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Faculdade de Medicina

Programa de Pós-Graduação em Ciências da Saúde da Criança e do Adolescente

Danilo Bastos Bispo Ferreira

ADOLESCENT SUICIDE AND SELF-HARM: PREDICTIVE MODELS AND IMPACTS OF THE COVID-19 PANDEMIC

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Danilo Bastos Bispo Ferreira

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Linha de pesquisa: **Desenvolvimento infantil**

Orientadora: Profa. Dra. Débora Marques de Miranda
Coorientadora: Profa. Dra. Renata Maria Silva Santos
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ATA DE DEFESA DE DISSERTAÇÃO

Às quinze horas e trinta minutos do dia quatro de fevereiro de dois mil e vinte e cinco, na sala 029 (Sala da Congregação da FM), andar térreo da Faculdade de Medicina da Universidade Federal de Minas Gerais, realizou-se a defesa de dissertação de mestrado do aluno **DANILO BASTOS BISPO FERREIRA**, número de registro 2023651268, graduado no curso de MEDICINA, como requisito parcial para a obtenção do grau de Mestre em CIÊNCIAS DA SAÚDE , pelo Programa de Pós-Graduação em Ciências da Saúde - Saúde da Criança e do Adolescente. A Presidência da sessão coube à Prof.ª Débora Marques de Miranda - Orientadora (UFMG). Inicialmente a Presidente após dar conhecimento aos presentes sobre o teor das Normas Regulamentares do trabalho final de Pós-Graduação, fez a apresentação da Comissão Examinadora, assim, constituída pelos seguintes Professores Doutores: Débora Marques de Miranda - Orientadora (UFMG), Maria Carolina Lobato Machado (UFMG), Jonas Jardim de Paula (UFMG), Antônio Marcos Alvim Soares Júnior (UFMG), Renata Maria Silva Santos (UFMG). Em seguida a Presidente autorizou o aluno a iniciar a apresentação de seu trabalho final intitulado **"ADOLESCENTES, SUICÍDIO E AUTOMUTILAÇÃO: MODELOS PREDITIVOS E IMPACTOS DA PANDEMIA DE COVID-19"**. Seguiu-se à arguição pela comissão Examinadora, com a respectiva defesa do aluno. Logo após a Comissão reuniu-se sem a presença do candidato e do público para julgamento e expedição do resultado da avaliação do trabalho final do aluno e considerou a dissertação **aprovada**. O resultado final foi comunicado publicamente ao aluno pela Presidente da Comissão. Nada mais havendo a tratar, a Presidente encerrou a sessão e lavrou a presente ata que, após lida, será assinada eletronicamente por todos os membros da Comissão Examinadora presente na sessão através do SEI (Sistema Eletrônico de Informações) do Governo Federal.

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RESUMO

A adolescência é um período crítico de mudanças físicas, emocionais e sociais, marcado por uma vulnerabilidade crescente a problemas de saúde mental, incluindo autoagressão e suicidabilidade. A pandemia de COVID-19 exacerbou esses desafios globalmente, amplificando condições preexistentes, como depressão e ansiedade, devido ao fechamento de escolas, isolamento social e uso excessivo de telas. Esta revisão sistemática investiga a prevalência e os fatores de risco associados à autoagressão e aos comportamentos suicidas entre adolescentes antes e durante a pandemia, com foco no papel dos determinantes psicossociais, econômicos e culturais. Disparidades de gênero e variações culturais emergiram como fatores-chave que influenciam os comportamentos suicidas, afetando particularmente adolescentes do sexo feminino. A revisão segue o protocolo PRISMA e utiliza a estratégia PECO, analisando dados de estudos quantitativos em populações de 10 a 19 anos, publicados entre 2010 e 2024. Os achados visam informar políticas públicas e estratégias de intervenção para mitigar o impacto da pandemia na saúde mental de adolescentes. Esta pesquisa contribui para a compreensão de como crises globais agravam vulnerabilidades juvenis, oferecendo insights sobre fatores de risco e alvos para intervenções de saúde mental culturalmente sensíveis.

Palavras-chave: adolescentes; suicidabilidade; autoagressão; pandemia; saúde mental; fatores de risco; prevalência

ABSTRACT

Adolescence is a critical period of physical, emotional, and social change, marked by increased vulnerability to mental health issues, including self-harm and suicidality. The COVID-19 pandemic exacerbated these challenges globally, amplifying pre-existing conditions like depression and anxiety due to school closures, social isolation, and excessive screen time. This systematic review investigates the prevalence and risk factors of self-harm and suicidal behaviors among adolescents before and during the pandemic, focusing on the role of psychosocial, economic, and cultural determinants. Gender disparities and cultural variations emerged as key factors influencing suicidal behaviors, with adolescent girls particularly affected. The review follows the PRISMA protocol and employs the PECO strategy, analyzing data from quantitative studies in populations aged 10-19, published between 2010 and 2024. The findings aim to inform public policy and intervention strategies to mitigate the pandemic's impact on adolescent mental health. This research contributes to understanding how global crises exacerbate youth vulnerabilities, providing insights into risk features and targets culturally sensitive mental health intervention.

Keywords: adolescents; suicidality; self-harm; pandemic; mental health; risk factors; prevalence

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LISTA DE ABREVIATURAS

ACE: Adverse Childhood Experiences

AI: Artificial Intelligence

AUC: Area Under the Receiver Operating Characteristic Curve

CEPAI-FHEMIG: Centro de Emergência Psiquiátrica da Infância e Adolescência da Fundação Hospitalar do Estado de Minas Gerais

COVID-19: Coronavirus Disease 2019

EHRs: Electronic Health Records

FoMO: Fear of Missing Out

F1: Métrica F1

HBSC-SCL: Health Behaviour in School-aged Children Symptom Checklist

ID: Identifier

JBI: Joanna Briggs Institute (Instituto de Joanna Briggs).

LGBTQ: Lesbian, Gay, Bisexual, Transgender, Queer (or Questioning)

LR: Logistic Regression

ML: Machine Learning

NSSI: Non-Suicidal Self-Injury

OR: Odds Ratio

OV: Oversampling

PECO: Population, Exposure, Comparator, Outcome

PPV: Positive Predictive Value

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

PROSPERO: Registro de Revisões Sistemáticas e Meta-Análises

PTSS-COVID19: Post-Traumatic Stress Symptoms Related to COVID-19

RF: Random Forest

SHAP: Shapley Additive Explanations

SI: Suicidal Ideation

SR: Suicide Risk

STBs: Suicidal Thoughts and Behaviors

WHO: World Health Organization

XGB: eXtreme Gradient Boosting

YRBSS: Youth Risk Behavior Surveillance System

SUMÁRIO

1 INTRODUÇÃO

Segundo a Organização Mundial da Saúde (OMS), 14% dos jovens entre 10-19 anos têm problemas de saúde mental. Ter uma doença mental grave reduz a expectativa de vida em 13 a 32 anos (Chesney, Goodwin, Fazel, 2014; Ilyas, Chesney, Patel, 2017).

Depressão, ansiedade e distúrbios comportamentais estão entre as principais causas de transtornos mentais e incapacidade em adolescentes, sendo o suicídio já a quarta principal causa de morte entre jovens de 15-19 anos (OMS, 2021).

Transtornos como automutilação e comportamento suicida estão cada vez mais presentes nos hospitais pediátricos, onde a gravidade do quadro varia de acordo com o transtorno de base apresentado pelo paciente, bem como através do acesso a meios letais (Maguire, McGrath, Byrne, 2019).

Durante a pandemia do COVID-19, um estudo observou a redução das buscas ao serviço e urgência e emergência, junto a um aumento da taxa de automutilação de 7%. A população infanto-juvenil é pouco estudada quanto aos aspectos psiquiátricos, e é essencial compreender os fatores associados ao suicídio e automutilação nesse público. Determinando os fatores de risco associados, é possível implementar sistemas de acesso onde os pacientes de risco podem ser direcionados para tratamentos adequados de forma precoce (Iyengar et al., 2018).

Modelos para entender relações e até mesmo prever suicídio e automutilação vêm sendo estudados há bastante tempo e, nos últimos anos, várias abordagens baseadas em aprendizado de máquina (AM) foram propostas (Harris, Beese, Moore, 2019; Pirkis et al., 2022) . Muitos trabalhos realizados até então focam na prevenção destes fatores a partir de mensagens de texto e das redes sociais, enquanto que outros olham para os fatores clínicos e do ambiente. No primeiro grupo, modelos de linguagem como o BERT vêm sendo fortemente analisados. O uso de abordagens multi-tarefa também é comum (Ji et al., 2020).

A automutilação não-suicida cometida por um indivíduo refere-se à autolesão provocada contra um tecido corporal na ausência de intenção de morrer (Brown, Plener, 2017; Nock, 2010). Em geral, as formas mais comuns de agressão observadas entre crianças e adolescentes são cortes de pele, queimadura e arranhões de intensidades variáveis, principalmente em antebraços e coxas (Nock, 2010).

A autolesão não-suicida se difere qualitativamente do comportamento suicida, no entanto, a autolesão com ou sem intenção suicida representa diferentes versões do mesmo comportamento, que busca na autoagressão a substituição da dor emocional pela dor física. Dessa forma, crianças e adolescentes utilizam da automutilação como ferramenta de alívio do

sofrimento psíquico e da dor emocional, à medida que substituem a angústia emocional pelo prazer gerado pela autolesão, ainda que essa seja dolorosa fisicamente (Nock, 2010).

Já o suicídio é caracterizado por morte autoprovocada com sinais de que a pessoa pretendia morrer, de forma consciente e intencional. Os comportamentos suicidas são pensamentos de morte, ideação suicida (pensamento de causar a própria morte), tentativa de suicídio e o suicídio em si (Brahmbhatt et al., 2019).

Crianças e adolescentes com comportamento suicida são geralmente avaliados em um pronto-socorro pediátrico ou clínico. Nesses casos, a estabilização do paciente pela equipe deve ser prioridade. A maneira como os pacientes com comportamento suicida e seus familiares são tratados no pronto-socorro pode afetar a adesão ao acompanhamento (Trivedi, Kerschner, 2009).

Suicídio é a segunda causa de morte em crianças e adolescentes no mundo (Brahmbhatt et al., 2019). No Brasil, a taxa entre adolescentes aumentou 24% ao longo de 2006-2015 (Jaen-Varas et al., 2019).

A adolescência é um período crítico de mudanças físicas, emocionais e sociais, marcado por uma vulnerabilidade crescente a problemas de saúde mental, incluindo autoagressão e suicidabilidade. A pandemia de COVID-19 exacerbou esses desafios globalmente, amplificando condições preexistentes, como depressão e ansiedade, devido ao fechamento de escolas, isolamento social e uso excessivo de telas. Esta revisão sistemática investiga a prevalência e os fatores de risco associados à autoagressão e aos comportamentos suicidas entre adolescentes antes e durante a pandemia, com foco no papel dos determinantes psicossociais, econômicos e culturais.

2 REVISÃO DE LITERATURA

A pandemia de COVID-19 trouxe impactos profundos à saúde mental de adolescentes, exacerbando problemas preexistentes e criando novas vulnerabilidades. Medidas como o isolamento social e o fechamento de escolas contribuíram para o aumento da solidão e de comportamentos autolesivos, incluindo suicidalidade. Estudos realizados no Reino Unido relataram que a solidão foi um fator significativo associado à automutilação em adolescentes durante o primeiro lockdown (Geulayov et al., 2022), enquanto na Espanha, 20,8% dos adolescentes relataram pensamentos suicidas e 7,4% tentaram suicídio durante o confinamento, com o apoio social mostrando-se um fator protetor e o abuso psicológico aumentando em cinco vezes o risco de comportamento suicida (Suárez Soto et al., 2022).

Na China, adolescentes submetidos ao aprendizado remoto relataram prevalências significativas de depressão (16,3%), ansiedade (10,3%) e suicidalidade (20,3%), agravadas por má qualidade do sono, desempenho acadêmico insatisfatório e preocupação com a COVID-19 (Peng et al., 2021). Adolescentes rurais, especialmente crianças "deixadas para trás", também apresentaram taxas elevadas de suicidalidade devido a ansiedade e depressão (Hou et al., 2021). De forma semelhante, traços de personalidade como neuroticismo e impulsividade, associados à baixa funcionalidade familiar, aumentaram a incidência de automutilação sem intenção suicida (NSSI) no contexto chinês (Wang et al., 2023).

Globalmente, fatores como o cyberbullying emergiram como riscos importantes, com vítimas de violência online apresentando maior vulnerabilidade à suicidalidade, especialmente na Malásia (Mohd Fadhli et al., 2022). Na Suíça, adolescentes relataram prevalência de 14,4% de ideação suicida, associada ao bullying, ao uso excessivo de telas e às relações parentais enfraquecidas (Dumont et al., 2024). Já na Suécia, o comportamento autolesivo aumentou de 17,2% em 2011 para 27,6% em 2021, com o isolamento social intensificando o estresse emocional (Zetterqvist et al., 2021).

Nos Estados Unidos, adolescentes de minorias sexuais apresentaram maior risco de suicidalidade, influenciado por estigmas e discriminação. Leis de crimes de ódio que incluem orientação sexual como categoria protegida mostraram-se efetivas em reduzir esses riscos (Prairie et al., 2022). Paralelamente, experiências adversas na infância (ACEs) aumentaram significativamente as chances de automutilação e suicidalidade em jovens, com efeitos proporcionais ao número de ACEs relatados (Meeker et al., 2021).

Visitas a serviços de emergência para cuidados relacionados à saúde mental aumentaram substancialmente durante a pandemia, especialmente por casos de tentativa de suicídio e

autolesão. Nos Estados Unidos, houve uma elevação significativa nas taxas de internações em hospitais pediátricos devido a essas condições, destacando a necessidade urgente de intervenções voltadas a mitigar os efeitos da pandemia (Shankar et al., 2022).

Finalmente, adolescentes enfrentaram desafios diversos em contextos específicos, como rupturas familiares e dificuldades financeiras em Uganda, o que contribuiu para um aumento significativo de ideação suicida e tentativas de suicídio (Bukuluki et al., 2021). Esses achados reforçam a importância de estratégias de intervenção que considerem os contextos socioculturais e econômicos para proteger a saúde mental de adolescentes frente a crises globais.

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3 OBJETIVOS

3.1 Objetivos gerais

- Analisar os fatores de risco associados à automutilação e à suicidalidade em adolescentes antes e durante a pandemia de COVID-19
- Examinar os fatores psicossociais e ambientais que influenciam o comportamento suicida e a automutilação em adolescentes
- Identificar padrões e tendências de suicidalidade em adolescentes utilizando ferramentas de aprendizado de máquina e revisões sistemáticas
- Propor estratégias de intervenção baseadas em fatores de risco psicossociais e econômicos identificados na literatura

3.2 Objetivos específicos

- Analisar a prevalência de suicidalidade e automutilação em adolescentes entre 2010 e 2024, com ênfase nos impactos psicossociais da pandemia.
- Avaliar o papel de fatores culturais e de gênero na modulação do comportamento suicida em adolescentes, com foco em populações vulneráveis, como meninas e minorias sociais.
- Validar modelos preditivos de comportamentos suicidas e automutilação com base em características sociodemográficas e diagnósticas em um cenário de pronto-socorro psiquiátrico.
- Comparar os fatores de risco identificados nos períodos pré-pandemia e pós-pandemia, destacando elementos emergentes como bullying digital e conflitos familiares.

4 MÉTODOS

4.1 Revisão sistemática de literatura

4.1.1 Registro do Protocolo

Uma revisão sistemática foi conduzida para responder à seguinte questão de pesquisa: "Houve uma mudança na prevalência e nos fatores de risco para suicidabilidade e autolesão entre adolescentes antes e após o início da pandemia de COVID-19 até os dias atuais?" A revisão seguiu o protocolo PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Shamseer et al., 2015) e foi registrada no PROSPERO sob o número de registro CRD42024538641.

4.1.2 Seleção do estudo

A busca oficial foi realizada em 07/05/2024, combinando os descritores “adolescentes”, “suicidalidade”, “automutilação” e “prevalência”. Para a busca pós-pandemia, foi adicionado o descritor “COVID-19”. Os descritores foram combinados utilizando o operador AND nas seguintes bases de dados: PubMed, Psycnet, Embase e Scopus.

4.1.3 Critérios de inclusão

Para garantir uma busca sensível, foram utilizados os seguintes critérios de elegibilidade: estudos quantitativos em amostras comunitárias com populações de 10 a 19 anos (adolescentes), publicados em inglês entre 2010 e 2024. O período foi estabelecido para abranger a fase de expansão tecnológica com maior engajamento de adolescentes na internet, permitindo a comparação com o período da pandemia de COVID-19, com o objetivo de avaliar a magnitude desses dois eventos em relação aos desfechos do estudo.

4.1.4 Critérios de exclusão

Foram excluídos estudos qualitativos, revisões de qualquer tipo, relatos de caso, séries de casos, literatura cinzenta e estudos realizados com amostras clínicas. Para garantir maior especificidade, os pesquisadores excluíram estudos que não abordassem as associações entre prevalência e fatores de risco para suicidalidade e automutilação.

4.1.5 Coleta de dados e análise

Os procedimentos de seleção foram realizados por pelo menos dois pesquisadores, de forma independente e às cegas, utilizando a plataforma de IA Rayyan (Johnson e Phillips, 2018). O consenso foi alcançado por meio de discussão entre os três autores: o mestrando e uma co-orientadora, e uma segunda co-orientadora que sanou as divergências encontradas nesse processo, sobre quais artigos seriam incluídos na revisão. A qualidade dos estudos foi avaliada utilizando a Ferramenta de Avaliação Crítica do Instituto Joanna Briggs (JBI). Este instrumento, baseado em uma lista de verificação, foi escolhido devido aos seus critérios rigorosos de avaliação para os estudos incluídos e sua recomendação na literatura para uso em estudos observacionais analíticos transversais e de coorte que buscam coletar dados sobre risco ou causalidade (Majid e Vanstone, 2018; Moola et al., 2019). A ferramenta avalia a descrição detalhada da amostra para garantir compatibilidade com a população de interesse.

4.2 Estudo original

4.2.1 Design do estudo

Este estudo constitui um braço de outro projeto já aprovado pelo Comitê de Ética (CEP) da Faculdade de Ciências Médicas sob o número 83419717.0.0000.5134. Serão utilizados dados públicos disponibilizados na literatura, assim como dados previamente coletados pelos pesquisadores do projeto-base que serve de fundamento para este projeto. Em relação aos dados públicos, serão analisadas bases de dados contendo informações sociodemográficas, clínicas e psicopatológicas, além de bases de textos provenientes de pesquisa em bases de dados.

A metodologia envolverá inicialmente análises simples baseadas na identificação de padrões frequentes para compreender melhor as variáveis e suas relações com os desfechos de interesse. Após essa etapa, será criado um modelo de representação dos dados, que poderá ser

multimodal, considerando a presença de dados tabulares e textuais. Por fim, serão desenvolvidos modelos causais capazes de lidar com problemas de distribuição de dados e os diferentes custos associados às classes de interesse para realizar inferência contrafactual.

4.2.2 Participantes

O estudo utilizou dados de uma pesquisa retrospectiva coletados na Urgência Psiquiátrica de um hospital em Belo Horizonte, desenhada para a coleta padronizada de informações de prontuários de crianças e adolescentes atendidos ao longo de um ano no serviço de urgência psiquiátrica do único centro de referência estadual para demandas psiquiátricas infantis (Lobato Machado et al., 2022). Por meio dessa estratégia, foram incluídos pouco mais de 2000 indivíduos que buscaram atendimento de urgência psiquiátrica ao longo de 2017. Os dados foram coletados em uma tabela padronizada que incluiu informações como diagnóstico atual, diagnóstico anterior, cidade de residência, idade, escolaridade do participante, entre outras, totalizando mais de 30 variáveis.

O conjunto de dados abrange 2.365 prontuários de saúde de pacientes atendidos no CEPAI-FHEMIG, sendo que alguns tiveram múltiplos atendimentos, resultando em 1.720 pacientes únicos (Lobato Machado et al., 2022). A base de dados de emergência psiquiátrica inclui idades que variam de 1 a 18 anos, com informações coletadas entre junho de 2017 e maio de 2018. O conjunto de dados contém 27 características pessoais e sociodemográficas, como raça, gênero, local de nascimento, local de residência, situação escolar, situação de moradia, responsável legal pelos pacientes, e 123 características clínicas, abrangendo detalhes como motivos para buscar assistência psiquiátrica, histórico familiar de transtornos mentais, informações sobre abuso de substâncias, diagnósticos psiquiátricos recebidos após o tratamento na unidade, atrasos no desenvolvimento neuropsicomotor e eventos traumáticos prévios, entre outros aspectos relevantes.

Três valores-alvo, automutilação, ideação suicida e tentativa de suicídio, foram extraídos da motivação dos pacientes para buscar ajuda, sendo esses os alvos de previsão. Nesse cenário, identificaram-se 337 casos de automutilação em 2.291 registros (14,71%), 309 casos de ideação suicida (13,48%) e 323 casos de tentativas de suicídio positivas (14,09%).

A automutilação foi definida operacionalmente como qualquer manifestação não suicida de autoenvenenamento ou autolesão, desprovida de intenção explícita de induzir mortalidade. A ideação suicida foi identificada em casos em que os indivíduos relataram contemplação ou

planejamento estratégico associados a tendências suicidas. Paralelamente, uma tentativa de suicídio foi caracterizada como um ato deliberado de autoenvenenamento ou autolesão com o objetivo explícito de induzir mortalidade.

4.2.3 Resultados e instrumentos

Os dois textos abordam a temática de suicidabilidade e automutilação em adolescentes sob diferentes perspectivas metodológicas. O primeiro artigo, intitulado *"Predicting suicidal behavior in observational study of children and adolescents within psychiatric emergency setting"*, utilizou aprendizado de máquina para prever comportamentos suicidas (ideação suicida, automutilação e tentativas de suicídio) em um ambiente de emergência psiquiátrica pediátrica. O estudo incluiu 1.687 pacientes com idades entre 13 e 18 anos e analisou variáveis demográficas, clínicas e motivacionais. Os algoritmos utilizados foram Logistic Regression, Random Forest e XGBoost, com o Random Forest apresentando o melhor desempenho geral. A sensibilidade variou entre 69,37% e 78,04%, enquanto a especificidade foi maior que 75% em todas as categorias. Fatores de risco como depressão, isolamento social, ideação suicida e características familiares foram os mais preditivos, interpretados por meio da ferramenta SHAP (Shapley Additive Explanations).

O segundo texto, intitulado *"Suicidality and self-harm in adolescents, before and after the COVID-19 pandemic: A systematic review"*, realizou uma revisão sistemática para investigar a prevalência e os fatores de risco associados à suicidabilidade e automutilação em adolescentes antes e durante a pandemia de COVID-19. A pesquisa seguiu o protocolo PRISMA, registrada no PROSPERO, e utilizou a estratégia PECO para estruturar a análise, incluindo estudos quantitativos publicados entre 2010 e 2024. Antes da pandemia, a prevalência anual de tentativas de suicídio era de 0,57%, enquanto a automutilação não suicida (NSSI) era de 0,056%. Após a pandemia, as tentativas de suicídio caíram para 0,19% ao ano (-66,67%), enquanto a prevalência de NSSI aumentou para 0,61% (+992,86%). Fatores como isolamento social, uso excessivo de telas, conflitos familiares, dificuldades acadêmicas e falta de suporte social emergiram como determinantes críticos. Adolescentes do sexo feminino e grupos LGBTQ+ apresentaram maior vulnerabilidade. A qualidade dos estudos foi avaliada pela ferramenta JBI Critical Appraisal Tool, garantindo rigor metodológico.

Ambos os artigos oferecem uma visão ampla sobre os fatores de risco e mudanças nos comportamentos suicidas e de automutilação em adolescentes, destacando a importância de intervenções direcionadas, especialmente em contextos de crise, como a pandemia de COVID-

19. Enquanto o primeiro artigo fornece insights preditivos detalhados baseados em tecnologia, o segundo traz uma perspectiva histórica e contextual, permitindo uma análise complementar dos fenômenos estudados.

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5 RESULTADO E DISCUSSÃO

Os resultados e as discussões serão apresentados sob forma de dois artigos ainda não publicados.

- Artigo de revisão: *Predicting suicidal behavior in observational study of children and adolescents within psychiatric emergency setting*
- Artigo original: *Suicidality and self-harm in adolescents, before and after the COVID-19 pandemic: a systematic review*

5.1 Artigo de revisão

Predicting suicidal behavior in observational study of children and adolescents within psychiatric emergency setting

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Abstract

Background: Suicide is one of the leading causes of death worldwide. Prediction of suicide behavior is a challenge, since it is a relatively rare event. While middle- and low-income countries have most suicides, there are a small number of studies. Here we propose a prediction of suicide behavior in youths in a middle-income population. **Methods:** In this study, an enriched sample from a Child Psychiatry Facility, dedicated to the care of children and adolescents with psychiatric disorders, resulted in a comprehensive database with sociodemographic and diagnostic information. Machine learning strategies were employed to predict three outcomes: self-harm, suicide ideation, and suicide attempts. **Results:** In this setting, suicide-related behavior consisted of 28.7% of the demands. Using the most effective model for prediction, sensitivities achieved were of 69.37% for self-harm, 78.04% for suicide ideation and 71.18% for suicide attempts. Specificity was higher than 75%, although the accuracy was still low, especially for suicide attempts. Among the risk features, some social clues emerged as risk factors to suicide-related behaviors, adding potential differences due to social condition. **Conclusions:** Self-harm and suicide ideation were accurately predicted,

promoting potential for early identification and features that may reduce suicide rates.

Keywords: suicide attempt; self-harm; suicide ideation; children; adolescents; risk features; prediction

1) Introduction:

Suicide claims a life every 40 seconds globally, impacting 60-135 people for each loss (Knipe et al., 2022). In 2020, a meta-analysis reported a suicide rate of 4.9/100,000 and a pooled rate of suicidal ideation of 17% among adolescents (Bersia et al., 2022). In developed countries, suicide stands as the foremost cause of death among children and adolescents (Knipe et al., 2022). The substantial and often underestimated burden of suicide and related behaviors, including self-harm, weighs heavily on low- and middle-income countries (Knipe et al., 2022; Naghavi and Global Burden of Disease Self-Harm Collaborators, 2019). Actually, low- and middle-income answer for 75% of suicides worldwide, so there is a need to have an effort to understand the phenomena since there still few studies where suicide happens more (Klonsky et al., 2016; Robinson et al., 2018).

It is estimated that self-harm occurs at 20 times higher frequency than suicide and often precedes suicide attempts (Mars et al., 2019a). Notably, in high-income countries, self-harm is a prominent predictor of suicide (Carroll et al., 2014). Both engaging in self-harm and being exposed to it are predictors of suicide attempts (Mars et al., 2019). Among adolescents, especially girls aged 15-17 in low and middle-income countries, the incidence of suicide planning and attempts is approximately 17% (Uddin et al., 2019). Given the profound individual, societal and familial impact of child and adolescent deaths, it is imperative to investigate the factors leading to this condition.

Predicting suicide is a formidable challenge even for proficient psychiatrists and mental health specialists, as it extends beyond health-related factors and evolves over a person's lifetime. Many machine learning (ML) trials have done models to predict suicide (Mulder et al., 2016). Understanding the interplay between social and environmental elements with mental health becomes crucial, as social factors often contribute to variations in behavior and suicide-related risks (Glenn et al., 2020; Navarro et al., 2021; Pollock, 2019; Robinson et al., 2018). This holds particular significance in low and middle-income countries like Brazil, where inequality and social shortcomings can magnify psychiatric risks (Glenn et al., 2020; Orellana et al., 2020).

The identification of robust predictors for suicide-related behaviors offers a pathway to intervene in individuals' behavior or monitor specific variables. Harris et al. (2019) conducted a systematic review of risk assessment tools for predicting adolescence's suicide, (Harris et al., 2019a, 2019b). They evaluated ten risk assessment tools used in the US and the UK and found that none of them could effectively predict suicidal behavior. This indicates the complexity of predicting such behavior, a matter that warrants significant attention given its widespread impact (Harris et al., 2019a, 2019b).

In a population-based longitudinal study of Scottish young adults aged 18 to 34, prediction of suicidal behavior using traditional ML techniques (van Mens et al., 2020) found that algorithms based on decision trees outperformed regular logistic regression, achieving a sensitivity of 0.47 and a specificity of 0.91 for suicide attempt prediction. When comparing short and long-term predictions of suicide risk using longitudinal data from structured electronic health records (EHRs) from the Connecticut Children's Medical Center, Su et al. (2020) developed a model that achieved a sensitivity of 0.62 and a specificity of 0.90. Their model exhibited superior performance for shorter prediction windows (Su et al., 2020).

Obtaining data to comprehend the factors influencing suicide risk is a huge challenge, as most data rely on self-reports, which may not capture all critical and informative aspects of a patient's mental state. Data about children and adolescents are particularly scarce in middle-income countries. A model derived from a Brazilian cohort revealed a heightened risk of depression among individuals who are female, socially isolated, non-white, involved in drug use and conflicts, experiencing academic difficulties, and victims of maltreatment (Orellana et al., 2020). This report underscores the necessity of a deeper understanding of how social and environmental factors interact with mental health.

Here, models were created to predict self-harm, suicidal ideation and attempts, using a enriched dataset for the outcome of suicide-behavior from the emergency unit of the Psychiatric Emergency Center for Children and Adolescents (CEPAI-FHEMIG) in Belo Horizonte, Brazil. This facility provides urgent psychiatric care to children and adolescents, primarily assisting individuals reporting depression, substance use, and symptoms of agitation and aggressiveness, as detailed in Lobato Machado et al. (2022). Considering the characteristics of CEPAI-FHEMIG, the sample had frequent suicide behavior than general population, which may facilitate the identification of risks to the outcome (Robinson et al., 2018).

This study extends the existing literature by employing traditional machine learning techniques on a comprehensive dataset obtained from an emergency mental health care institution for children and adolescents. It delves into the contribution of features to the final

predictions, highlighting those with significant predictive power.

2) Methods:

Project was evaluated and approved by the local ethical board.

Sample:

The dataset encompasses 2,365 health records of patients admitted to CEPAI-FHEMIG, some having multiple admissions, resulting in 1,720 unique patients (Lobato Machado et al., 2022). The psychiatric emergency database ages range from 1 to 18 years, collected from June-2017 to May-2018. The dataset includes 27 personal and socio-demographic features, such as race, gender, place of birth, residential location, school situation, living situation, legal guardian of the patients, and 123 clinical features, encompassing details such reasons for seeking psychiatric assistance, family history of mental disorders, substance abuse information, psychiatric diagnoses received after treatment at the facility, neuro-psychomotor development delays, and previous traumatic events, among other relevant aspects.

We excluded 75 admissions where patients: (i) had no information at all (5); (ii) had only personal information (37); (iii) had no information about the motivations for looking for help or diagnoses (31); (iv) had not completed the screening stages at the center (1); (v) or had missing age information (1). Regarding the features, 12 out of 110 contained textual information (eg., written reason why the patient left school). On average, more than 87% of the data in these 12 features were missing and were discarded. The original dataset also contained 21 features related to suicidal behavior, which were unfortunately mostly missing values (more than 80% of the instances were missing) and thus excluded due to the high risk of data imputation in this context.

With the assistance of psychiatry professionals, out of the remaining 77 features, 57 were considered more informative for the tasks at hand. We examined the following variables as predictors in the ML models: motivation for seeking psychiatric help, diagnosis received at CEPAI-FHEMIG.

From the selected features, 33 were categorical. These categorical features were binarized using a data dictionary, resulting in 21 new binary features corresponding to the 21 possible diagnoses (e.g., if the patient had depression, schizophrenia, or learning difficulties). The final dataset consisted of 2,289 admissions for 1,687 unique patients (1,071 male and 616

female), with each admission described by 154 features.

Outcomes:

Three target values - self-harm, suicidal ideation, and suicidal attempt - were extracted from the patient's motivation for seeking help, which was the prediction target. In this scenario, we had 337 out of 2,291 cases of self-harm (14.71%), 309 cases of suicide ideation (13.48%) and 323 positive suicide attempts (14.09%). More details were given in Figure 1(c).

Self-harm was operationally defined as any non-suicidal manifestation of self-poisoning or self-injury devoid of the explicit intent to induce mortality. Suicide ideation was identified in instances where individuals self-reported contemplation or strategic planning associated with suicidal tendencies. Concurrently, a suicide attempt was characterized as a deliberate act of self-poisoning or self-injury with the explicit aim of inducing mortality.

Analysis Methodology:

To build the prediction models for all outcomes, the classic methodology for dealing with data was followed. The first step was data preparation, as reported in the previous section, followed by a feature selection phase. Three models - Logistic Regression, Random Forest, and Gradient Boosting (Zaki and Meira, 2014) - were selected for testing to assess their comparative performance. These tests also explored model performance enhancements through data oversampling and context-sensitive techniques, such as parameter tuning. For each task, the most influenced features were analyzed using the model with the best performance. Shapley Additive Explanations (SHAP) were used to gain a deeper understanding of the factors associated with each of the outcomes (Lundberg and Lee, 2017).

The models were trained using two distinct sets of features. The first set incorporates all available features and is denoted as "All Features" in the results table. The second set, referred to as "Feature Selection", includes only specific factors such as the motivations for seeking help, the diagnoses received in the medical assessment, hospitalization status, first-time admission to CEPAI-FHEMIG, and personal data, including gender, age, and the number of people in the household. This latter subset was generated using pre-selected features based on expert knowledge, inspired by (van Mens et al., 2020), which also manually selects a subgroup based on its most descriptive features.

When training the models, the target variables were excluded from the features used as

predictors in the training process. Considering the relationship between suicide ideation and suicide attempt, ideation was used as a predictor for suicide attempt, but not the opposite, even though there are instances in the data where the attempt happens without any ideation being reported. For the self-harm prediction task, both suicidal ideation and suicide attempts were used as predictors, in line with previous research (Mars et al., 2019b).

As previously mentioned, both datasets were fed into three (ML) models: Logistic Regression (LR), Random Forest (RF), and eXtreme Gradient Boosting (XGBoost). LR was chosen for being easily interpretable, while RF and XGboost, as tree-based models, excel at capturing non-linear relationships in the data and may facilitate the emergence of interpretable models. The experiments were conducted using the Scikit-learn (Pedregosa et al., 2011) and XGBoost libraries (Chen and Guestrin, 2016). A detailed description of these algorithms can be found in Bishop (2006)(Bishop, n.d.). Given the imbalanced nature of the data, which is a result of the highly contextualized data collected in an emergency room setting, instances with suicidal behavior were oversampled to constitute 30% of the training set. It's important to note that the data in the test set retained its original distribution.

In our study, each model used provided feature importance scores for the predictors, allowing us to compare the most significant features for each classification task. Additionally, SHAP values were generated (Lundberg and Lee, 2017). SHAP is an approach rooted in game theory, frequently used to explain the output of any machine learning model. It reveals the extent to which each feature contributes to the target feature. The interpretation of SHAP is akin to feature importance, but SHAP goes further by indicating whether each feature has a positive or negative relationship with the predicted value, offering a richer understanding of feature impact.

Experimental setup:

The three aforementioned models underwent testing with both the complete set of attributes, referred to as "All Features," and a reduced set of features, referred to as "Feature Selection." Both experiments were conducted with and without oversampling.

A 10-fold cross-validation strategy was implemented to evaluate the models, following the methodology detailed in Bishop (2006)(Bishop, n.d.). To prevent data leakage, we ensured that all admissions for the same patient were included in a single fold, maintaining a consistent proportion of positive cases for the target variable across all folds. However, since each model allowed for parameter tuning, a train/validation/test split strategy was employed. In essence,

with the data divided into 10 stratified folds for each fold, the approach involved training the model on 8 folds, validating on one fold, and testing on the remaining. During the validation step, the model did not have access to the test set. In the test step, the validation set was excluded to prevent any influence on the model, especially since parameter choices were determined based on the validation set.

In the case of LR, the sole parameter considered during the tuning process was the classification threshold, from which point an example is considered positive or negative (default value of 0.5). As for XGBoost, a grid search was conducted to identify a better combination of parameters. This search encompassed 4 parameters: (1) number of boosting iterations, (2) ratio of features used to train a tree, (3) maximum tree depth, and (4) ratio of training instances in a subsample.

Concerning RF, five parameters were taken into account for tuning: (1) number of trees in the forest, (2) maximum depth of the tree, (3) minimum number of samples required to split an internal node, (4) minimum number of samples required to be at a leaf node and (5) whether bootstrap samples are used when building trees. Due to the multitude of possible parameter combinations, an initial random search within the parameter space was conducted. Subsequently, the best values identified in this search were tested through a grid search, to obtain the best parameter configuration.

Once the parameters for both Random Forest and XGBoost models were determined, further tuning involved adjusting their classification thresholds using the validation set. In this scenario, we balanced the values of sensitivity and specificity using the F1 metric, which considers the harmonic mean of PPV and sensitivity. After that, the models were evaluated on the test sets.

The performance of the models was assessed using four metrics:

1. Area Under the Receiver Operating Characteristic Curve (AUC): Assesses the model's performance across all classification thresholds of the true positive rate and false positive rate, providing a comprehensive view of the model's ability to discriminate between classes.
2. Positive Predictive Value (PPV): Proportion of correctly predicted positive instances out of all predicted positive ins/tances, offering insights into the accuracy of positive predictions.
3. Sensitivity: Proportion of actual positive instances correctly identified by the classifier, indicating how well the model captures true positive cases.
4. Specificity: Proportion of actual negative instances correctly identified by the classifier, indicating how well the model captures true negative cases.

These metrics collectively offer a thorough evaluation of the model's performance in classification tasks. However, in the context of this project, the sensitivity score is considered more important than the other metrics, because the impact of not identifying a positive case of suicide attempt (or ideation, or self-harm) is considered more serious than misclassifying a negative case. This metric will be used to judge the models' performance against each other.

Finally, as the data is highly unbalanced, we performed a final experiment with oversampled data. Oversampling is a well-known technique that alters the data distribution in the training set, aiming to enhance the predictive model by providing more instances of the rarer class. There are many ways to oversample data, and here we simply create duplicate instances of the minority class. Consequently, tuning parameters on oversampled data may not yield a good configuration for the test data, as it does not reflect the actual data distribution but an "amplified" version.

An illustration of this behavior can be observed in the RF models: in some of the experiments with oversampled training data, untuned models exhibited a higher sensitivity score. As our primary goal is to have the most effective predictive models, the final results, which will be presented shortly, consistently show the model with the highest sensitivity score, regardless of whether it underwent a tuning process.

3) Results:

Descriptive Results

According to Figure 1a, most patients (≈ 62%) were between 13 and 18 years old. Figure 1b shows the number of admissions to CEPAI-FHEMIG. Although most of the patients were admitted only once, 21% of the individuals were admitted at least twice in the studied period, revealing an incidence of repeated suicide attempts (or thoughts or behaviours) in line with literature.

Figures 1c and 1d show the distribution of the motivations for looking for help, and diagnoses given by the psychiatric professional after the assessment, respectively. The most common reasons were related to agitation, aggressiveness, irritability and learning difficulties, which are not traditionally associated with suicidal behaviour. Factors commonly related to suicidal behaviour are depression, self-harm, anxiety and self-aggressiveness, which were present in 19,07%, 14,7%, 14,36% and 5,28% of the admissions registered. Depression and

general mood disorders were diagnosed in 21,69% of all admissions, being the most common diagnosis. Other symptoms reported were mainly related to impulsive and aggressive behaviors. Suicide-related behaviors were among the motivations given by patients or their guardians to seek psychiatric care. As previously reported, the motivations were used to define the outcome variables of the model. The dataset had 337 out of 2,291 cases of self-harm (14.71%), 309 cases of suicide ideation (13.48%) and 323 positive suicide attempts (14.09%).

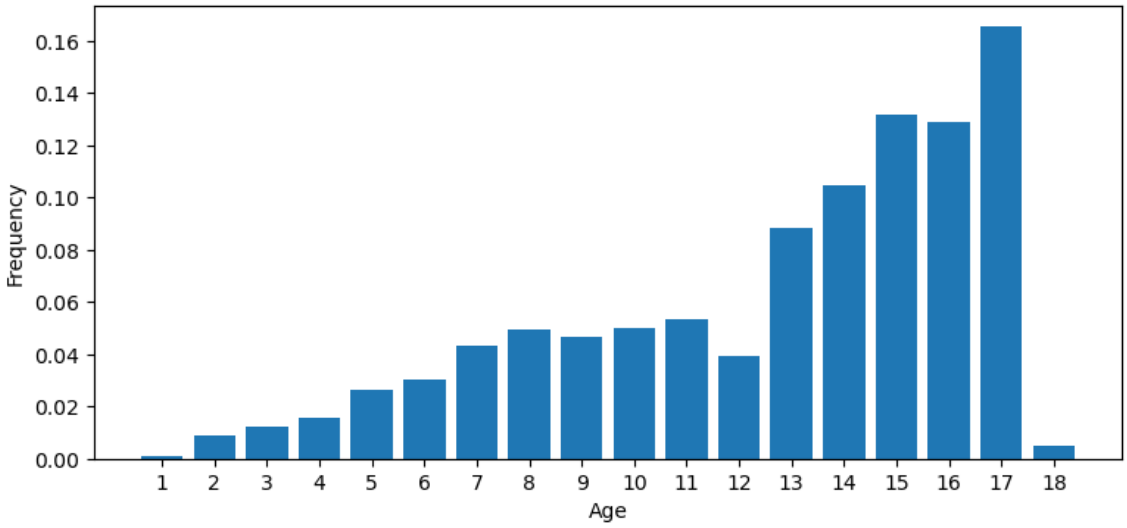

Figure 1a. Frequency of children searching for care in child psychiatry facilities for any reason.

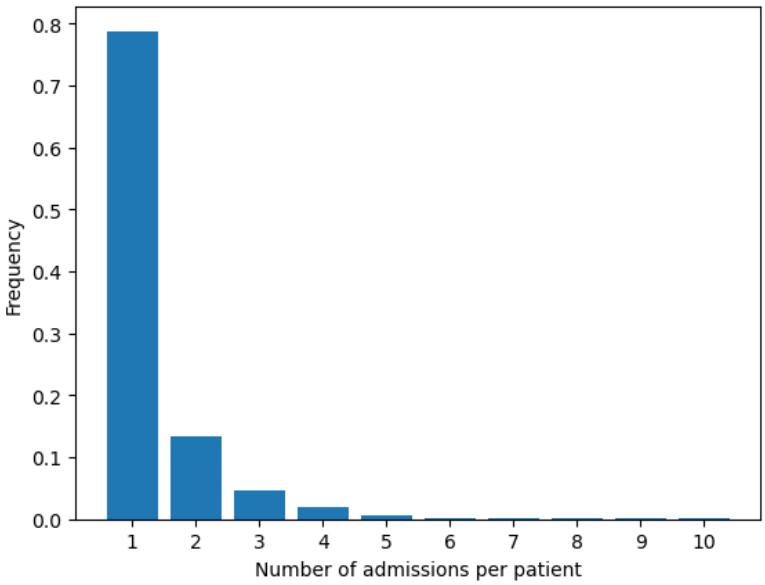

Figure 1b. Frequency of admissions for the same patient.

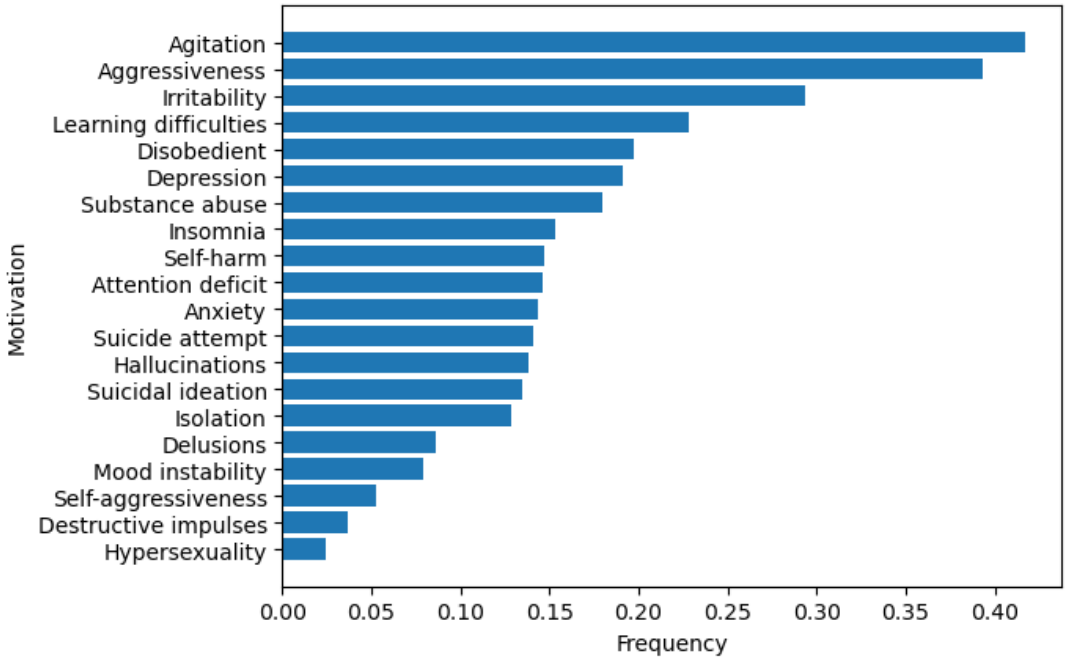

Figure 1c. Motives which motivated the family to search for child psychiatric care.

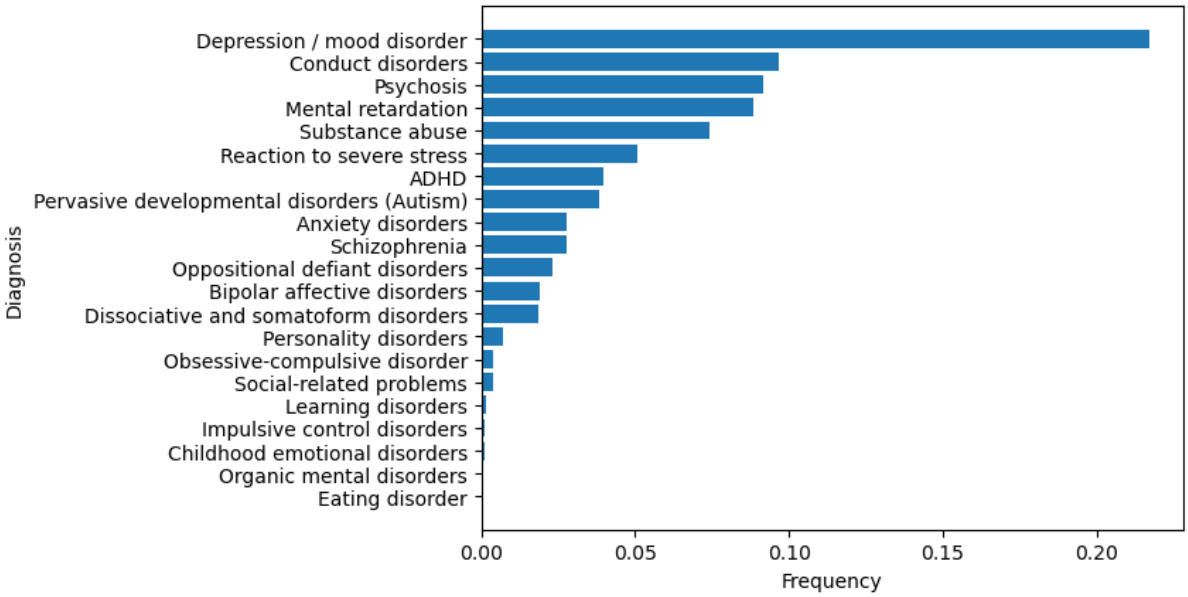

Figure 1d. Diagnosis from admission in the psychiatric facility.

Suicide Behavior Prediction Results

Tables 1, 2, and 3 present the results of the prediction models forecasting suicide attempts, suicidal ideation, and self-harm, respectively. In the tables, the acronym OV stands for OverSampling and refers to the models where data distribution was changed. The ratio of the outcome we want to predict corresponded to 30% of the training dataset. The Random Forest

model achieved the best overall performance when looking at the four metrics across all three tasks. The oversampling does not make a difference in the results of the current sample, as the results of the method with and without oversampling do not present statistical differences because their confidence intervals superpose. For suicide attempt and ideation prediction, the best-performing model used only the "Feature Selection" subset of features, achieving a sensitivity of 0.7118, specificity of 0.7592 and PPV of 0.3350 for suicide attempt prediction. For suicide ideation prediction, the method presented a sensitivity of 0.7804, specificity of 0.7763 and PPV of 0.3602. In the case of self-harm, the best model was trained using all available features, resulting in a sensitivity of 0.6937, specificity of 0.8177 and PPV of 0.4086.

Table 1. Suicide attempt prediction results.

All Features

Models	AUC	PPV	Sensitivity	Specificity
LR	0.6582±0.0628	0.3841±0.0835	0.4350±0.1494	0.8814±0.0462
LR OV	0.6956±0.0678	0.3372±0.0542	0.5837±0.1614	0.8076±0.0577
RF	0.7338±0.0659	0.3719±0.0829	0.6583±0.1067	0.8092±0.0547
RF OV	0.7379±0.0543	0.3461±0.0701	0.7047±0.0990	0.7710±0.0637
XGB	0.6769±0.0489	0.3256±0.0565	0.5406±0.1007	0.8132±0.0394
XGB OV	0.6989±0.0786	0.3574±0.0734	0.5682±0.1610	0.8295±0.0434

Feature Selection

Models	AUC	PPV	Sensitivity	Specificity
LR	0.6808±0.0523	0.4380±0.0951	0.4665±0.1135	0.8951±0.0376
LR OV	0.7264±0.0644	0.3686±0.0661	0.6428±0.1504	0.8100±0.0627
RF	0.7225±0.0430	0.3151±0.0563	0.7055±0.0932	0.7395±0.0636
RF OV	0.7355±0.0430	0.3350±0.0514	**0.7118±0.1079**	0.7592±0.0627
XGB	0.6812±0.0553	0.3155±0.0502	0.5628±0.1272	0.7995±0.0391
XGB OV	0.7132±0.0406	0.3012±0.0241	0.6899±0.0989	0.7364±0.0366

Table 2. Suicide ideation prediction results.

All Features

Models	AUC	PPV	Sensitivity	Specificity
LR	0.7053±0.0406	0.4640±0.0765	0.5075±0.1040	0.9031±0.0334
LR OV	0.7418±0.0445	0.4219±0.0861	0.6274±0.1252	0.8561±0.0492
RF	0.7599±0.0434	0.4324±0.0688	0.6625±0.1212	0.8572±0.0434
RF OV	0.7819±0.0540	0.4178±0.0751	0.7287±0.1373	0.8351±0.0467
XGB	0.7265±0.0513	0.3596±0.0683	0.6321±0.1086	0.8210±0.0384
XGB OV	0.7782±0.0304	0.3656±0.0667	0.7755±0.0896	0.7809±0.0573

Feature Selection

Models	AUC	PPV	Sensitivity	Specificity
LR	0.7250±0.0415	0.4952±0.1064	0.5449±0.1096	0.9051±0.0352
LR OV	0.7397±0.0364	0.4346±0.0696	0.6099±0.1046	0.8696±0.0397
RF	0.7557±0.0340	0.3999±0.0730	0.6781±0.1020	0.8334±0.0471
RF OV	0.7783±0.0363	0.3601±0.0615	**0.7804±0.0954**	0.7763±0.0525
XGB	0.6991±0.0466	0.3685±0.0615	0.5477±0.1001	0.8504±0.0362
XGB OV	0.7514±0.0505	0.3929±0.0643	0.6703±0.1304	0.8324±0.0475

Table 3. Self-harm prediction results.

All Features

Models	AUC	PPV	Sensitivity	Specificity
LR	0.6989±0.0511	0.4593±0.0702	0.5072±0.1348	0.8905±0.0481
LR OV	0.7315±0.0582	0.4045±0.0831	0.6348±0.1394	0.8281±0.0628
RF	0.7333±0.0367	0.4567±0.0678	0.5955±0.1039	0.8710±0.0490
RF OV	0.7557±0.0340	0.4086±0.0700	**0.6937±0.1075**	0.8177±0.0600
XGB	0.7198±0.0288	0.3690±0.0438	0.6305±0.0873	0.8091±0.0492
XGB OV	0.7199±0.0571	0.4693±0.0692	0.5524±0.1425	0.8874±0.0447

Feature Selection Models	AUC	PPV	Sensitivity	Specificity
LR	0.7070±0.0492	0.4906±0.0809	0.5107±0.1155	0.9033±0.0391
LR OV	0.7398±0.0340	0.4112±0.0640	0.6469±0.0995	0.8327±0.0505
RF	0.7233±0.0409	0.4594±0.0817	0.5695±0.1094	0.8771±0.0483
RF OV	0.7362±0.0338	0.4065±0.0608	0.6404±0.0956	0.8321±0.0498
XGB	0.7155±0.0405	0.3947±0.0395	0.5902±0.1084	0.8408±0.0427
XGB OV	0.7049±0.0579	0.4877±0.0454	0.5025±0.1407	0.9073±0.0299

In summary, the combination of a sensitivity above 0.69 and a specificity above 0.75 indicates accurate predictions, correctly identifying more than 69 out of 100 positive cases and more than 75 out of 100 negative cases. However, further studies to improve the PPV are still needed. PPV indicates the likelihood that an individual with a positive suicide prediction is truly going to commit suicide. Although in this context false positives are more desirable than false negatives, more accurate models have better economic and social advantages and are more feasible. Table 4 presents the 10 most relevant features for the best model of each outcome for Random Forest. Several features were common across all three outcomes.

The variable depression is represented in two ways in the dataset: (1) as a reason for seeking help (coded as "Depression (motivation)"), and (2) as a diagnosis given by the mental health specialist (coded as "Depression/mood disorder"). The gender feature is coded as "Gender", with "1" indicating male and "0" indicating female. CEPAI-FHEMIG offers three types of services based on the severity of the patient's psychological condition: (1) "Medical Services" for more severe conditions, (2) "Social Services" for lower-risk patients, and (3) "Medical + Social Services" for some special cases.

Table 4. Rank of the most important features according to the best models for suicide attempt, suicide ideation and self-harm prediction.

Rank, Suicide attempt prediction, Suicide ideation prediction, Self-harm prediction

1, Age, Self-harm, Suicidal ideation

2, Depression/mood disorder, Depression (motivation), Depression (motivation)

3, Agitation, Depression/mood disorder, Age

4, Self-harm, Age, Depression/mood disorder

5, Depression (motivation), Gender, Gender

6, Suicidal ideation, Number of people in the household, Suicide attempt

7, First time in CEPAI, Isolation, Number of people in the household

8, Number of people in the household, Hallucinations, No history of trauma

9, Was hospitalized, Agitation, Agitation

10, Gender, Substance abuse ,Aggressiveness

SHAP Values

Further, the impact of each feature on the model output was examined using SHAP values. Figures 2, 3, and 4 depict these values for the three tasks. In these plots, the horizontal axis indicates whether the effect of a particular value is linked to a higher or lower prediction value. The colors denote whether that attribute presents a high (in red) or low (in blue) value.

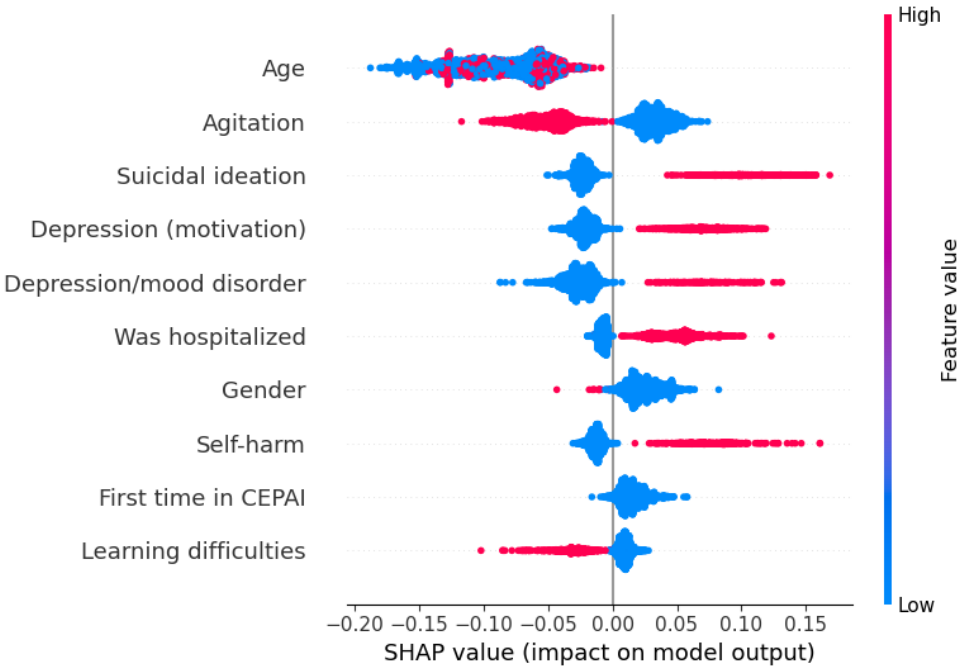

Figure 2: SHAP Values for Suicide Attempt Prediction

For example, higher values of “Agitation”, “Gender” (which means the patients are male), and “Learning difficulties” tend to produce lower predicted values for a suicide attempt (axis x), suggesting that male patients reporting agitation and learning difficulties are less likely to make a suicide attempt than the patients characterized by the opposite values of these binary variables (i.e., female patients, with no signs of agitation or learning difficulties). On the other hand, patients with depression, self-harm and suicidal ideation as motives for looking for help,

who were hospitalized in CEPAI-FHEMIG and diagnosed with depression, are more likely to have a suicide attempt.

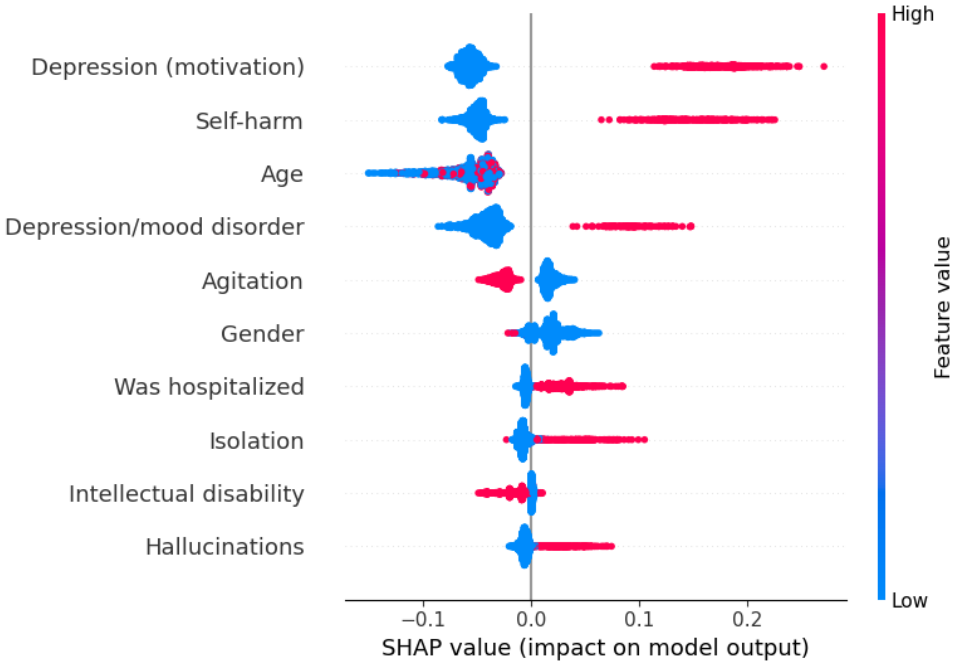

Figure 3: SHAP Values for Suicide Ideation Prediction

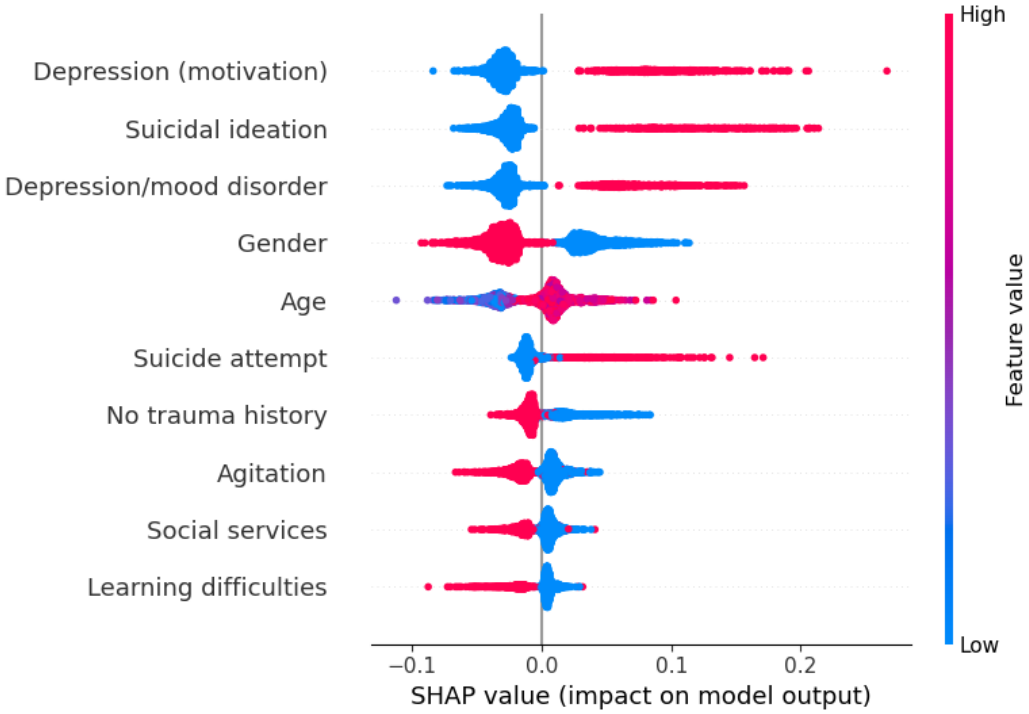

Figure 4: SHAP Values for Self-Harm Prediction

For suicide ideation (Figure 3), intellectual disability is linked to decreased risk, while isolation and hallucinations are associated with increased risk. As for the self-harm model (Figure 4), the relationships of gender and age with its prediction seems to be more regular, with older female patients being associated with a higher risk, while a patient with no trauma history using only CEPAI-FHEMIG's social services is linked to decreased risk, highlighting the distinct factors contributing to each outcome.

4) Discussion

The matter of children and adolescents requiring psychiatric care warrants attention. Roughly 1 in 5 children grapple with a mental, emotional, or behavioral disorder, yet fewer than 20% receive care from a mental health specialist (Vial and Almon, 2023). This lack of access to appropriate treatment is a pressing concern, particularly given that suicidal behavior, the most severe consequence of untreated mental health issues, is a major risk for this vulnerable population.

Suicide behavior is critical among adolescents, especially in middle and late adolescence and its consequences persist into adulthood, especially for those who have attempted suicide. Studies have shown both short- (6 months) and long-term (5 years) recurrence, which increases the suicidal attempts rates among formerly hospitalized individuals (Azcárate-Jiménez et al., 2019; Scoliers et al., 2009). Additionally, the prevalence of ideation and attempts vary from 14.3% to 22.6%; and from 4.6% to 15.8% respectively (Van Meter et al., 2023). The transitional phase between adolescence and young adulthood entails high healthcare costs and often involves a discontinuity of treatment for psychiatric disorders (Canaway et al., 2023). Significantly, during the adolescent years, the later years present the highest risk for suicide behavior, particularly in times of stress (Orri et al., 2020; Whalen et al., 2022). There is a clear need to comprehend the predictors of suicide behaviors to formulate interventions aimed at preventing them.

While machine learning excels at classification and prediction, predicting suicide outcomes remains a challenging endeavor. All suicide-related outcomes involve complex and multifactorial conditions that cannot be addressed by a simple solution. As mentioned in the first section, an attempt at building a suicide attempt prediction model was made by whose model achieved a sensitivity of 0.47 and a specificity of 0.91 (van Mens et al., 2020). Although direct comparison is challenging due to differences in the datasets used, their study achieved a higher specificity than ours (which was 0.76 for this task), at the cost of a lower sensitivity (ours

was 0.71), showcasing that threshold calibration is a big differential of our work. Threshold adjustment can have a significant impact on model performance, offering opportunities for parameterization to yield diverse outcomes. Considering the damage related to the predicted condition, we favor choices to improve sensitivity, but there is always a cost.

Dealing with prediction tasks is difficult because (i) the data has an intrinsic bias – all patients presenting at the emergency had psychiatric symptoms; (ii) the suicide attempt itself is an unbalanced data; (iii) the dataset is limited to a low number of patients; (iv) mispredicting a high-risk patient has more serious consequences, given that it is a cost-sensitive classification task. We are aware, it is certainly not generalizable to community population, but it is interesting because of the social context and the similarity of findings with studies with similar age, outcomes and risks even having so different social conditions (Stewart et al., 2020).

In face of the numerous predisposing conditions, the relative low frequency of the tragic event, and the undesirable possibility of error, the models proposed in this study demonstrate acceptable accuracy and can serve as valuable screening tools. These models can aid health professionals by identifying patients at risk of suicide behavior. They may function effectively as pre-screening tools, prioritizing individuals with a high probability of suicide risk for prompt medical attention. Such measures that promote access could potentially minimize the worst outcomes. This approach is particularly crucial in middle-income scenarios where access to psychiatric facilities and treatment is insufficient for the multitude of people in deep need of care (Dalgalarrondo et al., 2023).

The unique context of addressing psychiatric cases in an emergency setting significantly differentiates our work. Patients in crisis alter the expectation of rare events on a population basis, making them more frequent. In view of that, validating our models in other contexts is a crucial step to adapt to other situations. The emphasis put on identifying predictors of suicide-related behaviors allowed our models to pinpoint the most relevant factors for self-harm, suicidal ideation, and suicide attempts, permitting timely intervention. The potential of these predictor models lies in creating effective targets, prioritizing higher-risk patients for immediate emergency care, and identifying the risk factors involved in each individual case. Given the rarity of the outcome in high-risk populations (lower heterogeneity), there is a clear need to cross-validate our model on unseen data to generalize the results (Varoquaux, 2018). Beyond the difficulties to predict low frequency events, another limitation of the study strategy was the associative character of the risk features which does not add causal knowledge that should be addressed at some point.

In predicting self-harm, suicidal ideation, and suicide attempts, the consistency of the

10 most relevant features across the three models underscores the close relationship between these events. In a scenario with assessment constraints, notable features indicative of suicidal behavior emerge, and escalates, particularly those related to non-treatment or inadequate treatment and recurrence of seeking psychiatric care. Additionally, certain features, such as the number of people in the household, may indirectly provide insights into social vulnerability, which can differ in middle and low-income countries.

For children and adolescents, depression or related symptoms emerge as prevalent predictors of suicide-related behavior, similar to adults, corroborating earlier studies ("Depression and Suicide Risk Prediction Based on Machine Learning Models," n.d.; Jiang et al., 2021; Mubasyiroh et al., 2018). Depression was identified as a very important predictor in many of the models' tests, including the best ones, making it the primary target for intervention to avoid tragic outcomes. Timely identification and proper treatment of individuals grappling with depression could potentially mitigate the risk of suicide-related incidents and reduce healthcare expenses. Moreover, indicators such as self-harm and suicidal ideation serve as crucial warning signs for potentially more severe developments. Tackling modifiable social factors is imperative for a more comprehensive approach to mental health. Access to and availability of treatment are also linked to suicidal behavior, as at-risk individuals often turn to emergency centers due to a lack of prior access to psychiatric care. This emphasizes the critical importance of initiating care by promoting accessible mental health services to prevent severity.

Conflict of interest: Authors inform no conflict of interest.

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5.2 Artigo original

Suicidality and self-harm in adolescents, before and after the covid-19 pandemic: a systematic review

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Abstract

Adolescence is a critical period of physical, emotional, and social change, marked by increased vulnerability to mental health issues, including self-harm and suicidality. The COVID-19 pandemic exacerbated these challenges globally, amplifying pre-existing conditions like depression and anxiety due to school closures, social isolation, and excessive screen time. This systematic review investigates the prevalence and risk factors of self-harm and suicidal behaviors among adolescents before and during the pandemic, focusing on the role of psychosocial, economic, and cultural determinants. Gender disparities and cultural variations emerged as key factors influencing suicidal behaviors, with adolescent girls particularly affected. The review follows the PRISMA protocol and employs the PECO strategy, analyzing data from quantitative studies in populations aged 10-19, published between 2010 and 2024. The findings aim to inform public policy and intervention strategies to mitigate the pandemic's impact on adolescent mental health. This research contributes to understanding how global crises exacerbate youth vulnerabilities, providing insights into risk features and targets culturally sensitive mental health intervention.

1. INTRODUCTION

Adolescence is a crucial transition period between childhood and adulthood, characterized by significant changes in physical, emotional, and social development. The World Health Organization (WHO) defines adolescence as the stage of life that spans from ages 10 to 19, a critical period during which profound biological and psychological transformations occur, alongside the emergence of new vulnerabilities, particularly related to mental health (World Health Organization 2024). Adolescents have an increased risk of self-harm and suicidal behaviors, especially in contexts of social and economic crises, such as the COVID-19 pandemic (Singh et al., 2019)

The COVID-19 pandemic brought a series of negative impacts on adolescent mental health, exacerbating pre-existing conditions and generating new psychological challenges (Marques de Miranda et al., 2020). The prolonged closure of schools, social isolation, disruption of daily activities, and increased use of electronic devices contributed to the worsening of conditions such as depression, anxiety, self-harm, and suicidality (Rogers et al., 2023; Wang et al., 2023). Previous studies had already identified a growing trend of self-harm and suicidal behavior especially among girls before the pandemic; however, the pandemic period intensified these patterns (Geulayov et al., 2022; Zhu et al., 2022). Factors such as loneliness, bullying, family conflicts, and economic difficulties emerged as significant risk factors during the pandemic related to the increase in adolescents' vulnerability to mental health crises. Gender disparities and cultural variations modulates the expression of suicide-related behaviors, suggesting that effective interventions must be sensitive to the specific needs of different population groups (Mohd Fadhli et al., 2022; Zhou et al., 2022).

This systematic review aims to explore the prevalence and the risk features of self-harm and suicidal behaviors among adolescents in the period before and during the COVID-19 pandemic, as a particular stressful and uncertain timing with disorganized coping strategies, comparing the changes in these two contexts. Contributing to the understanding of the complex interactions between psychosocial, economic, and cultural factors that influence adolescent mental health, this article looks to provide insights into the formulation of public policies and interventions that can mitigate the effects of this global crisis on youth.

2. METHOD

A systematic review was conducted to address the following research question: *"Was there a change in the prevalence and risk factors of suicidality and self-harm among adolescents before and after the onset of the COVID-19 pandemic up to the present day?"* The review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol (Shamseer et al., 2015) and was registered in PROSPERO under the ID CRD42024538641. To define the search strategy, preliminary searches were independently conducted by two reviewers in the databases, following the PECO strategy, as detailed in Table 1.

Table 1: Description of PECO Strategy Elements

Component	Indicator
P: Population of interest	Adolescent
E: Exposure	Worldwide stressful condition related to pandemic or social measures to mitigate infection
C: Comparison	Studied before the COVID pandemic and after the COVID-19 pandemic
O: Outcome	Change in the prevalence of self-harm, suicidal ideation, suicide attempt, suicide

Considering the WHO concept of adolescence, individuals aged between 10-19 years were considered as adolescents for inclusion. The official search was conducted on 07/05/2024, combining the descriptors "adolescents", "suicidality", "self-harm", and "prevalence". For the post-pandemic search, the descriptor "COVID-19" was added. The descriptors were combined using the AND operator in the following databases: PubMed, Psycnet, Embase, and Scopus. To ensure a sensitive search, the following eligibility criteria were employed: quantitative studies

in community samples with populations aged 10 to 19 years (adolescents), published in English between 2010 and 2024. The time frame was established to encompass the period of technological expansion with increased adolescent engagement with the internet, allowing comparison with the COVID-19 pandemic period, aiming to assess the magnitude of these two events concerning the study outcomes.

Qualitative studies, reviews of any type, case reports, case series, gray literature, and studies conducted in clinical samples were excluded. To ensure greater specificity, the researchers excluded studies that did not address the associations between prevalence and risk factors for suicidality and self-harm. The selection procedures were performed by at least two researchers, independently and in a blinded manner, using the AI platform Rayyan (Johnson and Phillips, 2018). The consensus was reached by a discussion between the three authors D, MC and RM on which articles would remain in the review.

2.1. Data extraction

A standardized data extraction table was created to extract the information: reference and study type, country of publication, sample characteristics, study objectives, prevalence of self-harm and suicidality, main associations with risk factors, and the Evidence Quality Score of each article included in the review. The studies were listed in the table in alphabetical order. To define the magnitude of the associations found, Cohen's d test was extracted from the articles, which reflects the statistical power analysis for behavioral sciences (Cohen, 1988). If this test was not used, others such as Odds Ratio (OR) and regression tests, which could correspondingly provide the magnitude of the association, would be extracted from the studies, and effect sizes were defined according to the values presented. An OR of 1.44 corresponds to a small effect size, 2.47 to a medium effect size, and a large effect size begins at 4.25. For regression tests, 0.10 corresponds to a small effect size, 0.30 to a medium effect size, and a large effect size starts at 0.50 (Haddock et al., 1998).

2.2. Quality assessment

The quality of the studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tool. This checklist-based instrument was chosen due to its rigorous evaluation criteria for the included studies and its recommendation in the literature for use in analytical cross-sectional and cohort observational studies that seek to collect data on risk or causality (Majid and Vanstone 2018; Moola et al., 2019). The tool evaluates the detailed description of

the sample to ensure compatibility with the population of interest. The study should clearly describe the exposure measurement method and clarify any potential confounding factors that may influence the interpretation of the results. Additionally, measurements should be conducted using validated instruments, and the statistical method used should be the most appropriate (Moola et al., 2019).

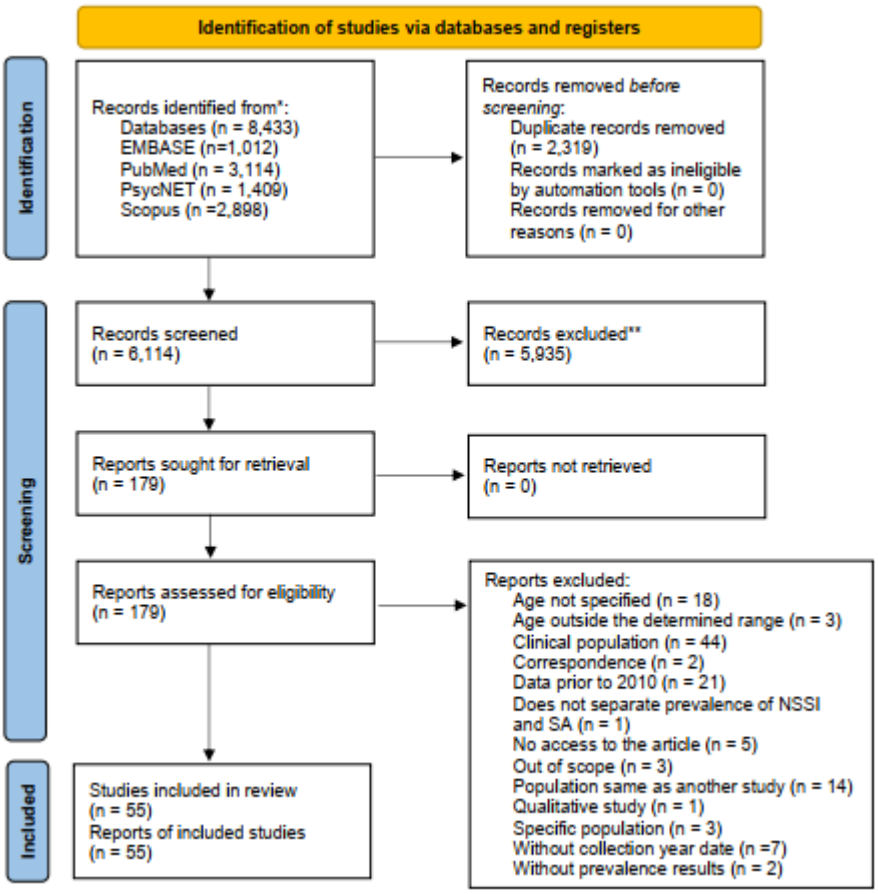
The available guidelines for applying the JBI tool do not specify a cutoff point for determining whether a study is of "High", "Moderate", or "Low" quality. Given the nature of the review and the inclusion of studies, mostly with a cross-sectional design, the team placed greater emphasis on criteria assessing risks of selection bias, measurement bias, and confounding bias, specifically questions 1, 3, 4, 5, 6, and 7. For cohort studies, greater weight was given to questions 1, 3, 4, 5, 6, 7, 8, and 9. Using this strategy, the overall methodological quality of each study was classified as "High", "Moderate", or "Low" based on the percentage of "Yes" responses considering these "key" items.

Studies classified as "High" quality must have 100% positive responses (“Yes”) to these key items. If they received one or two uncertain or negative responses (“Uncertain” or “No”, respectively), the methodological quality of the study was rated as "Moderate". If there were more than two uncertain or negative responses (“Uncertain” or “No”, respectively), the study's methodological quality was rated as "Low" (Munn et al., 2020). The evaluation was conducted in pairs, and discrepancies were resolved through consensus with a third reviewer.

3. RESULTS

The search yielded a total of 8,433 articles, of which 2,319 were duplicates, leaving 6,114 articles for title and abstract screening. At this stage, 5,935 articles were excluded for not meeting the pre-established inclusion criteria. Therefore, 179 articles were read in full, and 55 were included in this study, considering the inclusion of full-text articles retrieved. Figure 01 - PRISMA flow study diagram (Page et al., 2021), illustrates the selection process.

Figure 1: PRISMA Flowchart



3.1. Study characteristics

A total of 55 articles on suicidal behavior published between 2010 and 2024 were included in this study. Of these, 45 were cross-sectional (27 from the pre-pandemic period and 18 from the post-pandemic period), and 10 were longitudinal (3 from the pre-pandemic period and 7 from the post-pandemic period). Among the 30 articles analyzing self-harm and suicidal ideation during the pre-pandemic period, only 1 addressed both topics comprehensively. The

remaining studies focused on a single dimension: 4 exclusively on non-suicidal self-injury (NSSI) and 25 solely on suicidality. In contrast, of the 25 articles exploring the post-pandemic period, 3 examined both topics, while 7 focused on NSSI and 15 on suicidality.

The 55 studies included a total of 2,109,801 participants. Among the 30 studies covering the pre-pandemic period, 12 did not report mean ages (40% of the sample). In the 25 studies from the after-pandemic group, 7 did not provide this information (28% of the sample). The mean age was 15.08 years with a standard deviation of 1.23 for the articles allocated to the pre-pandemic group, and a mean age of 15.08 years with a standard deviation of 1.47 for the post-pandemic group, resulting in an overall mean age of 15.08 years with a standard deviation of 1.34. The age range was 5-22 years. The predominant gender was female. The geographical distribution of the studies is illustrated in Figure 2, and the characteristics of the pre- and post-pandemic studies are detailed in Tables 2 and 3.

Figure 2: Distribution of studies on suicidality and self-harm by country. The map shows the number of studies conducted distinguishing between national studies (marked with green icons) and multinational studies (marked with orange icons). The number of studies per country is listed on the right side of the map. The pie charts below detail the outcomes of the studies: 72.7% primarily address suicidality, 20% focus on self-harm, and 7.3% cover both topics. Most research focuses on suicidality, reflecting a heightened scientific interest in this specific dimension of mental health.

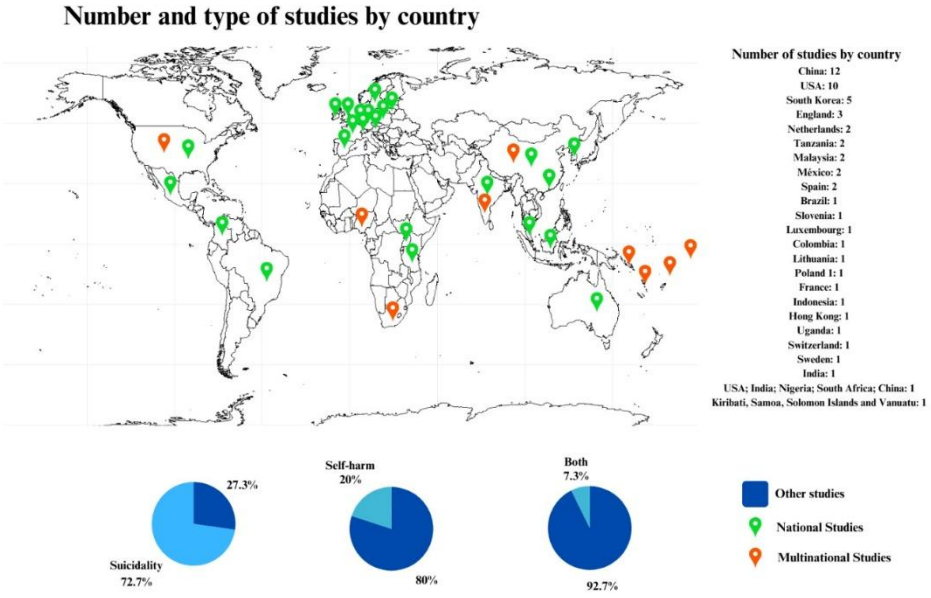


Table 2. Descriptive characteristics of included studies (Pre-Pandemic)

Reference, Country, Type of Study	**N / Age / Gender / Purposes**	**Prevalences of self-harm (NSSI) and/or suicidality**	**Main prevalence associations**	**Quality Score**
Alves Junior et al., 2016 Brazil Cross-sectional	N = 1,118 Age: 14–19 Mean age: 16.0 Male: 613 (54.2%) Female: 519 (45.8%) Assess the prevalence of suicidal ideation, planning, and attempts, while identifying the sociodemographic and lifestyle factors among adolescents in Brazil's southern region.	Suicidal Thinking: 153 (13.8%) Suicidal Planning: 117 (10.5%) Suicidal Attempt: 62 (5.5%)	Adolescents who engage in suicidal behaviors frequently struggle with inadequate sleep and an unhealthy perception of their body weight.	100%

Bamwine et al., 2020 USA Cross-sectional	N = 1,609 Age: 14–19 Mean age: 16.6 Male: 786 (49.1%) Female: 823 (50.9%) Investigate the prevalence of homicide survivals and their connections to suicidality and childhood adversities in a representative group of adolescents.	Suicidal Ideation: 16% among homicide survivors vs. 9% among non-survivors. Suicide Attempts: 11% (N = 179) among homicide survivors vs. 4% (N = 64) among non-survivors	After adjusting for demographic factors, homicide survival was linked to suicide attempts, though this association lost significance when childhood adversities were also considered. This indicates that exposure to numerous childhood adversities may play a key role in raising the risk of suicide attempts among those who have survived homicides.	100%
Bracic et al., 2019 Slovenia Cross-sectional	N = 1,547 Age: 15 Mean age: 14.9 Male = 708 (46.1%) Female = 839 (53.9%) Determine the occurrence and contributing factors of suicidal ideation among adolescents in Slovenia.	Suicidal thoughts: N = 240 (15.5%) M = 178 (21.2%) F = 62 (8.8%)	Depressive symptoms, increased loneliness, frequent health issues, lack of family support, and involvement in bullying; either as victims or perpetrators; are all linked to suicidal ideation in adolescents.	100%

Cheng et al., 2014 Baltimore, MD; New Delhi, India; Ibadan, Nigeria; Johannesburg, South Africa; Shanghai, China Cross-sectional	N = 2,393 Age: 15-19 Mean age: 16.76 Male = 1,227 (51.2%) Female = 1,112 (48.8%) Examining the connection between social support and the mental well-being of at-risk adolescents.	The prevalence of suicidal ideation varied between 7.9% and 39.6% across the countries, while suicide attempts ranged from 1.8% to 18.3%. Suicide attempts: (Male+Female = N) Baltimore 119+174=293 New Delhi 100+43=143 Ibadan 437+342=779 Johannesburg 282+239=521 Shanghai 67+141=208	Inadequate family support and weak ties to the community contribute to poor mental health outcomes, including suicidal ideation.	100%

Heinz et al., 2020 Luxembourg Cross-sectional	N = 5,262 Age: 12-18 Mean age: not mentioned Male = 2,481 (47.3%) Female = 2,764 (52.7%) This research aims to determine whether the Health Behaviour in School-aged Children Symptom Checklist (HBSC-SCL), which assesses eight subjective health complaints like headaches and low mood, can effectively serve as a screening tool for detecting suicidal thoughts and behaviors in adolescents.	Thought about suicide in the past 12 months: 778 (15.1%) Planned suicide in the past 12 months: 722 (14.1%) Attempted suicide in the past 12 months: 392 (7.6%)	The eight components of the HBSC-SCL, including headache, stomach-ache, back pain, feeling low, irritability, nervousness, sleep disturbances, and dizziness, are linked to suicidality. Each of these items shows a statistically significant correlation with the four SIB (Suicidal and Ideation Behavior) items, although the strength of these correlations varies.	100%
Ibrahim et al., 2017 Malaysia Cross-sectional	N = 1,769 Age: 13–17 Mean age: 14.4 Male: 838 (47.4%) Female: 931 (52.6%) Determine the prevalence and key predictors of depression and suicidal ideation among secondary school students in Malaysia	Suicidal ideation: Male: 214 (25.6%) Female: 279 (30.0%)	Suicidal ideation is significantly more prevalent among bullying victims and adolescents showing depressive symptoms, with a rate of 39.3%	100%

Kim et al., 2015 South Korea Cross-sectional	N = 191,642 Age: 12–18 Mean age: not mentioned Male: 95,800 (51.8%) Female: 95,842 (48.2%) Investigate the hypothesis that Korean adolescents exhibiting one of three specific sleep patterns are more likely to experience suicidality compared to those without such sleep disturbances. Data were drawn from the 2011–2013 Korea Youth Risk Behavior Web-based Survey.	Suicidal ideation: M = 12,955 (13.6%) F = 21,194 (22.1%) Suicidal plan: M = 4,400 (4.6%) F = 6,804 (7.1%) Suicide attempt: M = 2,408 (2.5%) F = 4,904 (5.1%)	Sleep problems were generally linked to suicide-related behaviors, with both awakening and bedtime patterns showing a U-shaped relationship, like findings in Korean adults.	100%

Lee et al., 2014 South Korea Cross-sectional	N = 73,238 Age: 12-18 Mean age: not mentioned Male: 38,391 (52.41%) Female: 34,847 (47.59%) Examine the variations in suicidal behaviors based on parental marital status.	Suicidal ideation: N = 14,011 M = 5,855 (15.3%) F = 8,156 (23.4%) Suicide attempt: N = 3,616 M = 1,391 (3.6%) F = 2,225 (6.4%)	Parental remarriage seems to pose a notable risk for suicidal behaviors in adolescents, with a more pronounced effect on girls. Additionally, low family wealth is linked to an increased likelihood of suicidal thoughts and attempts among girls.	100%

Liu et al., 2018 China Cross-sectional	N = 5,696 Age: 12–18 Mean age: 15.0 Female: 100% Investigate whether the onset of menarche and menstrual issues are linked to non-suicidal self-injury among female adolescents.	The lifetime prevalence and prevalence in the last year of NSSI were 28.1% (N=1600) and 21.4%, respectively	A link between menarche and NSSI is driven by the rapid physical and hormonal changes, along with the psychosocial stress that accompanies the start of menstruation, making adolescents more susceptible to emotional dysregulation and raising the risk of NSSI.	100%
Liu et al., 2019 China Longitudinal	N = 11,831 Age: 12–18 Mean age: 15.0 Male = 6,018 (51%) Female = 5,813 (49%) Investigate the prevalence, features, and risk factors of suicidal behaviors, encompassing ideation, planning, and attempts.	Total of suicide attempts N = 309 M = 127 (41.1%) F = 182 (58.8%)	Being female, along with factors such as smoking, alcohol use, internalizing and externalizing issues, feelings of hopelessness, a history of suicide among friends or acquaintances, low family income, and poor relationships with parents, were all strongly linked to a higher risk of suicidal behavior.	100%

Mitchell et al., 2014 USA Cross-sectional	N = 1,560 Age: 10-17 Mean age: 14.5 Male: 775 (49.6%) Female: 785 (50.4%) Investigate the relationship between exposure to websites promoting self-harm or suicide and the presence of self-harm or suicidal thoughts.	**NSSI:** 5% (N = 77) had thoughts of self-harm in the past month **Suicidality:** 2.5% (N = 39) had thoughts of suicide in the past month	Accessing websites that promote self-harm or suicide is linked to an increased likelihood of having self-harm or suicidal thoughts.	100%
Morey et al., 2016 England Cross-sectional	N = 2,000 Age: 13-18 Mean age: 13.0 Male = 957 (47.85%) Female = 1,043 (52.15%) Investigate the relationship between self-harm and overall well-being.	Total of participants who ever self-harmed: 309 (15.5%) F = 241 (23.1%) M = 68 (7.1%)	Self-harm has a higher prevalence in girls. The link between self-harm and mental well-being indicates a strong connection to emotional distress. Girls who engage in cutting on body areas beyond the arms should be prioritized to intervention, as these actions are tied to higher emotional risk factors.	100%

Orozco et al., 2018 Mexico Cross-sectional	N = 28,519 Age: 12-17 Mean age: not mentioned Male: 14,231 (49.9%) Female: 14,288 (50.1%) Outline the national prevalence of suicide attempts among Mexican students and assess the strength of the relationship between suicide attempts and four academic performance indicators, while controlling for other sociodemographic factors.	Lifetime suicide attempts: 3.0% for high school students, 4.2% for elementary school students. Suicide attempts were more prevalent among girls (5.2%) in high school and 6.8% in elementary school than among boys, 1.1% in high school and 1.5% in elementary school. Number of suicide attempts: 1,054	Academic performance factors, including poor self-perceived academic performance and a higher incidence of failures, were linked to suicide attempts. Students with poorer academic performance were more likely to attempt suicide, indicating a potential dose-response relationship across educational levels. Not being enrolled in the previous year and failing three or more school years were strong predictors of suicide attempts in high school students.	100%

Park & Lee., 2016 South Korea Cross-sectional	N = 727 Age: 12–18 Mean age: 15.06 Male: 376 (51.72%) Female: 351 (48.28%) Investigate the underlying reasons for suicide attempts among individuals from multicultural families in Korea.	Total number of suicide attempts: N = 41 (5.6%)	Foreign-born parents, being distant from family, and experiencing conflicts with a teacher contribute to a higher risk of suicide	100%
Peltzer & Pengpid., 2015 Kiribati, Samoa, Solomon Islands and Vanuatu Cross-sectional	N = 6,540 Age: 13–16 Mean age: not mentioned Male: 3,355 (51.3%) Female: 3,185 (48.7%) Examine the connection between early substance use, including alcohol, cannabis, and smoking, and its association with suicidal ideation and attempts.	Suicidal ideation: N = 25.8% Male = 26.8% Female = 24.4% Suicide attempt: N = 2,282 (34.9%) Male = 36.7% Female = 31.9%	Starting smoking, alcohol consumption, and drug use at an early age are linked to an increased risk of suicidal behaviors.	100%

Prairie et al., 2022 USA Cross-sectional	N = 83,852 Age: 15-18 Mean age: 16.0 (SD = 1.2) Male: 41,506 (49.5%) Female: 42,346 (50.5%) Analyze the impact of including sexual orientation as a protected category in state hate crime laws on the reduction of suicide attempts among high school students.	Suicide attempts: N = 5,282 from 2015-2018	Hate crime laws including sexual orientation have been linked to a significant 1.2 percentage point decrease in suicide attempts among adolescents. The reduction was more pronounced among questioning and bisexual youths compared to their gay and lesbian peers.	100%

Roche et al., 2021 USA Cross-sectional	Study 1: N = 547 Study 2: N = 340 Study 1: 11–15 Mean age: 12.8 Study 2: 15–18 Mean age: 16.37 Study 1: Male: 247 (45%) Female: 300 (55%) Study 2: Male: 177 (51.8%) Female 163 (48.2%) Investigate how differences in family immigration status influence Latino adolescents' reactions to immigration policies and news, and how these responses impact their overall adjustment.	Study 1: 14.5% (N = 77) reported suicidal ideation in the last 6 months.	Adolescents from families with more precarious immigration statuses exhibited heightened psychological and behavioral response to immigration issues. These challenges, including withdrawal behaviors, were linked to increased internalizing and externalizing symptoms, higher rates of substance use, and elevated suicidal ideation.	100%

Ruiz-Robledillo et al., 2019 Spain Cross-sectional	N = 1,386 Age: 11-19 Mean age: 13.42 Male = 698 (50.4%) Female = 688 (49.6%) To describe suicidal behavior and assess the connection between family and school environments and suicidal behavior, considering the potential mediating roles of depression and anxiety.	Suicidal ideation: N = 114 (8.2%) F= 61 (8.9%) M= 53 (7.6%) Suicide plan: N = 72 (5.2%) F = 39 (5.7%) M = 33 (4.7%) History of suicide attempt: N = 51 (3.7%) F = 30 (4.4%) M = 21 (3%) Suicide attempt: N = 71 (5.1%) F = 43 (6.3%) M = 28 (4%) More than one attempt: N = 73 (5.3%) F = 40 (5.8%) M = 33 (4.7%)	Depression, anxiety, and suicidal behavior are interconnected. Poor family communication is associated with a negative school climate and is positively linked to depression, anxiety, and suicidal behavior. Conversely, a positive school climate is inversely related to these mental health challenges.	100%

Shayo & Lawala., 2019 Tanzania Cross-sectional	N = 3,793 Age: 13–17 Mean age: not mentioned Male: 1,819 (47.9%) Female: 1,974 (52.1%) Assess the likelihood of suicidal behavior being connected to experiences of school bullying.	Total suicidal ideation: N = 536 (14.1%) Total suicide attempts: N = 422 (11.1%) Ages 13–17 Total suicidal ideation: N = 380 (69.8%) Total suicide attempts: N = 311 (72.3%) Suicide attempts: N = 71 (5.1%) F = 43 (6.3%) M = 28 (4%) More than one attempt: N = 73 (5.3%) F = 40 (5.8%) M = 33 (4.7%)	Being a victim of bullying was identified as a predictor of suicidal ideation and attempts among adolescents in school.	100%

Shayo & Lawala., 2019 Tanzania Cross-sectional	N = 3,793 N 13-17y = 2,987 Mean age: not mentioned N 3,793: Male = 1,819 (47.9 %) Female = 1,974 (52.1%) N 13-17y 2987: Male = Not mentioned Female = Not mentioned Assess the relationship between food insecurity and suicidal behaviors among school-aged adolescents, considering the influence of common psychosocial factors.	Suicidal ideation: 14.1%; Suicide attempt: 11.1% N 13-17y 2987 Suicide ideation N = 380 (12.72%) Suicide attempt N = 311 (10.41%)	Adolescents facing food insecurity showed a significantly higher likelihood of experiencing suicidal thoughts and attempts. The stress, anxiety, and shame associated with food insecurity can aggravate mental health issues, elevating the risk of suicidal behaviors.	100%

Stallard et al., 2013 England Longitudinal	N = 3,964 Age: 12 - 16 Mean age: not mentioned There were losses across the time, not allowing to measure the number of males and females' participants Investigate the prevalence of self-harm in early adolescents and the factors that influence the development and continuation of this behavior over a one-year period.	Total number of self-harm thoughts N = 27% at some point in the past year Self-harm N = 594 (15%) at some point in the past year.	Frequent exposure to bullying doubled the risk of developing self-harm thoughts, while cannabis use heightened the likelihood of persisting with these thoughts. Conversely, a stronger sense of school belonging was associated with reduced risk of self-harming thoughts.	100%
Suárez Colorado et al., 2019 Colombia Cross-sectional	N = 339 Age: 13–19 Mean age: 16.3 Male = 143 (42.2%) Female = 196 (57.8%) Investigate the relationship between trust, communication, and feelings of alienation with suicide risk among school-aged adolescents in Colombia.	30% prevalence of suicide risk	A link was found between elevated suicide rates and low levels of trust or poor communication with either the mother or father.	100%

Tang et al., 2018 China Cross-sectional	N = 15,623 Age: 12–18 Mean age: 15.2 Male = 8,043 (51.1%) Female = 7,580 (48.5%) Carry out a nationwide survey to investigate the prevalence and identify the risk factors for non-suicidal self-injury among adolescents in China.	Non-suicidal self-injury (5 times or more): N = 1,908 M = 951 (49.8%) F = 957 (50.2%) Pre-self-injury (1 to 4 times): N = 2,651 M = 1,296 (48.9%) F = 1,355 (51.1%)	Female, minor ethnicity, being the only child in the family, father's education, neglect, maltreatment, loneliness, lack of social support, bad emotional management ability and suicidal behaviors were strongly linked to non-suicidal self-injury (NSSI).	100%

Thakur et al., 2015 India Cross-sectional	N = 715 Age: 14-19 Mean age: not mentioned Male = 361 (51.2%) Female = 344 (48.8%) Assess the prevalence of suicidal thoughts and investigate the factors that predict their occurrence.	N = 218 had suicidal ideation (30.9%). Of these: F = 128 (37.2%) M = 90 (24.9%) 121 aged 16-19 years (37.8%) 97 aged 14-15 years (25.2%)	Adolescents facing family-related challenges, verbal or physical abuse, and concerns about body image showed higher odds of experiencing suicidal thoughts. The prevalence was higher among females, possibly due to feelings of embarrassment in discussing these thoughts, which led to a sense of social isolation.	100%

Toomey et al., 2018 USA Cross-sectional	N – 120,617 Age: 11–19 Mean age: 14.7 Female: 60,973 (50.6%) Male: 57,871 (48%) Transgender, Male to Female: 202 (0.2%) Transgender, Female to Male: 175 (0.1%) Transgender, Not Exclusively Male or Female: 344 (0.3%) Questioning: 1,052 (0.9%) This study aimed to examine the prevalence of suicidal behavior across six gender identity groups: female, male, transgender female (MTF), transgender male (FTM), transgender non-binary, and questioning. Furthermore, it explored how differences in key sociodemographic factors influence suicidal behavior within these identity categories.	14.1% of adolescents (N = 17,007) in the sample reported that they had ever tried to kill themselves one or more times	Transgender populations have an increased risk to suicide.	100%

Van Vuuren et al., 2021 Netherlands Cross-sectional	N = 8,499 Age: 13-16 Mean age: not mentioned Not mentioned the number of males and females' participants Assessing the progression of suicidal thoughts and behaviors (STBs) among Dutch multi-ethnic students at two key ages: 13-14 years (t1) and 15-16 years (t2).	Suicidal thoughts at t1: 12.7%. Suicide attempts at t1: 1.7% (N = 144) Suicidal thoughts at t2 for those with suicidal thoughts at t1: 26.3%. Suicide attempts at t2 for those with suicide attempts at t1: 12.5% (N = 1,062)	Suicidal thoughts and behaviors (STBs) were common in adolescents, they typically fade within two years. However, a subset of adolescents, particularly those facing psychosocial challenges and living in an unsafe environment, continuous experience STBs, placing them at greater risk for suicide.	100%

Van Vuuren et al., 2021 Netherlands Longitudinal	N = 26.273 Age: 13-14 Mean age: 13.6 Not mentioned the number of males and females' participants Analyze the 5-year trends in suicidal thoughts and attempts among adolescents, while exploring potential variations in these trends across different sociodemographic groups.	Suicidal thoughts: 17.6% (2010-2011) to 13.2% (2014-2015) Suicide attempts: N = 630 (2.4%) 2.9% (2010-2011) to 1.9% (2014-2015)	Adolescents of Surinamese, Turkish, and Moroccan descent showed a notable decline in suicidal thoughts, while the rates for Dutch-origin students remained relatively stable. Similarly, the largest reductions in suicide attempts were observed among adolescents from Turkish and Moroccan backgrounds.	100%

Yun et al., 2016 USA Cross-sectional	N = 265,268 Age: 13-18 Mean age: not mentioned Male: 133,987 (50.51%) Female: 129,398 (49.49%) Investigate racial and ethnic disparities in risk behaviors associated with injuries and deaths among adolescents in Missouri, with a particular emphasis on Hispanic adolescents. Missouri Youth Risk Behavior Survey (YRBS) was used.	Considered suicide: 23.0% (Hispanics) 14.2% (non-Hispanic whites) 11.4% (non-Hispanic blacks) Planned suicide: 20.0% (Hispanics) 12.2% (non-Hispanic whites) 7.4% (non-Hispanic blacks) Attempted suicide: 17.8% (Hispanics) 6.0% (non-Hispanic whites) 5.4% (non-Hispanic blacks) Considered suicide: N = 1,585 (14.2%) Planned suicide: N = 1,584 (12.1%) Attempted suicide: N = 1,458 (6.9%)	Hispanic adolescents exhibit a higher rate of injury-related risk behaviors, including feelings of sadness or hopelessness, suicidal ideation, planning, and attempts, compared to their non-Hispanic White and Black counterparts.	100%

Zaborskis et al., 2016 Lithuania Cross-sectional	N = 3,572 Age: 13-15 Mean age: not mentioned Male = 1,805 (50.5%) Female = 1,767 (49.5%) Examine the prevalence of suicidal ideation and attempts, along with their associations with various family factors	Considered the attempt of suicide: N = 844 (23.8%) M = 297 (16.6%) F = 547 (31.1%) Planning: N = 486 (13.7%) M = 195 (10.9%) F = 291 (16.5%) Attempt: N = 471 (13.2%) M = 205 (11.4%) F = 266 (15.1%) Attempted suicide: N = 1458 (6.9%)	Adolescents in Lithuania are more likely to experience suicidal ideation and attempts when coming from non-intact families or those with poor family functioning, highlighting these as significant predictors.	100%

Zygo et al., 2019 Poland Cross-sectional	N = 5,685 Age: 13–19 Mean age: 16.91 Male = 1,705 (30%) Female = 3,980 (70%) The objective was to assess the occurrence of suicidal thoughts, tendencies, and attempts in young people, while also identifying the key factors that these individuals believe contributed to their suicide attempts.	Suicidal ideation: N = 1269 24.66% F = 1026 (28.57%) M = 243 (15.63%) Suicidal plans: N = 797 (15.55%) F = 646 (18.04%) M = 151 (9.77%) Suicide attempts: N = 225 (4.37%) F = 192 (5.34%) M = 33 (2.14%)	Girls were more likely to attempt suicide due to feelings of helplessness, loneliness, rejection, guilt, and conflicts with parents or peers, while boys were more often driven by peer pressure or online interactions. Suicide attempts were notably higher among girls aged 13–19 and more frequent in urban settings. Adolescents who experienced suicidal thoughts, plans, or attempts were more often raised in single-parent households and were more likely to report parental alcohol abuse and experiences of psychological or physical violence within the family.	100%

Table 3. Descriptive characteristics of included studies (Post-Pandemic)

Reference, Country, Type of Study	N / Age / Gender / Purposes	Prevalences of self-harm (NSSI) and/or suicidality	Main prevalence associations	Quality Score
Bukuluki et al., 2021 Uganda Cross-sectional	N = 219 Age: 13-19 Mean age: not mentioned Male: 71 (32%) Female:148 (68%) The goal was to evaluate suicidal ideation and attempts among adolescents considered to be at higher risk.	Suicide ideation in the past 4 weeks: N = 67 (30.6%) F = 50 (33.8%) M = 17 (23.9%) Suicide ideation in the past 1 week: N = 28 (13.3%) F = 23 (16.1%) M = 5 (7.4%) Suicide plan for suicide in the past 1 week: N = 21 (9.6%) F = 17 (11.5%) M = 4 (5.6) Ever attempted suicide: N = 101 (46.1%) F = 71 (48.0%) M = 30 (42.3%) Attempted suicide in the last 6 months: N = 53 (24.2%) F = 35 (23.6%) M = 18 (25.4%)	Financial hardship, living apart from biological family or in fractured family environments, and psychological distress are the primary drivers of the high prevalence of suicidal ideations and attempts.	100%
Cheng et al., 2024 China Cross-sectional	N = 18,900 Age = 12-18 Mean age: 14.99 Male: 9,416 (49.8%) Female: 9,880 (52.3%) Investigate the direct impact of cell phone addiction on suicidal	Number of cases according to the stage of suicidality Ideation M = 778 (8.3%) F = 1,238 (13.1%) Planning	Cell phone addiction is directly linked to suicidal ideation and planning, while poor sleep quality, female gender, and being a rural adolescent are associated with an	100%

	behavior, as well as the indirect influence of poor sleep quality.	M = 586 (6.2%) F = 997 (10.5%) Attempt M = 362 (5.2%) F = 644 (5.5%)	increased risk of suicidal behavior.

Dumont et al., 2024 Switzerland Cross-sectional	N = 492 Age: 14-17 Mean age: 15.4 Male: 234 (48%) Female: 258 (52%) The study explores the prevalence of suicidal ideation among adolescents during the COVID-19 pandemic and highlights both direct and indirect risk factors linked to this issue.	Presented suicidal ideation: N = 71 (14.4%) F = 53 (75%) M = 18 (25%) Attempted suicide: 5 (1,0%)	Girls had a notably higher likelihood of experiencing suicidal ideation, as did adolescents identifying as lesbian, gay, or bisexual (LGB), or those facing high psychological distress, low self-esteem, limited social support, academic struggles, or bullying. Heavy social media use, smoking, alcohol consumption, or significant impact from the pandemic showed an increase in suicidal ideation.	100%

Geulayov et al., 2024 England Cross-sectional	N = 10,460 Age: 12–18 Mean age: not mentioned Male = 3,856 (36.9%) Female = 6,604 (63.1%) The objective was to assess the prevalence of loneliness and self-harm in a large, diverse community sample of 10,460 adolescents aged 12–18, following the initial months of the COVID-19 pandemic, and to explore the relationship between loneliness, changes in loneliness during lockdown, and self-harm. Loneliness and self-harm were self-reported by participants.	Lifetime self-harm: N = 1,452 (13.9 %) M = 283 (7.3%) F = 1,169 (17.7%) Past year self-harm: N = 1,129 (10.8%) M = 204 (5.3%) F = 925 (14.0%) Past six months: N = 879 (8.4%) M = 152 (3.9%) F = 727 (11.0%) Self-harm during 1st UK lockdown: N = 787 (7.5%) M = 135 (3.5%) F = 652 (9.9%)	Shifts in loneliness are linked to an increased risk of self-harm. Loneliness interventions might be a potential target for intervention.	100%

Hou et al., 2021 China Cross-sectional	N = 761 Age: 14-18 Mean age: 16.09 Male = 451 (59.3%) Female = 310 (40.7%) The objective is to explore the prevalence of suicidal ideation and attempts while analyzing the similarities and differences in the influencing factors between left-behind children and their non-left-behind peers.	Suicidal ideation: N = 277 (36.4%) Suicide attempt: N = 79 (10.4%)	Girls exhibited a higher susceptibility to suicidal ideation compared to boys in both groups. Adolescents whose parents had higher education levels showed a greater likelihood of suicidal ideation. Those with average or below-average financial conditions had a lower risk of suicidal ideation. Maladaptive coping strategies were linked to an increased risk of suicidal ideation, while anxiety and depression were also associated with a potential heightened risk.	100%

Jollant et al., 2022 France Longitudinal	N = 85,679 Age: 10-80+ Mean age: not mentioned Male = 31,955 (37.2%) Female = 53,724 (62.8%) Even though the article evaluates ranges, like 10-19 years, it doesn't specify the number for this population, neither the number of males nor females Examine the lasting effects of the COVID-19 pandemic on individuals admitted to hospitals for self-harm.	Number of hospitalizations for self-harm in France from September 2020 to August 2021 N = 20,964 M = 3,794 (18%) F = 17,170 (82%)	The number of self-harm hospitalizations declined overall. However, variations were observed based on age and gender.	93,75%

Lee et al., 2022 Korea Cross-sectional	N = 167,099 Age: 12-18 Mean age: 15.0 Male = 82,679 (51.9%) Female = 76,510 (48.1%) 2019 M = 28,084 (51.8%) F = 25,964 (48.2%) 2020 M =27,199 (52.0%) F = 25,295 (48.0%) 2021 M = 27,396 (51.9%) F = 5251 (48.1%) This study explored the short-term (2020) and long-term (2021) effects of the COVID-19 pandemic on suicide-related behaviors among Korean adolescents, comparing them to the pre-pandemic year (2019), while also analyzing the factors contributing to these changes, based on data from the Korea Youth Risk Behavior Web-based Survey.	Suicidal ideation: N = 26,207 (12.2%) 2019 N = 6,871 (12.7%) 2020 N = 5,619 (10.7%) 2021 N = 6,535 (12.4%) Suicide planning: N = 8,116 (3.7%) 2019 N = 2,000 (3.6%) 2020 N = 1,794 (3.4%) 2021 N = 2,010 (3.8%) Suicide attempts: N = 5,208 (2.4%) 2019 N = 1,474 (2.6%) 2020 N = 1,007 (1.9%) 2021 N = 1,125 (2.1%)	The initial decline in mental health issues during 2020 could be attributed to reduced academic pressures and fewer interpersonal conflicts caused by school closures. However, the worsening mental health in 2021 emphasizes the need for ongoing interventions, particularly for vulnerable adolescents, such as those from lower socioeconomic backgrounds.	100%

Meeker et al., 2021 USA Cross-sectional	N = 1,532 Age: 14-18 Mean age: not mentioned Male: 735 (48%) Female: 797 (52%) Analyze the prevalence of Adverse Childhood Experiences (ACEs) in a community sample of adolescents and investigate how exposure to multiple ACEs influences various health risk behaviors.	**NSSI:** Non-suicidal self-injury (NSSI) report: 18.9% of youths with two or more ACEs versus 3.5% of those without ACEs. **Suicidality:** Suicidal ideation: 30.3% of youth with two or more ACEs versus 4.7% of those without ACEs Suicide attempt: 15.4% of youth with two or more ACEs versus 0.9% of those without ACEs	Adolescents with multiple ACEs were significantly more likely to report mental health symptoms, suicidal thoughts, violent behavior, and substance use. The accumulation of traumatic experiences is linked to several health risk factors during adolescence.	100%

Mohd Fadhli et al., 2021 Malaysia Cross-sectional	N = 1,290 Age: 13-17 Mean age: 14.48 Male = 385 (29.8%) Female = 905 (70.2%) Assess the prevalence of cyberbullying and suicidal behavior among adolescents in Peninsular Malaysia and examine the relationship between these two factors.	Suicidal behavior: N = 221 (17.1%) Suicidal thought: N = 154 (11.9%) Suicide plan: N = 132 (10.2%) Suicide attempt: N = 108 (8.4%)	Link between being a victim of cyberbullying and an increased chance of exhibiting suicidal behavior. Adolescents who experienced cyberbullying were more likely to show suicidal tendencies. Additional risk factors were younger age, female gender, presence of depression, a history of abuse, and witnessing parental conflicts.	100%

Nguyen et al., 2023 USA Cross-sectional	N = 13,605 Age: 12-18 Mean age: 15.0 Male: 6,690 (50.64%) Female: 6,862 (49.37%) This study explores the relationship between in-school and electronic bullying and suicide-related behaviors, as well as feelings of despair among adolescents, accounting for sociodemographic factors, abuse history, risk-taking behaviors, and physical appearance/lifestyle. Data comes from the 2019 U.S. Youth Risk Behavior Surveillance System (YRBSS) national survey.	Considered suicide: N = 755 (18.5%) Planned suicide: N = 1,306 (15.7%) Attempted suicide at least once: N = 1,018 (8.9%) Suicidal tendencies: N = 7,912 (58.5%)	An association was found between bullying and depressive symptoms with both conditions being linked to an increased risk of suicidality.	100%
Park et al., 2023 Korea Cross-sectional	N = 227,139 Age: 12-18 Mean age: not mentioned 2018-2019 Male before Covid-19 = 60,304 (52.0%) 2020-2021 Male during Covid-19 = 56,754 (51.8%) 2018-2019 Female before Covid-19 = 57,039 (48.0%) 2020-2021 Female during Covid-19 = 53,042 (48.2%) Investigate the impact of the COVID-19 pandemic on the mental health of students in	Suicidal ideation: 2018-2019 M = 9.5% F = 17.3% 2020-2021 M = 8.8% F = 15.0% 2019 M = 9.4% F = 17.1% 2020 M: 8.1% F: 13.9%	Depressive symptoms, suicidal thoughts, and stress were more prevalent among adolescents who did not live with their families, had low socioeconomic status, or perceived their health as poor.	100%

Korea.

Peng et al., 2022 China Cross-sectional	N = 39,751 Mean age: 14.79 Male: 18,966 (47.7%) Female: 20,785 (52.3%) Examine the connection between homeschooling during the pandemic and the risks of anxiety, depression, and suicide among elementary and high school students.	15.8% of men and 24.4% of women reported having suicidal thoughts in the two weeks prior to the date the study questionnaire was administered. 1,006 (5.3%) were suicide attempters	Girls were particularly affected during the pandemic. Sleep quality and time spent online influenced mental health. Strategies aimed at enhancing sleep and limiting exposure to pandemic-related content could help alleviate these negative impacts.	100%

Rogers et al., 2023 USA Longitudinal	N = 102 Age: 10-19 Mean age: 16.0 Male = 80 (78.4%) Female = 22 (21.6%) Examine the effects of COVID-19 on adolescent suicide rates in Maryland from 2019 to 2021.	Number of deaths by suicide among adolescents: 2019: N = 37 cases 2020: N = 31 cases 2021 N = 34 cases	Economic hardships and social isolation were risk features. When evaluating by year, there was a reduction in the number of suicides. Closer family moments seem like a protective feature. From 2020 to 2021 there is an increase, but no difference in comparison to the pre-pandemic period.	68,75%

Shankar et al., 2022 USA Cross-sectional	Total N = 8,127 Mean age: not mentioned Before the pandemic: N = 5,278 During the pandemic: N = 2,849 Age: 5-17 Male: 41.5% Female: 58.5% Determine the causes for emergency department (ED) visits and the frequency of such visits during the COVID-19 pandemic.	**NSSI:** Study links self-harm and suicide attempts: Pre-pandemic: N = 1,077 (20.4%) During the pandemic: N = 772 (27.1%) Total: N = 1,849 (22.8%) **Suicidality:** Study links self-harm and suicide attempts: Pre-pandemic: N = 1,077 (20.4%) During the pandemic: N = 772 (27.1%) Total: N = 1,849 (22.8%)	Disruptive, impulse-control, and behavioral disorders have seen a notable rise, potentially exacerbated by limited access to outpatient care and stressors brought on by the pandemic.	100%

Suárez Soto et al., 2020 Spain Cross-sectional	N = 163 Age: 14-17 Mean age: 15.81 Male: 52 (32.5%) Female: 106 (65.6%) Did not respond: 3 (1.2%) 1 person identified as another gender (not specified) (0.6%) Investigate sociodemographic factors (gender, age, sexual orientation), victimization experiences (physical, psychological, and verbal abuse, violence, cyberbullying), and resilience factors linked to suicidal behavior among Spanish adolescents since the onset of the pandemic.	Out of 163, 45 reported involvements in some form of suicidal behavior F = 16 M = 28 20.8% of the participants expressed some thoughts, 22.6% considered a method/form of self-destruction. 7.4% attempted suicide. Suicidal ideation: F = 24 M = 9 Suicidal planning: F = 24 M = 13 Suicidal attempt: F = 10 M = 2	Individuals who experience psychological abuse are five times more likely to exhibit suicidal behavior; no significant link exists between gender and suicidal behavior, but there is a connection between sexual orientation and such behavior, with higher rates observed in the heterosexual group.	100%

Valdez-Santiago et al., 2022 Mexico Cross-sectional	July 2018 - June 2019: N = 17,925 August - November 2020: N = 4,812 Age: 10-19 Mean age: not mentioned Does not separate gender in the total population; only in those who had suicide attempts. In 2018-2019: N = 333 Male = 77 (23.12%) Female = 256 (76.88%) 2020: N = 101 Male = 13 (12.8%) Female= 88 (87.2%) Examine the prevalence of suicide attempts among Mexican adolescents in the 12 months preceding and following the lockdown.	Prevalence of suicide similar in both studies. Pre-pandemic: 1.8% During the first month of the pandemic: 2.1%. Prevalence decreased in men in 2020 (0.3%), compared to 2018-19 (1%) Increase in women (3.8% in 2020 versus 2.7% in 2018–19). Prevalence among 10-14 years was 1.4% in both studies Increased prevalence among 15-19 years (2.3% to 2.8%). Suicide attempts in 2020: 101	Women, adolescents from urban areas who lost a family member to COVID, those in families affected by job loss, or who did not participate in online schooling are at a higher risk of attempting suicide.	100%

Wang et al., 2023 China Longitudinal	T1: N = 3,588 T2: N = 2,527 Age T1: 15-18 Age T2: 16-18 Mean age: 16.13 Male = 1,217 (48.2%) Female = 1,310 (51,8%) Explore the effects of COVID-19 and assess psychological risk factors among adolescents exhibiting non-suicidal self-injury (NSSI).	Self-harm emerging rate: N = 261 (10.3%) Sustained self-harm: N = 686 (27.2%) Total number of NSSI: 947	Reduced self-control, elevated neuroticism, and heightened impulsivity are linked to non-suicidal self-injury.	90,9%

Wang et al., 2022 China Longitudinal	N = 5,854 Age: 10-19 Mean age: 12.04 Male: 3,020 (51.6%) Female: 2,834 (48.4%) Assess the mediating roles of depressive symptoms, emotional competence, and COVID-19-related post-traumatic stress symptoms in the connection between family functioning and non-suicidal self-injury, based on data collected in 2020.	Total of adolescents who presented NSSI N = 1,768 (30.2%) 165 were hospitalized Bite (16.93%) Cut (15.70%) Scratch (13.75%)	Pandemic exacerbated students' vulnerability to NSSI, particularly among those with personality traits such as high neuroticism and impulsivity. It was found that there is a relationship between family functioning and NSSI; and that the variables depression, emotional competence, and PTSS-COVID19 had a significant mediating effect on this relationship.	90,9%

Yosep et al., 2024 Indonesia Cross-sectional	2019: N = 175 2020: N = 268 Age: 14-18 Mean age: 13.2 2019: Male: 79 (45.7%) Female: 96 (53.3%) 2020: Male: 102 (38.1%) Female: 166 (61.9%) Examine the connection between bullying and the risk of suicide in adolescents.	Total of adolescents at risk of suicide 2020: F = 50 (71.4%) M = 20 (28.6%) 2019: N = 64 (it does not divide into men and women)	Both perpetrators and victims of bullying may face an elevated risk of suicide attempts or threats.	100%

Yu et al., 2022 China Cross-sectional	N = 1,248 Mean age: 16.8 Male = 417 (33.41%) Female = 831 (66.59%) The objective of this study was to evaluate the current suicide risk and determine its connection to various forms of trauma, using data from the Chinese Youth Health-Related Behavior Questionnaire.	**NSSI:** Self-mutilation: N = 151 (12.10%) **Suicidality:** Suicidal ideation: N = 179 (14.34%) Suicidal plan: N = 103 (8.25%) Suicidal attempt: N = 102 (8.7%)	There is a higher prevalence of suicide risk (SR) among adolescents compared to the global adolescent suicide rate from previous two years ago, and higher than the findings in Chongqing in 2019, particularly among junior and senior high school students.	100%

Zetterqvist et al., 2021 Sweden Longitudinal	T1 2011: N = 3,060 T2 2014: N = 5,743 T3 2020-2021: N = 3,258 Mean age T3: 18.19 Age: 16-18 T1: Female: 1,537 (50.2%) Male: 1,509 (49.3%) T2: Female: 3,153 (54.9%) Male: 2,536 (44.2%) T3: Female: 1,787 (54.8%) Male: 1,445 (44.4%) Examine the rise in non-suicidal self-injury rates throughout the pandemic.	Total number and percentage of lifetime prevalence of NSSI in adolescents in three time points: T1: N = 525 (17.2%) F = 402 (26.4%) M = 120 (8%) T2: N = 1.015 (17.7%) F = 778 (24.7%) M = 222 (8.8%) Non-binary: 15 (28.3%) T3: N = 898 (27.6%) F = 649 (36.3%) M = 231 (16%) Non-binary: 18 (69.2%)	Levels of depression and anxiety were elevated in 2020-2021 compared to 2014	93,75%

Zhao et al., 2023 China Longitudinal	First wave N = 2,090 Second wave N = 1,609 Age: 12-18 Mean age: 16.5 Male: 588 (36.5%) Female: 1,021 (63.5%) Explore the relationship between PTSD symptoms during the pandemic and NSSI in adolescents over time. Analyze the mediating role of sleep problems and depressive symptoms in the connection between PTSD and NSSI.	Total number of adolescents who reported at least one episode of NSSI: N = 513 (31.9%) M = 169 (32.9%) F = 344 (67.1%)	Early PTSD symptoms persisted, influencing and forecasting future issues with sleep and depression, which subsequently heightened the likelihood of self-harming behaviors in adolescents.	95%

Zhou et al., 2022 China Cross-sectional	N = 8,361 Mean age: 14.62 Male: 4,397 (52.58%) Female: 3,964 (47.41%) Examine the relationship between non-suicidal self-injurious behaviors, gender, coping strategies, and their interactions among Chinese students during the COVID-19 pandemic.	Total number of adolescents who experienced NSSI: N = 476 (5.7%)	Coping strategies such as seeking social support, tolerance, emotional expression, and denial/fantasy are independent predictors of non-suicidal self-injury. Parental separation and enrollment in vocational high schools are associated with an increased likelihood of non-suicidal self-injury.	100%

Zhu et al., 2022 China Cross-sectional	N = 5,175 Age: 9-19 Mean age: 13.38 Male = 2,673 (51.7%) Female = 2,502 (48.3%) An online cross-sectional survey was conducted to assess the prevalence of suicidal ideation (SI) during the COVID-19 lockdown among Chinese adolescents and to examine gender-specific factors associated with SI.	The prevalence of suicidal ideation during the COVID-19 pandemic lockdown of all the participants was 3%: F = 3.64% M = 2.39% Total number of adolescents with a history of previous suicide attempts: N = 610 (11.79%)	The prevalence of suicidal ideation (3%) among adolescents was lower compared to other studies (12.7%). Adolescent suicide rates did not increase during the COVID-19 pandemic. Several factors may be related to home isolation may have reduced negative peer interactions; strain relationships with parents but returning to school may have minimized these conflicts.	100%

Zhu et al., 2021 China, Hong Kong Longitudinal	N = 1,491 Age: 10-17 Mean age: 13.04 Male: 695 (46.6%) Female: 792 (53.4%) Examine shifts in suicidal episodes and explore the factors linked to suicidal ideation and recurrence among children and adolescents in Hong Kong.	Number of suicidal episodes Pre-pandemic (2019): 24% Experienced suicidal episodes only before the pandemic Total: 193 (14%) F = 85 (6.2%) M = 108 (7.8%) During the pandemic (2020): 21% Experienced suicidal episodes only during the pandemic Total: 148 (10.7%) F = 84 (6.1%) M = 64 (4.6%) Experienced episodes before and during the pandemic: Total: 143 (10.4%) F = 99 (7.2%) M = 44 (3.2%)	Depression, anxiety, stress, loneliness, social anxiety, a fixed mindset, reduced sense of life meaning, diminished self-control, and lack of parental support and supervision were key factors. Poor psychological well-being, limited family support, and the negative effects of the pandemic were consistently linked to suicidal ideation among students during this time.	100%

3.2. Prevalence profile of suicidality and non-suicidal self-injury over the past 14 years

Despite the shorter and more variable durations of post-pandemic study periods, a significant shift in self-harm prevalence was observed, particularly in NSSI. During the pre-pandemic period, spanning nine years (2010–2019 based on study time frames), data revealed that 45,233 adolescents attempted suicide, 5,025/yearly, representing 5.14% of the investigated population, while 4,411 adolescents engaged in NSSI, 490/yearly, accounting for 0.5%.

In contrast, the post-pandemic period (2020-2024 spanning 4 years), characterized by shorter and more heterogeneous study intervals, included datasets with varying temporal

coverage. Aggregated data for the post-pandemic period revealed a significant reduction in suicide attempts, with 9,436 adolescents attempting suicide (0.76% of the population), 2,359/yearly. Conversely, NSSI prevalence surged, involving 29,970 adolescents, 7,492/yearly or 2.43% of the population.

To account for differences in study durations, the average annual prevalences were calculated. For suicide attempts, the pre-pandemic average was 0.57%, decreasing to 0.19% post-pandemic, representing a 66.67% reduction. Conversely, NSSI showed a significant increase, with the pre-pandemic average of 0.056% rising to 0.61% post-pandemic, corresponding to a 992.86% increase. These findings highlight a pronounced escalation in NSSI behaviors among adolescents during the post-pandemic period, despite the marked reduction in suicide attempts. Although the focus on suicidality has dominated the scientific agenda, recent findings underscore a significant and genuine rise in self-injury rates post-pandemic, reflecting the amplification of risk factors exacerbated by the pandemic context.

3.2.1. Associated factors

The main factors associated with self-harm and suicidality included lack of family and social support (n=30; 54.5%), physical and psychological health problems (n=21; 38.1%), and, to a lesser extent, bullying involvement (n=9; 16.3%), psychoactive substance use (n=8; 14.5%), self-image and self-esteem issues (n=5; 9%), and academic performance difficulties (n=4; 7.2%). These findings provide critical insights into the pandemic’s multifaceted impact on adolescent mental health. The "n" mentioned in this paragraph refers to the number of studies addressing the specific themes under discussion.

3.3. Across time: changes in prevalences between the pre- and post-pandemic periods

During the period from 2010 to 2019, most studies (n=24, corresponding to 82% of the articles) reported a high prevalence of suicidality and non-suicidal self-injury (NSSI) among adolescents. Physical, psychological, contextual, and environmental factors were consistently associated with these behaviors. Notably, the lack of family support, bullying, mental health problems, and academic difficulties were key factors.

Gender also played a significant role, with a higher prevalence of suicidality among female adolescents, often linked to low self-esteem and family conflicts.

Regarding the 2020–2024 period, most reviewed studies (n=18, corresponding to

69.23% of the articles evaluated in this review) identified an increase in the prevalence of suicidality and self-harm among adolescents. Contributing factors included a lack of family support, psychological and physical problems, socioeconomic and environmental issues, as well as excessive use of psychoactive substances.

The COVID-19 pandemic transformed the landscape of risk factors associated with suicidality and NSSI among adolescents, revealing new dimensions of mental vulnerability. Social isolation and increased loneliness, driven by prolonged school closures and social distancing measures, emerged as critical risk factors. Increased loneliness correlated strongly with self-harm risk, emphasizing the urgency of preventive interventions. Furthermore, intensified use of technology and social media, while serving as an outlet for many, exacerbated deteriorations in sleep quality, a factor directly linked to heightened suicidal ideation and self-harm behaviors.

This scenario was aggravated by financial instability and complex family dynamics. Families facing economic hardship and pandemic-related losses presented adolescents with an elevated risk of suicide and self-harm. Adolescents experiencing heightened levels of depression and anxiety during the pandemic showed intensified vulnerabilities, amplified by low self-esteem and lack of family support.

Gender remained a critical determinant, with a higher prevalence of suicidality and self-harm among female adolescents. Sexual orientation and gender identity also significantly influenced these behaviors, with higher rates of suicidal ideation among homosexual and transgender adolescents compared to their heterosexual and cisgender peers.

Finally, adolescents who face academic difficulties, bullying, or low self-esteem exhibited a substantial increase in suicidal ideation and self-harm behaviors.

4. Discussion

Risk factors for suicidality and non-suicidal self-injury (NSSI) among adolescents underwent significant changes during the COVID-19 pandemic. Pandemic stressors, such as loneliness during social isolation and economic hardship, were strongly heightened the risk non-suicidal self-injury (NSSI) globally, as observed in countries like China, the United Kingdom, Uganda, and South Korea (Bukuluki et al., 2021; Cheng et al., 2024; Geulayov et al., 2022; Lee and Hong 2022). Contrary to widespread concerns about a potential surge in suicide-related behaviors during the COVID-19 pandemic, evidence from numerous studies suggests a more stable pattern in adolescent suicidality. For instance, research conducted in Maryland revealed that adolescent suicide rates remained relatively consistent throughout the pandemic, with only minor fluctuations during specific periods (Rogers et al., 2023). Similarly, a study in Mexico found no significant differences in the prevalence of suicide attempts between pre-pandemic and pandemic periods, further emphasizing the stability of these behaviors (Valdez-Santiago et al., 2022). In Korea, longitudinal analysis showed improvements in suicidal ideation and attempts during both short- and long-term pandemic phases, highlighting potential resilience among adolescents (Lee and Hong, 2022). These findings collectively challenge the assumption of a uniform increase in suicide-related behaviors, demonstrating variability across different contexts and populations.

Well-known pre-existing stressors exacerbate the impact of new stressors, such as remote schooling, social isolation, and economic instability. These factors heightened loneliness, disrupted sleep patterns, and intensified anxiety and depression, particularly in adolescents already at risk (Cheng et al., 2024; Suárez Colorado and Campo-Arias, 2019). The interplay between contextual and individual risk factors created heightened challenges, emphasizing the need for targeted interventions (Dumont et al., 2024).

4.1. Environmental or contextual risk factors

4.1a. Family and socioeconomic challenges

Factors such as lack of family support, financial instability, and family disconnection, previously were linked to increased suicidality, became even more pronounced as economic hardships deepened and social isolation restricted access to coping resources (Bukuluki et al., 2021; Cheng et al., 2024; Geulayov et al., 2022; Suárez Colorado and Campo-Arias, 2019). These challenges created new layers of vulnerability, highlighting the effects of pre-existing

stressors (Dumont et al., 2024). Supportive family environments have been shown to reduce self-injury rates by fostering psychological resilience and mitigating depressive symptoms (Gao et al., 2024). Conversely, dysfunctions within the family, such as conflict, poor communication, and lack of parental supervision, exacerbate maladaptive behaviors and significantly contribute to psychological distress and suicidal behaviors among adolescents (Indiana-Luz Rojas-Torres et al., 2022; Zhu et al., 2021).

The loss of primary caregivers due to COVID-19-related deaths placed many adolescents in precarious living arrangements, often with unfamiliar or distant relatives. These new environments sometimes led to exploitation or continued cycles of abuse, exacerbating adolescents' sense of grief and emotional instability (Lee et al., 2024; Marques et al., 2020; Pereda and Díaz-Faes, 2020; Zetterqvist et al., 2023). Parental stress fosters environments conducive to abuse. Economic hardships, job losses, and fears of COVID-19 infection contributed to elevated levels of parental anxiety, which often manifested as aggressive or neglectful behaviors toward adolescents (Marques et al., 2020; Pereda and Díaz-Faes, 2020). Parents struggling with substance abuse during lockdowns further diminished their caregiving capacities, creating an environment where physical and emotional maltreatment became more frequent and severe (Oliveira et al., 2024). This is consistent with earlier findings that households with pre-existing dysfunctions, including parental alcoholism, saw a marked increase in violence and neglect during prolonged periods of stress (De Luca et al., 2022; Grzejszczak et al., 2024).

Economic instability, including parental job loss and food insecurity, significantly heightens these risks, as adolescents facing household financial difficulties display higher rates of depressive symptoms, suicidal ideation, and suicide attempts (Farooq et al., 2021; Jones et al., 2023; Kim et al., 2022; Park and Ha, 2023). The experience of reduced access to healthcare compounds their mental health challenges (Park and Lee, 2023; Pinchoff et al., 2021).

Cultural and ethnic dynamics introduced additional layers of complexity. Adolescents from ethnic minority groups and immigrant families faced increased vulnerability to suicidality (Lee et al., 2014; Park and Lee, 2023; Roche et al., 2021; van Vuuren et al., 2021). Unemployment and financial uncertainty have been shown to increase the prevalence of suicidal behaviors, particularly among adolescents from low-income households (Farooq et al., 2021; Jung et al., 2024).

The interplay between chronic stressors and acute stressors such as pandemic-related disruptions add on the effects on depression and suicide-related behaviors (Vidal et al., 2024; Zhu et al., 2021).

4.1b. Bullying

The COVID-19 pandemic significantly altered the prevalence and dynamics of bullying behaviors. Traditional bullying generally decreased during lockdowns due to reduced peer interaction in physical school settings, a trend attributed to school closures and enhanced parental supervision at home (Forsberg and Thorvaldsen, 2022; Vaillancourt et al., 2021). However, this decrease was counterbalanced by a substantial increase in digital bullying, as adolescents turned to online platforms for social interaction during periods of isolation (Forsberg and Thorvaldsen, 2022; Vaillancourt et al., 2023). Cyberbullying often intensified in severity, with prolonged digital exposure augmenting risks of mental health deterioration, particularly in individuals with pre-existing conditions, such as anxiety and depression (Mohd Fadhli et al., 2022; Xie et al., 2022). Digital bullying impact is profound and multifaceted, coursing with heightened anxiety, depression, and social withdrawal, conditions exacerbated by the anonymity and permanence of online harassment (Vaillancourt et al., 2023; Xie et al., 2022). Victims of any bullying exhibited markedly higher rates of suicidal ideation and attempts, often accompanied by depressive symptoms and diminished self-esteem (Bračič et al., 2019; Ibrahim et al., 2017; Nguyen et al., 2023; Xie et al., 2022). During and after the pandemic, both traditional and cyberbullying emerged as significant predictors of suicidal behaviors (Mohd Fadhli et al., 2022; (Suárez Soto et al., 2022). Again, specific groups, including low-income households, LGBTQ+ and racialized youth, faced disproportionate rates of cyberbullying, reflecting enduring patterns of identity-based victimization that were intensified during the pandemic (Pinchoff et al., 2021; Sorrentino et al., 2023; Vaillancourt et al., 2023).

Socioeconomic and cultural contexts played a crucial role in shaping bullying dynamics. In countries with stricter public health measures, traditional bullying rates declined due to increased teacher supervision and minimized unstructured peer interactions (Forsberg and Thorvaldsen, 2022; Vaillancourt et al., 2021). Cyberbullying trends varied significantly, with sharp increases reported in regions with extended lockdowns and less stringent anti-cyberbullying policies (Sorrentino et al., 2023; Vaillancourt et al., 2023).

4.2 Individual factors

4.2a. Psychiatric and psychological problems

Pre-existing mental health conditions such as anxiety and depression experienced significant worsening of symptoms due to the stress of the pandemic (Fujimoto et al., 2024). Poor sleep quality and excessive screen time disrupted emotional regulation (Cheng et al., 2024). Adolescents with difficulties regulating emotions often turned to maladaptive coping mechanisms like NSSI to manage overwhelming feelings of loneliness and helplessness during prolonged lockdowns (Zetterqvist et al., 2021). This pattern underscores the pivotal role of emotional regulation skills in mitigating the adverse effects of pandemic-related stress on mental health (Grzejszczak et al., 2024; Zetterqvist et al., 2023).

Prolonged confinement in households where abuse was already present increased exposure to physical, emotional, and even sexual violence, as adolescents were isolated from potential protective buffers (Marques et al., 2020; Pereda and Díaz-Faes, 2020). Adverse childhood experiences (ACEs) heightened emotional distress and reduced the ability of adolescents to adapt to changing circumstances (Bukuluki et al., 2021; Meeker et al., 2021; Wang et al., 2021). Accumulative exposure to ACE played a significant role in increasing susceptibility to self-harm and suicidal ideation. Low resilience emerged as a critical factor, who lacked robust coping mechanisms facing greater challenges in managing stress effectively (Reiss et al., 2024). The ones with limited coping skills and emotional resources were less equipped to handle pandemic-related stressors, leaving them particularly vulnerable to suicidality and NSSI (Chung et al., 2024; Reiss et al., 2024). Difficulties in access to mental health resources, disproportionately affected underserved communities, intensifying their struggles with mental health (De Luca et al., 2022; Grzejszczak et al., 2024) . Increases in self-injury behaviors were driven by a lack of effective coping strategies and emotional resilience (Lee et al., 2024).

4.2b. Substance use and media exposure

The use of psychoactive substances, including alcohol and tobacco, was frequently associated with suicidal behaviors, particularly in socially vulnerable adolescents (Dumont et al., 2024; Roche et al., 2021). Dependency on digital platforms also emerged as a significant factor, with adolescents experiencing higher rates of anxiety and depression due to constant comparison and exposure to harmful content online (Cheng et al., 2024). Substance use and

digital dependency appear to act as mechanisms for coping with stress and emotional distress, though they simultaneously exacerbate mental health vulnerabilities (Xu et al., 2021; Xu et al., 2022).

When it comes to digital dependency, a phenomenon must be cited: Snapchat dysmorphia. It represents a growing phenomenon intricately linked to the interaction between social media usage, body self-image, and self-esteem, particularly among adolescents. Platforms like Snapchat, with their AI-driven filters, create unrealistic standards of beauty, often leading to distorted self-perceptions and behaviors aimed at achieving unattainable physical ideals (Fardouly et al., 2020; Wilksch et al., 2020). Adolescents became particularly susceptible to body dissatisfaction and disordered eating behaviors, such as meal skipping and compulsive exercise, as they attempted to conform to the idealized images portrayed on these platforms (Wilksch et al., 2020). The appearance-based activities, including editing selfies and comparing oneself to filtered images, strongly correlate with depressive symptoms and body dissatisfaction, particularly in female adolescents (Fardouly et al., 2020). These activities perpetuate a cycle of negative self-evaluation, reinforcing the need for external validation and increasing vulnerabilities to mental health challenges (Fardouly et al., 2020). In the long-term, it seems to compromise identity formation, as constant exposure to idealized imagery contributes to maladaptive self-modeling and body image distortions (Tremblay et al., 2020). In extreme cases, adolescents use Snapchat as a platform to exchange extreme dieting goals and set unrealistic body standards. When these goals are not met, some engage in self-punishing behaviors, including self-harm, reflecting the pressures of peer influence and digital beauty culture (Tremblay et al., 2020; Wilksch et al., 2020).

In a Saskatchewan study, the risk associated with co-occurring substance use was identified, particularly the simultaneous use of cannabis and alcohol. Adolescents with problematic use of both substances demonstrated a significant increase in suicidal ideation compared to those using only one substance (Adeyinka et al., 2023). Recent changes in substance use patterns, such as increased frequency or quantity, were linked to heightened vulnerability, particularly among younger ones (Adeyinka et al., 2023). Online gaming environments have been increasingly linked to heightened risks of problematic behaviors, including the consumption of alcohol. Adolescents, isolated due to pandemic restrictions, often turned to online gaming and alcohol consumption as maladaptive coping mechanisms to alleviate stress and loneliness (Vessey et al., 2022; Xu et al., 2021; Xu et al., 2022). The reward systems in online gaming, coupled with peer interactions and challenges normalize or even

incentivize risky behaviors like alcohol consumption (Xu et al., 2021; Xu et al., 2022).

The interplay between gaming and substance use has been explained through the shared mechanism of escapism and coping strategies. Gamers, particularly those engaged in multiplayer games, are exposed to social interactions where alcohol consumption may be encouraged or rewarded, implicitly or explicitly (Vessey et al., 2022; Xu et al., 2021; Xu et al., 2022). Anonymity and detachment provided by digital platforms, reduces the perceived consequences of risky behaviors (Xu et al., 2021; Xu et al., 2022). The competitive and immersive nature of online gaming often leads to long sessions, in which players may resort to substances like alcohol to sustain engagement or bond socially, amplifying the risks of dependency and health issues (Vessey et al., 2022).

These patterns are especially concerning for adolescents who are simultaneously navigating identity development and social relationships. Vulnerable groups, such as those already facing bullying or other social pressures, may find online gaming a double-edged sword, a refuge that inadvertently exposes them to additional risks, such as substance abuse (Vessey et al., 2022).

4.2c. Self-image and self-esteem

Negative self-image and low self-esteem were closely linked to suicidality, particularly in adolescents facing body image challenges or social conflicts (Junior et al., 2016; Thakur et al., 2015). Personality traits such as neuroticism and impulsivity, which were amplified during the pandemic, further heightened vulnerability to self-injurious behaviors (Dumont et al., 2024; Wang et al., 2023).

Another interesting behavioral phenomenon is Fear of Missing Out (FoMO), which also plays a crucial role in the interaction between social media use, self-image, and self-esteem, particularly among adolescents. FoMO increases vulnerability to the negative influences of social media on self-image and self-esteem. The pervasive use of platforms amplifies feelings of inadequacy and exclusion, particularly when individuals perceive themselves as missing out on rewarding experiences shared by their peers (Topino et al., 2023). This phenomenon often drives excessive engagement with social media, contributing to a cycle of comparison and dissatisfaction with personal achievements or appearance (Tan Dat et al., 2023). The adolescents from families with poor cohesion or rigid structures are more likely to seek validation and social gratification online, intensifying the risks associated with low self-esteem

and distorted self-perception (Topino et al., 2023).

The impact of FoMO on adolescents' mental health is worsened by societal pressures to conform to idealized standards of beauty and success frequently portrayed on social media. This exposure often exacerbates existing insecurities, particularly when with limited emotional regulation skills (Pang and Quan, 2024). As adolescents, they struggle to reconcile their perceived inadequacies with the curated realities of their peers (Topino et al., 2023).

4.2d. Academic performance

The COVID-19 pandemic significantly altered the educational landscape for adolescents, introducing new challenges to academic performance, particularly through the increased use of social media and rising levels of procrastination. Academic difficulties were amplified by the COVID-19 pandemic, following the abrupt closure of schools and the shift to remote learning (Engzell et al., 2021). The pandemic disrupted routines, increased stress levels, and created barriers to effective learning, particularly for students without access to adequate resources or those who struggled to adapt to online platforms (Asanov et al., 2021). The lack of a structured learning environment at home contributed to a loss of academic performance that had lasting effects on adolescents' mental health (Engzell et al., 2021).

Low academic performance or repeated failures were strongly linked to an increased likelihood of suicidal ideation and attempts (Orozco et al., 2018). Adequate school support and a positive school environment served as protective factors, reducing the risk of suicidal thoughts and self-harm (Orozco et al., 2018; Ruiz-Robledillo et al., 2019; Stallard et al., 2013; Zaccoletti et al., 2020).

Adolescents facing academic challenges experienced intensified feelings of isolation and stress due to the lack of interaction and support (Ogurlu et al., 2020). Improved access to digital resources, mental health interventions, and strategies to mitigate the psychological impact of academic stress could have been beneficial (Engzell et al., 2021; Zaccoletti et al., 2020).

Social media became a primary tool for adolescents to maintain connections during periods of isolation, but this also led to increased screen time, distracting students from academic tasks and promoting procrastination (Morello et al., 2023; Wu et al., 2023). Long online engagement disrupted study routines and sleep schedules, which are critical for cognitive

functioning and academic success (Delawalla et al., 2024; Morello et al., 2023).

The shift to online learning intensified the temptation to engage with non-educational digital content, detracting from academic focus. Adolescents who struggled to regulate their social media use reported higher levels of academic stress and lower performance outcomes (Delawalla et al., 2024; Morello et al., 2023; Wu et al., 2023). The lack of in-person interactions with teachers and peers deprived students of essential support structures, undermining their ability to stay motivated and engaged with schoolwork (Wu et al., 2023). The interaction between procrastination and social media use during the pandemic reveals a cyclical relationship: adolescents turned to social media to avoid academic responsibilities, but this avoidance magnified feelings of guilt and anxiety about incomplete tasks, perpetuating a cycle of procrastination (Delawalla et al., 2024; Morello et al., 2023).

Social isolation deprived adolescents of essential protective factors, such as meaningful peer interactions and structured environments, which typically buffer against psychological distress. For instance, the absence of in-person schooling not only limited access to mental health resources but also removed a critical outlet for problem-solving and stress management (Delawalla et al., 2024). This loss, compounded by family conflicts and economic instability, left adolescents with diminished opportunities to engage in constructive coping, forcing many to turn to harmful alternatives, including social media overuse and substance abuse to manage their distress (Vessey et al., 2022; Wu et al., 2023). Adolescents who previously relied on external support systems, including peers, teachers, and extracurricular activities, found these resources unavailable, leading to increased reliance on maladaptive behaviors such as avoidance, rumination, and self-harm (Lee et al., 2024; Marques et al., 2020). Addressing these vulnerabilities requires a concerted effort to rebuild supportive school environments and strengthen interventions aimed at reducing academic stress, particularly in underserved populations (Asanov et al., 2021; Zaccoletti et al., 2020).

Lack of access to therapy, school counseling, and community programs significantly hindered adolescents' ability to navigate heightened stressors. These barriers contributed to an increased prevalence of maladaptive behaviors, such as NSSI and suicidality, as adolescents struggled to process grief, fear, and uncertainty (Fardouly et al., 2020; Pang and Quan, 2024). Additionally, the normalization of harmful behaviors through online platforms, such as exchanging dieting tips or self-harm methods, amplified these challenges (Topino et al., 2023; Wilksch et al., 2020).

5. LIMITATIONS

This study faced several limitations that should be acknowledged. The diversity in methodologies, study designs, and population characteristics hindered the ability to integrate data effectively and draw consistent conclusions. The predominance of cross-sectional studies restricted the analysis to associations, without allowing for the establishment of causal links between risk factors and outcomes such as suicidality and NSSI. Additionally, the reliance on self-reported data introduced inherent biases, such as recall and social desirability biases, which may have compromised the accuracy of the reported behaviors and perceptions.

The adoption of digital tools for education and communication reshaped adolescent experiences, creating variability in risk factors and outcomes over time. Lastly, the reliance on digital platforms for data collection during the pandemic likely excluded adolescents from lower-income households with limited access to technology. This may result in an underestimate of the prevalence of mental health challenges among these groups, particularly in regions where digital differences were significant.

Despite these limitations, this study provides valuable insights into the complex interplay of risk factors influencing adolescent mental health during and beyond the pandemic. Future research should aim to address these gaps by adopting standardized methodologies, incorporating longitudinal designs, and ensuring inclusive sampling that captures the diverse and evolving experiences of adolescents worldwide.

6. CONCLUSION

The pre- and post-pandemic data analysis provides a nuanced answer to the question: *"Was there a change in the prevalence and risk factors of suicidality and self-harm among adolescents before and after the onset of the COVID-19 pandemic up to the present day?"* The answer is yes, with important distinctions. There is a significant rise in non-suicidal self-injury (NSSI) during the pandemic, while the prevalence of suicide attempts seems to decrease in pooled data. While the prevalence of suicide attempts decreased significantly during the pandemic (approximately 66.67%), NSSI exhibited a dramatic increase of about 992.86%.

Risk factors evolved and intensified throughout the pandemic change, with common challenges including lack of family support, academic difficulties, bullying, and mental health issues such as depression and anxiety, which persist to this day. In contrast, NSSI was strongly associated with poor emotional regulation, heightened loneliness, and the normalization of self-injury through online platforms. These findings highlight the distinct emotional and contextual pathways leading to these outcomes.

A complex interplay between pre-existing vulnerabilities and novel stressors, such as social isolation, economic hardship, and disruptions to routine particularly minority groups and poor faced disproportional severe impacts, emphasizing the interplay between socioeconomic and cultural dynamics in shaping mental health outcomes. Despite a decrease in suicide attempts, the persistence and escalation of NSSI behaviors highlight the enduring emotional toll of the pandemic, further exacerbated by restricted access to mental health services during critical periods. This represents a convergence of new and pre-existing challenges, carrying significant long-term repercussions.

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6 CONSIDERAÇÕES FINAIS

Os estudos analisados destacam tendências importantes no comportamento suicida e autolesivo em adolescentes, ressaltando mudanças significativas nos fatores de risco associados, especialmente antes e depois da pandemia de COVID-19. Observou-se uma redução nas taxas de tentativas de suicídio pós-pandemia, enquanto comportamentos de autolesão sem intenção suicida (NSSI) tiveram aumento substancial. Esses padrões ilustram como crises globais podem impactar de formas distintas a saúde mental de populações vulneráveis.

Fatores comuns emergiram como determinantes-chave ao longo do período analisado, incluindo falta de suporte familiar, dificuldades econômicas, isolamento social e problemas acadêmicos. A pandemia intensificou alguns desses fatores, criando um ambiente que ampliou vulnerabilidades, especialmente entre adolescentes já predispostos a problemas de saúde mental. As disparidades de gênero, com maior prevalência de comportamentos suicidas em adolescentes do sexo feminino, também foram consistentemente relatadas.

Um ponto de convergência foi o impacto de influências digitais, como o cyberbullying e o uso excessivo de tecnologia, que se mostraram fatores exacerbantes de ideação e tentativas suicidas, bem como de autolesões. Adolescentes com dificuldades pré-existentes em regulação emocional mostraram maior propensão a recorrer a mecanismos de enfrentamento desadaptativos nesses contextos. A aplicação de ferramentas de aprendizado de máquina (ML) em contextos psiquiátricos também trouxe insights valiosos, especialmente ao identificar preditores de comportamentos suicidas. Apesar do progresso, a baixa acurácia em certos modelos, como na previsão de tentativas de suicídio, evidencia a complexidade de prever tais comportamentos.

Para aprofundar o entendimento das dinâmicas suicidas e autolesivas em adolescentes, futuras pesquisas devem explorar os efeitos a longo prazo de crises globais, como a COVID-19, sobre esses comportamentos, considerando diferentes contextos culturais e econômicos. Além disso, é necessário investir em métodos de ML mais robustos e personalizados, integrando dados longitudinais e contextuais para aumentar a acurácia das previsões. Outra frente importante é a pesquisa sobre a eficácia de programas digitais voltados para reduzir o impacto do cyberbullying e promover a regulação emocional em adolescentes. Estratégias que considerem as diferenças de gênero são fundamentais, especialmente focando em adolescentes do sexo feminino e em questões ligadas à identidade de gênero e orientação sexual. Por fim, é

essencial identificar e promover fatores protetores, como suporte familiar e estratégias de enfrentamento positivas, para mitigar os riscos associados aos comportamentos suicidas e autolesivos.

Essa integração entre achados prévios e futuros estudos oferece caminhos promissores para intervenções mais efetivas e culturalmente sensíveis, contribuindo para a saúde mental dos adolescentes em contextos globais em constante transformação.