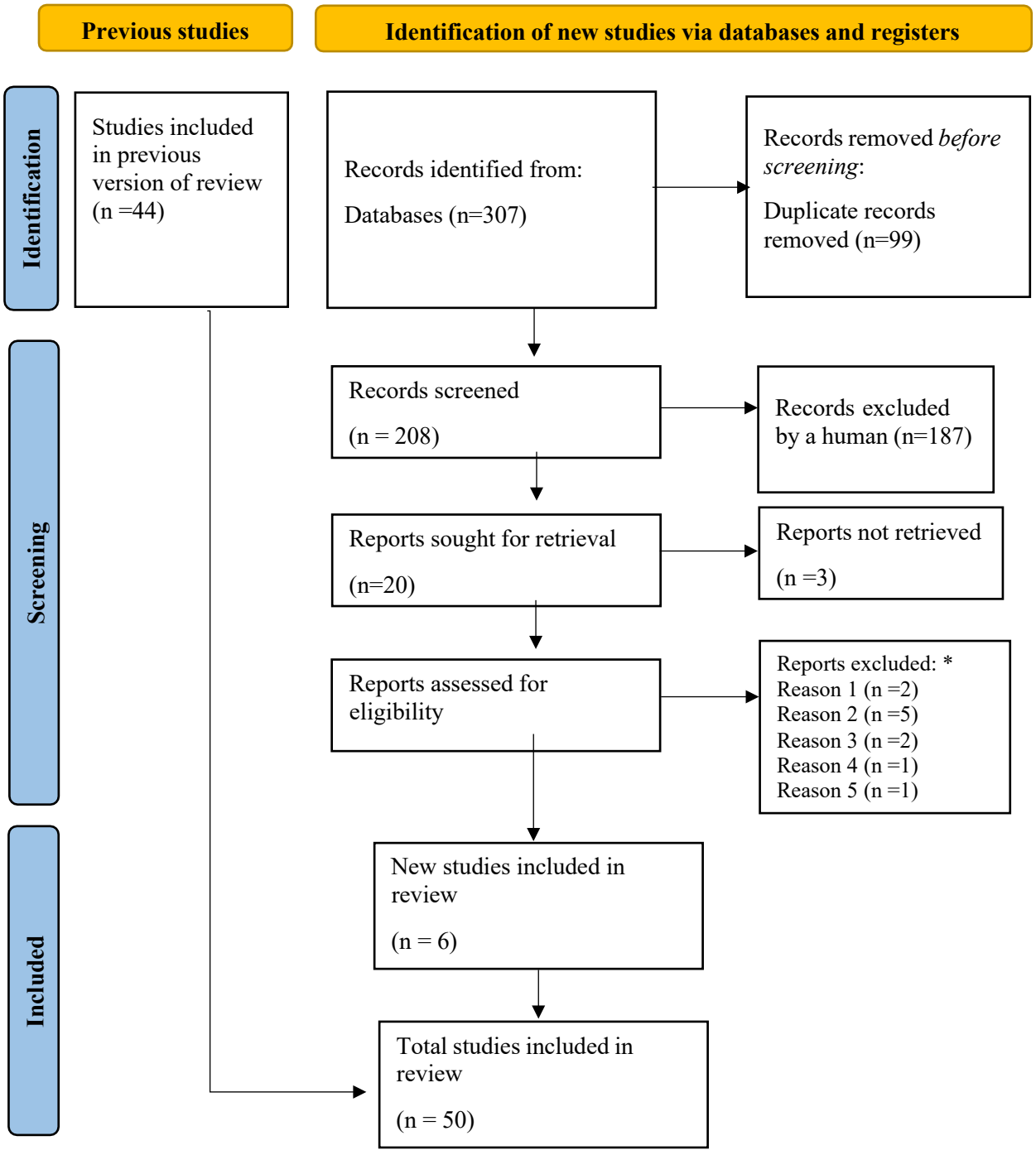
Data Base	Search strategies
Pubmed	All fields: ((adolescents) AND (screen time)) AND (mental health)
PsycInfo	Any field: adolescents AND Any Field: screen time AND Any Field: mental health
Scopus	(ALL (adolescents) AND ALL ("screen time") AND ALL ("mental health"))

APÊNDICE G - Artigo 2 - PRISMA flowcharts (Additional File 2: Figure 1 and Figure 2).

Figure 1. PRISMA Flow Diagram.



Artigo 2 - Figure 2. PRISMA flow diagram of the updated search for adolescent review.



*Reason 1: Did not use validated scale to assess mental health
*Reason 2: Mix children in the adolescent sample
*Reason 3: Outside the scope of the study
*Reason 4: Did not directly associate ST and MH
*Reason 5: Sample with problematic screen usage

APÊNDICE H - Artigo 2 - Table 2 (Additional file 1: Table 2) Sample by country of adolescent review

Country	Number of studies	Total participants
Canada	13	105,148
China	9	47,451
United Kingdom (UK)	7	634,554
Australia	5	7,563
United States of America (USA)	4	511,954
Germany	2	1,982
Bangladesh	2	1,176
South Korea	1	54,243
Iceland	2	2,000
Japan	1	7,847
Sweden	1	1,139
Switzerland	1	674
Brazil	1	217
42 North American and European countries	1	577,475

APÊNDICE I - Artigo 2 - Screen time and mental health assessments (Additional file 3).

Screen Time Assessment

Screen time (ST) was self-reported and established in different ways by the studies in this review. The study by [44] compared passive and active screen use. Some studies (n=14) have considered screen time as sedentary behavior. Seven studies verified compliance or not with the 24-hour movement guidelines established in Canada, that consist on a composite analysis including 9 to 11 hours of sleep per night for 5 to 13 years old and 8 to 10 hours per night for 14 to 17 years old, 60 minutes of moderate to vigorous physical activity and less than 2 h/day of screen time. One study separately quantified time watching television and playing video games [34]. Another study excluded computer games [35]. Studies considered only recreational screens (n=5), the recreational screen on different devices was accounted separately [36], or just the time spent on social media [41]. But most articles (n=36) considered screen time as covering online studies and all other uses.

Different patterns of screen time evaluation were observed. One study measured screen time using the Multimedia Activity Recall for Children and Adolescents (MARCA) [68]. Some studies applied t sedentary activities questionnaire (ASAQ), considering screen-based recreational activities [67,55,58] and school activities [60]. One study used the Leisure-Time Sedentary Activities questionnaire (46) and the other the Adolescent Physical Activity Questionnaire - Sedentary Behavior Subscale (PAQ-A) [52]. The Time Use Diary (TUD) was used in three studies, for all screen uses [23], for the use of social networks only [39] and separately for digital media (games) and social networks [28]. Some studies used the strategy of creating clusters, classes or behavior profiles, such as physically active or sedentary individuals. These studies created lifestyle-based outcome blocks that included physical activity and screen time [42, 50], sleep, physical activity, and screen time [31, 45], and another that stratified into profiles of different types of screen-based devices [68].

Mental Health Assessment

Other outcomes were evaluated in addition to mental health aspects, such as school performance or even physical performance; however, we focused on the mental health-evaluation. Of the 50 articles reviewed, the symptoms evaluated were depression (n=10), depressive symptoms (n=22), anxiety (n=16), and self-esteem (n=9). Some studies focused on positive aspects of mental health, highlighting mental well-being, and evaluating dimensions such as adolescent flourishing (n=5) and resilience (n=1).

Some studies evaluated dimensions that reflect the general state of mental health, such as life satisfaction (n=5), self-efficacy (n=2), physical self-concept (n=3), social difficulties (n=3), psychosocial difficulties (n=1) and stress (n=2). In addition to emotional symptoms, some studies have evaluated behavioral symptoms, including conduct problems, hyperactivity/inattention, and pro-social behavior (n=4). Engagement

in self-harm behavior was addressed in some articles (n=6) and suicidal ideation was assessed in two studies [47, 56]. One study evaluated mental disorders defined by the criteria of the Diagnostic and Statistical Manual of Mental Disorder (DSM IV), for a major depressive episode, generalized anxiety disorder, social phobia, and specific phobia [44]. One study assessed overall mental health using the adapted version of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) and also assessed loneliness using the (University of California, Los Angeles) Loneliness Scale- UCLA [26]. Studies that referred to mood disorders [30,37, 44] evaluated anxiety and depression. Two studies assessed psychological distress [64,69], and one emotional distress (Kandola et al., 2022). Two studies evaluated internalizing and externalizing symptoms [51,68] and one study (47) evaluated only depression as an internalizing symptom. Exposure to alcohol and tobacco, as a determinant of mental health, was also addressed in a study [42]. On the other hand, some studies have focused their efforts on capturing positive aspects of adolescent mental health, such as positive mental health [43], psychological Well-Being (38), Well-Being [32,54,59] .

Due to the geographic and methodological diversity of the included studies, 42 scales used to assess the mental health of adolescents were identified. The most used scales were the 10-item Center for Epidemiologic Studies Depression Scale Revised−10 (CESD-R-10), Rosenberg Self-Esteem Scale, Strengths and Difficulties Questionnaire (SDQ), Short Form of the Mood and Feelings Questionnaire (SMFQ) and the Diener's Flourishing Scale.

APÊNDICE J – Artigo 2 - Quality assessment of studies (Additional file 4: Table 4)

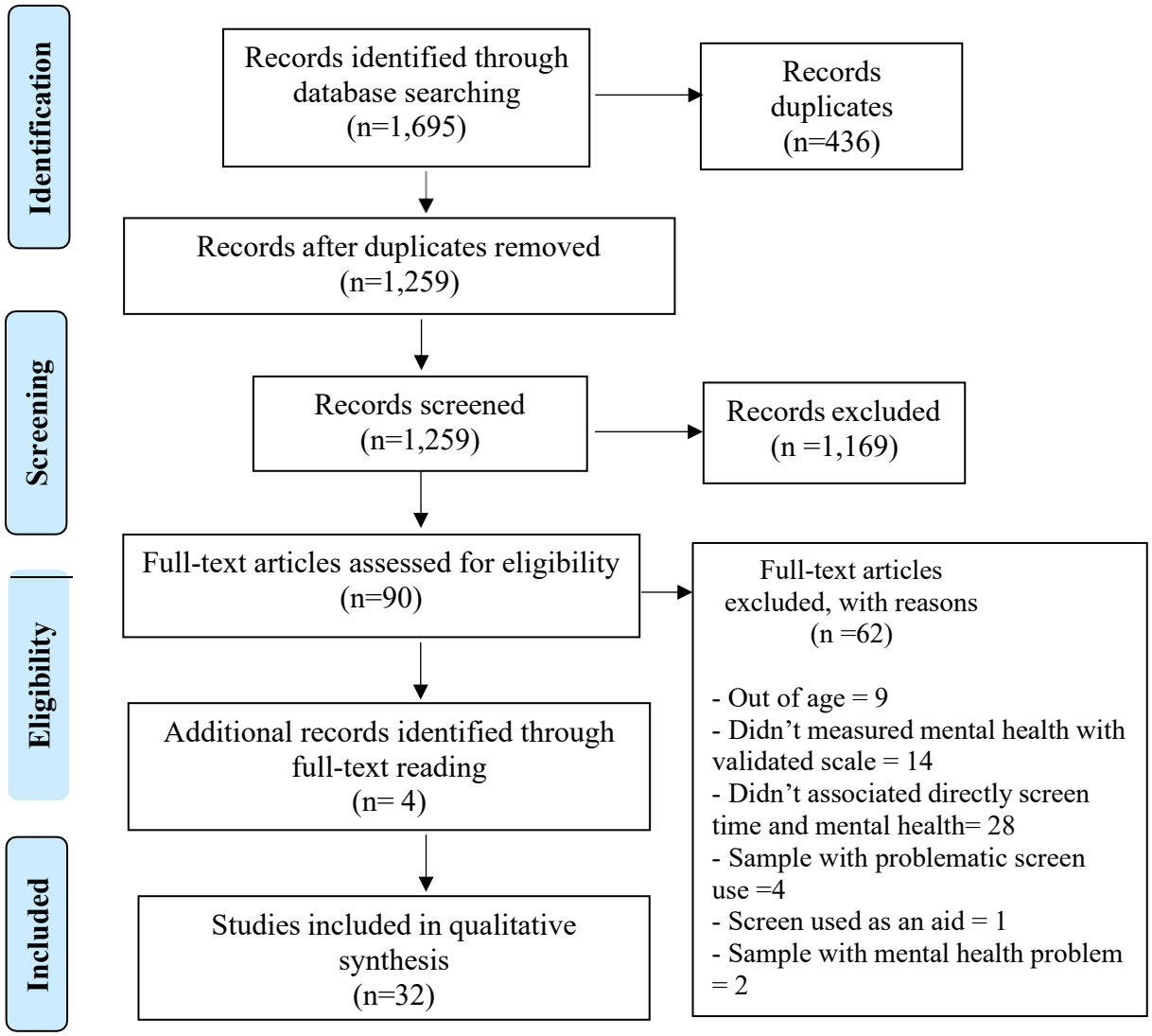
References	Design	Selection	Comparability	Outcome	Total
Chen et al. [22]	Cross-sectional	3	2	2	7
Forte et al. [23]	Cross-sectional	3	2	3	8
Kandola et al. [24]	Prospective Cohort	2	2	2	6
Kjellenberg et al. [25]	Cross-sectional	3	2	3	8
Kidokoro et al. [26]	Cross-sectional	3	2	2	7
Marciano et al. [27]	Prospective Cohort	2	2	2	6
Khan et al. [28]	Cross-sectional	3	2	3	8
McAllister et al. [29]	Cross-sectional	3	2	3	8
Sampasa-Kanyinga et al. [30]	Cross-sectional	3	2	3	8
Ren et al. [31]	Cross-sectional	3	2	3	8
Brown et al. [32]	Prospective Cohort	2	2	2	6
Brown & Kwan [33]	Cross-sectional	3	2	3	8
Gilchrist et al. [34]	Cross-sectional	3	2	3	8
Khan & Burton [35]	Cross-sectional	3	2	3	8
Nigg et al. [36]	Prospective Cohort	2	2	2	6
Twenge & Farley [37]	Cross-sectional	3	2	3	8
Xiao et al. [38]	Cross-sectional	2	2	3	7
Bang et al. [39]	Cross-sectional	3	2	2	7
Barthorpe et al. [40]	Cross-sectional	3	2	3	8
Cao et al. [41]	Cross-sectional	3	2	3	8
Coyne et al. [42]	Prospective Cohort	2	2	2	6
Faria et al. [43]	Cross-sectional	2	2	3	7
Faulkner et al. [44]	Prospective Cohort	2	2	3	7
Kim et al. [45]	Cross-sectional	3	2	3	8
Weatherson et al. [46]	Cross-sectional	4	2	3	9
Zhang et al. [47]	Cross-sectional	3	2	3	8
Orben & Przybylski [48]	Cross-sectional	3	2	3	8

Khouja et al. [49]	Prospective Cohort	3	2	3	8
Liu et al. [50]	Cross-sectional	3	2	3	8
Liu et al. [51]	Cross-sectional	3	2	3	8
Paulus et al. [52]	Cross-sectional	3	2	3	8
Perrino et al. [53]	Prospective Cohort	2	2	3	7
Hrafnkelsdottir et al. [54]	Cross-sectional	2	2	3	7
Gireesh et al. [55]	Cross-sectional	3	2	3	8
Khan et al. [56]	Cross-sectional	2	2	3	7
Twenge et al. [57]	Prospective Cohort	3	2	3	8
Yan et al. [58]	Cross-sectional	3	2	3	8
Khan & Burton [59]	Cross-sectional	2	2	3	7
Przybylski & Weinstein [60]	Cross-sectional	3	2	3	8
Babic et al. [61]	Prospective Cohort	1	2	3	6
Goldfield et al. [62]	Cross-sectional	2	2	3	7
Gunnell et al. [63]	Prospective Cohort	3	2	3	8
Hayward et al. [64]	Cross-sectional	3	2	3	8
Trinh et al. [65]	Cross-sectional	3	2	3	8
Maras et al. [66]	Cross-sectional	2	2	3	7
Suchert et al. [67]	Cross-sectional	3	2	3	8
Nihill et al. [68]	Cross-sectional	3	2	3	8
Straker et al. [69]	Prospective Cohort	2	2	3	7
Arbour-Nicitopoulos et al. [70]	Cross-sectional	3	2	3	8
Cao et al. [71]	Cross-sectional	3	2	3	8

Evidência forte: estudos de alta qualidade 6/9; Evidência moderada: estudos de baixa qualidade e/ou um estudo de alta qualidade 4-5/9; Evidência limitada: estudo de qualidade inferior < 4.

Strong evidence: high quality studies 6/9; Moderate evidence: low quality studies and/or one high quality study 4-5/9; Limited evidence: lower quality study < 4.

APÊNDICE K - Artigo 3 - PRISMA Diagram [Supplementary File 1: Fig 1].



APÊNDICE L - Artigo 3 - RCT's 'Risk of Bias' assessment (Supplementary File 2: Fig 2 and Fig 3)

Figure 2 - Risk of bias graph: authors' judgements about each risk of bias item presented as percentages across RCT's included. The Cochrane Collaboration's risk of bias tool.

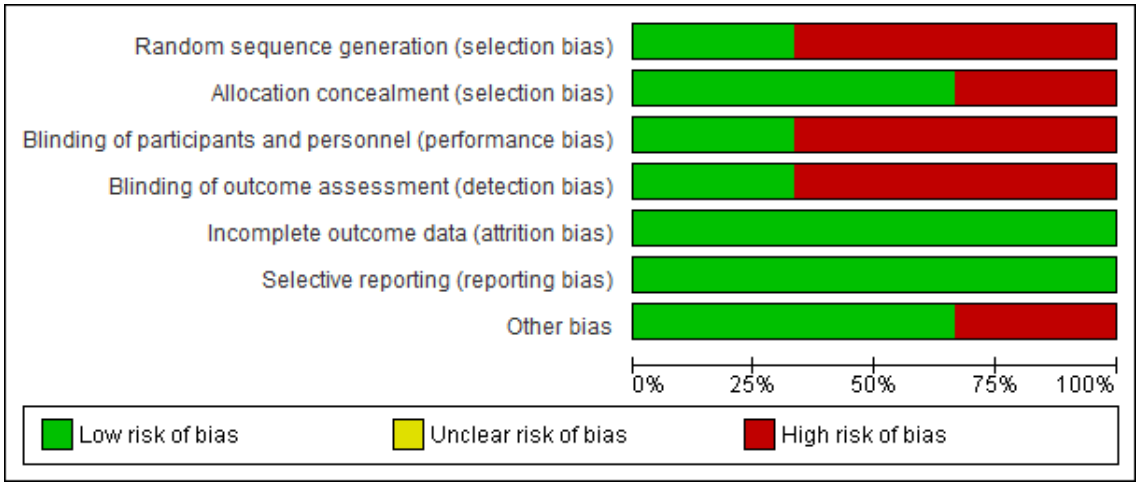
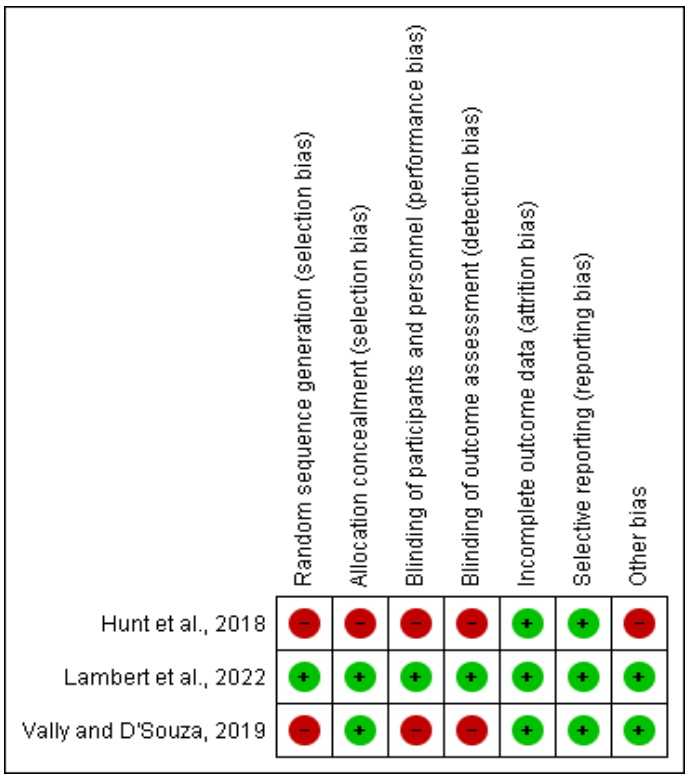


Figure 3 - Risk of bias summary: authors' judgements about each risk of bias item for RCT's included. The Cochrane Collaboration's risk of bias tool.



APÊNDICE M - Artigo 3 - Methodological evaluation of the observational studies-Critical Appraisal Tools of the Joanna Briggs Institute (JBI) (Supplementary File 2: Table 2 and Table 3)

Table 2. Quality evaluation of cross-sectional studies - Joanna Briggs Institute (JBI) Critical Appraisal Tools.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Aliverdi et al., 2022	Y	Y	Y	Y	N	N	Y	Y
Dennis et al., 2022	N	N	Y	U	N	N	Y	Y
Feng et al., 2014	N	Y	N	Y	Y	Y	Y	Y
Gao et al., 2020	N	N	N	U	N	N	Y	Y
Gao et al., 2021	N	Y	Y	Y	N	N	Y	Y
Ge et al., 2020	Y	Y	N	Y	Y	Y	Y	Y
Griffioen et al., 2021	N	N	Y	Y	N	N	Y	Y
Hu et al., 2020	Y	Y	Y	N	N	N	Y	Y
Jáuregui et al., 2022	N	N	N	Y	Y	N	Y	Y
Meyer et al., 2020	Y	Y	N	N	N	N	Y	Y
Rebar et al., 2014	N	Y	N	N	Y	Y	Y	Y
Tamminen et al., 2020	Y	Y	N	Y	Y	Y	Y	Y
Tashiro et al., 2022	Y	Y	N	Y	Y	Y	Y	Y
Tsou, 2022	N	Y	Y	Y	Y	Y	Y	Y
Vieira et al., 2021	Y	Y	N	Y	Y	Y	Y	Y
Vizcaino et al., 2020	Y	Y	Y	Y	N	N	Y	Y
Wu et al., 2015	N	Y	N	Y	Y	Y	Y	Y
Xu et al., 2021	N	Y	N	Y	N	N	Y	Y
Yu et al., 2019	N	Y	N	Y	Y	Y	Y	Y
Zhang et al., 2022	N	Y	N	Y	N	N	Y	Y
Zhang et al., 2021	Y	Y	N	Y	Y	Y	Y	Y
Zhou et al., 2021	Y	Y	N	Y	N	N	Y	Y

Q1. Os critérios de inclusão na amostra foram claramente definidos? Q2. Os sujeitos do estudo e

o ambiente foram descritos detalhadamente? Q3. A exposição foi medida de forma válida e confiável? Q4. Foram utilizados critérios objetivos e padronizados para medição da condição? Q5. Estamos identificando fatores de confusão? Q6. Foram declaradas estratégias para lidar com fatores de confusão? Q7. Os resultados foram medidos de forma válida e confiável? Q8. Foi utilizada análise estatística apropriada?

N = Não; U = Não claro; S = Sim

Q1. Were the criteria for inclusion in the sample clearly defined? Q2. Were the study subjects and the setting described in detail? Q3. Was the exposure measured in a valid and reliable way? Q4. Were objective, standard criteria used for measurement of the condition? Q5. We're confounding factors identified? Q6. Were strategies to deal with confounding factors stated? Q7. Were the outcomes measured in a valid and reliable way? Q8. Was appropriate statistical analysis used?

N = No; U = Unclear; Y = Yes

Table 3. Quality evaluation of cohort studies - Joanna Briggs Institute (JBI) Critical Appraisal Tools.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Fumagalli et al., 2021	U	Y	Y	N	N	Y	Y	Y	U	U	U
Giuntella et al., 2021	Y	Y	N	N	N	Y	Y	Y	Y	Y	U
Hossain et al., 2019	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Meyer et al., 2021	Y	Y	N	N	N	Y	Y	Y	U	U	Y
Olds et al., 2018	U	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Sewall et al., 2021	U	U	Y	N	N	Y	Y	Y	U	U	Y
Wu et al., 2016	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y

Q1. Os dois grupos eram semelhantes e recrutados na mesma população? Q2. As exposições foram medidas de forma semelhante para atribuir as pessoas a grupos expostos e não expostos? Q3. A exposição foi medida de forma válida e confiável? Q4. Estamos identificando fatores de confusão? Q5. Foram declaradas estratégias para lidar com fatores de confusão? Q6. Os grupos/participantes estavam livres do desfecho no início do estudo (ou no momento da exposição)? Q7. Os resultados foram medidos de forma válida e confiável? Q8. O tempo de acompanhamento foi relatado e suficiente para ser longo o suficiente para que os resultados ocorressem? Q9. O acompanhamento foi completo e, caso contrário, os motivos da perda do acompanhamento foram descritos e explorados? Q10. Foram utilizadas estratégias para abordar o acompanhamento incompleto? Q11. Foi utilizada análise estatística apropriada? N = Não; U = Não claro; S = Sim

Q1. Were the two groups similar and recruited from the same population? Q2. Were the exposures measured similarly to assign people to both exposed and unexposed groups? Q3. Was the exposure measured in a valid and reliable way? Q4. We're confounding factors identified? Q5. Were strategies to deal with confounding factors stated? Q6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)? Q7. Were the outcomes measured in a valid and reliable way? Q8. Was the follow up time reported and sufficient to be long enough for outcomes to occur? Q9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored? Q10. Were strategies to address incomplete follow up utilized? Q11. Was appropriate statistical analysis used? N = No; U = Unclear; Y = Yes