Resilience as a Key to Mental Well-Being in Higher Education: A Systematic Review of Evidence and Strategies*

La resiliencia como clave para el bienestar mental en la educación superior: una revisión sistemática de evidencias y estrategias

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ABSTRACT

University students face multiple demands, making resilience essential for adapting, recovering, and thriving amid academic and personal challenges. This PRISMA-guided systematic review synthesizes evidence from 33 cross-sectional studies (2019–2024) including 49,868 participants (mean age ≈22) without major mental health conditions. Searches covered PubMed, Web of Science, and Scopus. Resilience was assessed with validated instruments, primarily the Connor-Davidson Resilience Scale (CD-RISC) and the Brief Resilience Scale (BRS), and commonly examined alongside stress, depression, and anxiety. Findings were consistent: higher resilience was strongly associated with lower stress, anxiety, and depressive symptoms, and with better well-being, sleep quality, and academic engagement. Resilience also emerged as a protective factor against burnout, loneliness, and problematic mobile phone use. Collectively, the evidence highlights resilience as a central determinant of mental health and life satisfaction in university populations. Implications for higher education include implementing targeted, evidence-based programs to build resilience, such as psychoeducational skills training, social support initiatives, and promotion of healthy lifestyle habits (physical activity, sleep hygiene). Strengthening resilience may enhance academic performance, personal functioning, and overall well-being, offering a practical foundation for policies and practices that support student success.

Keywords
University students; resilience; mental health; cross-sectional studies, education.

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RESUMEN

El alumnado universitario afronta múltiples desafíos, por lo que la resiliencia resulta clave para adaptarse, recuperarse y prosperar ante demandas académicas y personales. Este estudio, siguiendo PRISMA, sintetiza 33 trabajos transversales (2019–2024) con 49.868 participantes (edad media≈22) sin trastornos mentales mayores, identificando

prevalencia, factores asociados y vínculos con la salud mental y el bienestar. Las búsquedas se realizaron en PubMed, Web of Science y Scopus. La resiliencia se evaluó con instrumentos validados (p. ej., CD-RISC, BRS) y se analizó junto a estrés, depresión y ansiedad. Los resultados muestran asociaciones consistentes: mayores niveles de resiliencia se relacionan con menos estrés, ansiedad y depresión, y con mejor bienestar, calidad del sueño y compromiso académico. Asimismo, la resiliencia actúa como factor protector frente a burnout, soledad y adicción al móvil. En conjunto, la evidencia subraya el papel central de la resiliencia para promover la salud mental y la satisfacción vital en estudiantes universitarios. Se recomienda implementar intervenciones específicas en educación superior, incluyendo programas de habilidades psicoemocionales, apoyo social y hábitos saludables, para fortalecer la resiliencia y, con ello, mejorar resultados académicos y personales. Estas conclusiones ofrecen una base para diseñar políticas y prácticas focalizadas.

Palabras clave
Estudiantes universitarios; resiliencia; salud mental; estudios transversales, educación.

Introduction

Higher education students face persistent stressors, including academic demands, financial responsibilities, adapting to new social environments, and limited family support (Jiang, 2020; Pascoe et al., 2019). These challenges are exacerbated by pressures such as limited free time and fear of failure. The COVID-19 pandemic further intensified these stressors with the shift to online education, leading to increased workload, social isolation, and reduced concentration and productivity (Pajarianto et al., 2020).

More than just "bouncing back," resilience involves emotional regulation, adaptive coping, and interpersonal relationship-building, promoting well-being and mitigating stress impacts (Meenakshi et al., 2020). It is linked to subjective well-being, life satisfaction, and academic performance (Song et al., 2024). Defined as the process of adapting to challenges with mental, emotional, and behavioral flexibility (American Psychological Association, 2024), resilience supports stress management (Southwick & Charney, 2018) and equips students to navigate both academic and professional challenges (Ang et al., 2021).

Resilience fosters emotional and social competencies essential for transforming higher education challenges into growth opportunities (Liu & Boyatzis, 2021). However, limited global data on university students' resilience (Brewer et al., 2019; Sanderson & Brewer, 2017) hinders targeted interventions. Understanding the prevalence and influencing factors of resilience is vital for designing tailored programs to enhance stress management and overall well-being, and for improving academic and professional outcomes (Abulfaraj et al., 2024).

This study conducts a comprehensive analysis of resilience in higher education students, synthesizing evidence from cross-sectional studies to examine associated factors, methodologies, and global trends. Insights from this research will guide evidence-based strategies to support students in overcoming challenges and fostering holistic development throughout life.

Despite the growing body of literature on resilience in higher education, important gaps remain. Existing studies show considerable heterogeneity in instruments, populations, and outcomes, limiting comparability and the extraction of practical implications for universities. Therefore, the main objective of this systematic review is to synthesize recent evidence (2019-2024) on resilience levels in higher education students, examining their relationship with mental health, academic outcomes, and contextual factors, to identify common patterns, methodological limitations, and opportunities for intervention in higher education.

Methods

Protocol and Registration

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Moher et al., 2009).

Data Sources and Search Strategy

A comprehensive literature search was conducted in PubMed, Web of Science, and Scopus for studies published between January 2019 and November 2024. The search strategy combined controlled vocabulary and free-text terms related to resilience and university students, applying Boolean operators (AND/OR) and truncators (*). Filters included language (English/Spanish), document type (article), and open access. The complete search strings for each database are presented in Supplementary Table 1.

The exact search strings used were as follows:

PubMed: ("university students"[Title/Abstract] OR "college students"[Title/Abstract] OR undergraduates[Title/Abstract] OR universitarians[Title/Abstract]) AND ("resilience"[Title/Abstract] OR "psychological resilience"[Title/Abstract] OR "resilient capacity"[Title/Abstract] OR resilien*[Title/Abstract]) AND ("cross-sectional"[Title/Abstract] OR "descriptive study"[Title/Abstract])). Filters: 2019/01/01–2024/11/08; Humans; English/Spanish; Free full text; Article

Web of Science (Core Collection): TS=("university students" OR "college students" OR undergraduates OR universitarians) AND TS=("resilience" OR "psychological resilience" OR "resilient capacity" OR resilien*) AND TS=("cross-sectional" OR "descriptive study"). Refined by: Open Access; Languages: English/Spanish; Document Types: Article; Timespan: 2019–2024

Scopus: TITLE-ABS-KEY("university students" OR "college students" OR undergraduates OR universitarians) AND TITLE-ABS-KEY("resilience" OR "psychological resilience" OR "resilient capacity" OR resilien*) AND TITLE-ABS-KEY("cross-sectional" OR "descriptive study") AND (PUBYEAR > 2018 AND PUBYEAR < 2025) AND (LIMIT-TO(LANGUAGE, "English") OR LIMIT-TO(LANGUAGE, "Spanish")) AND (LIMIT-TO(OPENACCESS, "all")) AND (LIMIT-TO(DOCTYPE, "ar"))

The search results were exported to Mendeley for organization and deduplication, and subsequently imported into Rayyan QCRI (https://rayyan.qcri.org/) to facilitate independent screening by reviewers.

Eligibility Criteria

The eligibility of the studies was reviewed independently by two researchers (L.G.-P and R.P.-R). Using the PICOS framework, which considers participants, intervention, comparator, outcomes, and study design, the following inclusion criteria were established:

-Population (P): Higher education/university students;

-Intervention/condition (I): Psychological resilience;

-Comparison (C): Not applicable (observational studies);

-Outcomes (O): Mental health indicators (stress, anxiety, depression, well-being), academic outcomes (e.g., engagement, procrastination), and related factors (e.g., sleep, social support, mobile phone use);

-Study design (S): Cross-sectional studies (descriptive and analytical).

Cross-sectional designs were prioritized because they allow estimation of prevalence and associations across large and diverse samples, consistent with the descriptive and associative objectives of this review. Only open-access articles were included, in line with open science principles to ensure transparency, replicability, and accessibility. We acknowledge that this restriction may introduce availability bias.

Studies were excluded if they met any of the following conditions:

-Study design: Non-cross-sectional studies, including longitudinal, experimental, case-control, or qualitative designs;

-Type of publication: Reviews, meta-analyses, theoretical papers, conference abstracts, or non-peer-reviewed sources;

-Population: Samples not composed of higher education/university students;

-Focus: Studies addressing unrelated psychological constructs or outcomes not directly linked to resilience;

-Reporting: Articles with incomplete, insufficient, or unclear data on resilience measurement or outcomes;

-Accessibility: Studies not available in full text or not published in open-access format.

Study Selection Process

Two reviewers independently screened titles and abstracts of all retrieved records. Full texts were then assessed for eligibility according to the inclusion/exclusion criteria. Discrepancies were resolved through discussion, and unresolved cases were arbitrated by a third reviewer. The references of the studies included were also screened for additional relevant articles. The process is summarized in the PRISMA flow diagram (Figure 1).

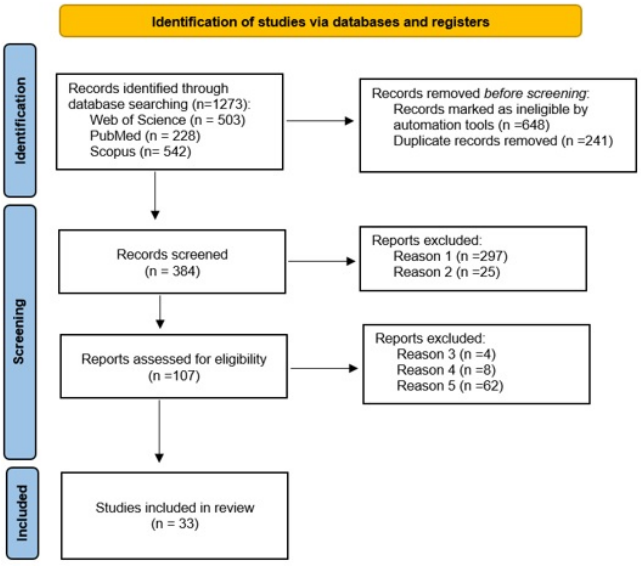

Figure 1.
Studies included through the review process according to the Preferred Reporting Items for Systematic Reviews (PRISMA) statement.

Risk of Bias Assessment

The Appraisal Tool for Cross-Sectional Studies (AXIS) tool (Downes et al., 2016) was applied to assess methodological quality across 20 items. Two reviewers independently assessed each study, and inter-rater reliability was calculated using the intraclass correlation coefficient (ICC = 0.93), indicating excellent agreement. Disagreements were resolved through discussion and, if needed, a third reviewer. Following best practice, we did not generate a cumulative score but categorized each study qualitatively as low, moderate, or high risk of bias.

Data Extraction and Synthesis

The main findings, derived from cross-sectional studies focusing on resilience and related factors, were systematically organized by key criteria: author(s) and year of publication, country, participant demographics (age, degree, sample size, and gender), and study characteristics (objective, evaluated variables, instruments used, and main resilience-related results). To ensure accuracy and reliability, data extraction was independently reviewed by two researchers (author1 and author2), reducing errors and enhancing consistency.

Search and Study Selection Process

An exhaustive database search retrieved 1,273 records: Web of Science (n = 503), PubMed (n = 228), and Scopus (n = 542). After applying inclusion criteria (last five years, Spanish/English, open access), automation tools marked 648 records as ineligible, and 241 duplicates were removed, leaving 384 records for initial screening. During screening, 277 records were excluded for incorrect publication type (n = 252) or questionnaire validations (n = 25), reducing the count to 107 reports. Further assessment excluded 74 reports due to incorrect study design (n = 4), inadequate population (n = 8), and irrelevant outcomes (n = 62). Ultimately, 33

studies met inclusion criteria for the final analysis (see Figure 1).

Study Characteristics

The characteristics of the studies are described in Table 1, with the included studies, published between 2020 and 2024, revealing a growing academic focus on resilience among university students.

Table 1
Key Characteristics of Included Studies

	Authors (year)	Country	Sample (N)	College Degree	Age (years)	Sex		
						Male (N)	Female (N)	Gender Queer (N)
1	Wu et al. (2020)	China	1168	Medicine; Marine technology; Engineering; Architecture; Other unspecified;	17-26	575	593	-
2	Koob et al., (2021)	Germany	559	Social work; Nursing	18-35	96	463	-
3	De la Fuente et al. (2021)	Spain	1069	Primary Education; Psychology	19-25	156	913	-
4	Luibl et al. (2021)	Germany	236	Medicine	18-33	80	156	-
5	Awoke et al. (2021)	Ethiopia	337	Health Sciences	22-25	174	163	-
6	Dong et al., (2021)	China	698	Nursing	18.77±0.86	73	625	-
7	Popa-Velea et al. (2021)	Romania	118	Medicine	22.86±1.76	25	93	-
8	Öztürk & Kundakçi (2021)	Turkey	1028	-	20.17±2.45	408	620	-
9	Drach-Zahavy et al. (2022)	Israel	492	Nursing	25.34±4.30	77	415	-
10	Ghogare et al. (2022)	India	381	Medicine; Nursing; Dentistry; Physiotherapy; Physiotherapy	20.10±1.49	106	275	-
11	Jia et al. (2022)	China	767	-	20.33±1.49	407	354	6
12	Huang et al. (2022)	China	683	Nursing	19.84±1.19	152	531	-
13	Misra et al. (2022)	Arab Emirates	798	-	16-41	196	597	-
14	Feyisa et al. (2022)	Ethiopia	381	-	21.78±1.62	252	129	-
15	Hassan et al. (2022)	Iraq	819	Science; Technology; Engineering; Mathematics; Humanities; Art; Literature.	23.65±6.31	413	406	-
16	Zhao et al. (2023)	China	289	-	20.31±1.60	236	53	-
17	Al Omari et al. (2023)	Oman	676	Agriculture; Art; Education; Engineering; Law; Nursing; Medicine; Economics; Education; Nursing; Medicine; Economics	20.9±2.50	208	468	-
18	Li y Guo (2023)	China	1622	Technology; Sports; Other unspecified.	21.18±1.52	893	729	-
19	Alkaissi et al. (2023)	Palestine	290	Nursing	≈20	146	144	-
20	Rayani et al. (2024)	Saudi Arabia	175	Nursing	-	72	103	-
21	Setlogelo y Nyoni (2024)	South Africa	221	Nursing	19-39	18	203	-
22	Aryuwat et al. (2024)	Thailand	319	Nursing	19-37	32	287	-
23	Zhang et al. (2024)	China	256	Nursing	-	186	70	-
24	Hu et al. (2024)	China	8457	-	≈20	2540	5918	-
25	Rometsch et al. (2024)	Italy	1912	-	-	-	-	-
26	Gause et al. (2024)	South Africa	123	Nursing	18-24	15	108	-
27	Mohammed et al. (2024)	Egypt	2465	Medicine	20-23	1216	1249	-
28	Wu et al. (2024)	China	1423	Nursing	≈20	498	925	-
29	Kartol et al. (2024)	Turkey	780	Health; Education; Fine Arts	-	294	486	-
30	Selak et al. (2024)	Slovenia	4645	-	22.9±3.2	1240	3405	-
31	Luo et al. (2024)	China	120	Nursing	20.89±1.47	45	75	-
32	de Andrade et al. (2024)	Brazil	8650	Engineering; Health; Applied Social; Agriculture; Humanities; Biology; Linguistics; Arts.	20.53±8.4	2955	5660	35
33	Prado et al. (2024)	Brazil and Germany	7911	Applied Sciences Other unspecified	25.77±6.61	2565	5346	-

The distribution includes 1 study in 2020, 7 studies each in 2021 and 2022, 4 studies in 2023, and a significant increase to 14 studies in 2024. This sharp rise in 2024 underscores heightened recognition of the importance of resilience and a strong academic commitment to understanding its implications (Figure 2).

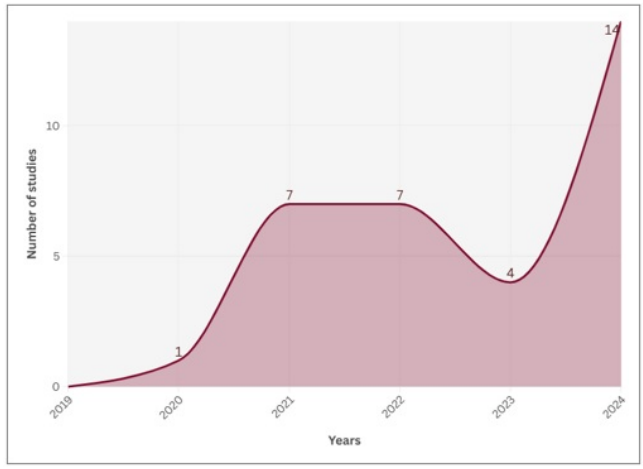

Figure 2.
Trend in the publication of studies.

The reviewed studies reflect a global interest in resilience research, with China contributing the highest number ($n = 8$), followed by Germany ($n = 3$), and additional contributions from Spain, Ethiopia, and Brazil. This diversity highlights the widespread academic focus on resilience across different cultural and geographical contexts (see Figure 3). Other contributing countries included Turkey, India, Iraq, Romania, UAE, Israel, Oman, Palestine, South Africa, Thailand, Saudi Arabia, Egypt, Slovenia, and Italy. This broad geographic representation underscores resilience as a topic of universal academic and cultural relevance.

Figure 3.
Distribution of publications by countries.

The 33 studies analyzed included 37,547 participants aged 17 to 41, with women and men comprising 61.96% and 37.80%, respectively, and 0.11% identifying as non-binary or gender fluid. Health-related degrees were the most studied, particularly nursing, medicine, and health sciences, highlighting a predominant focus on this field. Other fields, such as psychology, technology, education, and engineering, were also represented. Sample sizes ranged from 102 to 8,457, reflecting the broad diversity and scope of the analysis.

Results

Prevalence of Resilience Levels

Among the 33 studies analyzed, moderate resilience levels were the most common, observed in 70.6% of cases. Low resilience was reported in 14.7%, high resilience in 8.8%, and 5.9% of studies identified intermediate levels categorized as low-moderate resilience (see Table 2).

Most Frequent Assessment Outcomes

The reviewed studies consistently positioned resilience as a central variable, often examined alongside additional factors to provide a multidimensional perspective. Stress emerged as the most commonly assessed variable, featured in 27% of studies, followed by depression (21%) and anxiety (18%). Other frequently studied factors included self-efficacy (12%), coping strategies (15%), burnout, social support, and well-being, while individual studies explored academic engagement, procrastination, sleep quality, loneliness, physical activity, and mobile phone addiction. This diversity highlights the broad scope of resilience research and its connection to psychological, behavioral, and academic outcomes.

Most Frequently Used Instruments

Various instruments were used alongside resilience to assess related variables, highlighting its multidimensional nature. Stress was frequently evaluated using tools like the Perceived Stress Scale (PSS) and the Depression, Anxiety, and Stress Scale (DASS-21). Self-efficacy was measured in some studies using the General Self-Efficacy Scale (G-SES). Additional assessments included the Multidimensional Perceived Social Support Scale (MSPSS) for social support, the Maslach Burnout Inventory for burnout, and the Pittsburgh Sleep Quality Index (PSQI) for sleep quality. Loneliness and mobile phone addiction were also explored using specialized scales. This diverse range of tools underscores the complexity of resilience and its links to various psychological and behavioral factors.

Key Findings

Most studies identified moderate resilience as the most common level, with fewer participants exhibiting high or low resilience. Resilience consistently emerged as a protective factor across academic, personal, and health contexts, showing strong correlations with reduced stress, depression, and anxiety (typically $|r| \approx 0.30–0.55$). Stronger effects were reported for procrastination ($r = –0.69$) and coping strategies ($r = 0.74$). Regression models confirmed

resilience as a significant predictor of well-being, academic engagement, and sleep quality (β range = 0.12–0.35). Moreover, odds ratios indicated that each additional point of resilience reduced the likelihood of depression and suicidal ideation (e.g., OR = 0.91; 95% CI: 0.88–0.94).

In academic settings, resilience was associated with higher self-efficacy and reduced procrastination, as well as the mitigation of problematic behaviors such as mobile phone addiction and loneliness, underscoring its broad protective benefits (see Table 2).

Table 2

Main Data Collected in the Studies Analyzed

	Objective	Outcomes and instruments for measurement	Level of Resilience	Category indicated by authors	Key results focusing on Resilience
1	To examine the relationship between psychological resilience, demographic characteristics, and positive coping styles in university students.	Resilience- Asian Resilience Scale (ARS) Coping- Simplified Coping Style Questionnaire (SCSQ)	70.41±9.91	Moderate	Resilience strongly predicts positive coping styles ($r = 0.524$; $p < 0.001$)
2	To explore the factors influencing academic engagement under pandemic conditions.	Resilience- Brief Resilience Scale (BRS) Academic engagement -Utrecht Work Engagement Scale (UWES) Resilience- Connor-Davidson Resilience Scale (CD-RISC 2) Coping- Coping Strategies Scale (ECC). Positivity- Positivity scale	4.02±0.63	High	Resilience significantly predicted higher study engagement during the pandemic ($\beta = 0.129$; $p = 0.002$). Resilience shows a strong association with positivity ($r = 0.592$; $p < 0.001$) and positively predicts adaptive coping strategies ($r = 0.408$, $p < 0.001$). Additionally, resilience is inversely associated with less adaptive coping ($r = -0.069$, $p = 0.05$), highlighting its role in fostering healthier behavioral responses. Higher resilience is also linked with greater engagement ($r = 0.346$; $p < 0.001$), emphasizing its importance in promoting academic and personal involvement. Conversely, lower resilience predicts higher levels of academic burnout ($r = -0.372$, $p < 0.001$), underscoring the protective nature of resilience against negative outcomes.
3	To analyze the predictive relationships between resilience, positivity, coping strategies, and motivational states.	Burnout syndrome- Maslach Burnout Inventory	3.74±0.46	Moderate	
4	To evaluate resilience and the sense of coherence from a salutogenic perspective.	Resilience- Resilience Scale RS-13 Sense of Coherence- Sense of Coherence Scale (SOC-L9).	67.58±12.15	Moderate	There is a moderate positive correlation between resilience and sense of coherence ($r = 0.43$; $p < 0.01$). Male students scored significantly higher resilience compared to females ($\Delta = 3.56$; $p < 0.01$), while students scored lower than the general population average for resilience ($\Delta = -2.44$; $p < 0.01$). These findings highlight variations in resilience across different groups and its association with psychological constructs.
5	To assess perceived stress and coping strategies.	Stress- Perceived Stress Scale (PSS-10) Coping- Brief-COPE Scale	72.34±12.31	Moderate	Higher stress perception was associated with lower resilience levels (AOR = 4.61; $p < 0.01$). Students with active coping approaches reported higher resilience ($r = 0.33$; $p < 0.02$), while avoidance strategies were linked to lower resilience ($r = 0.29$; $p < 0.03$).
6	To analyze how family resilience mediates the relationship between childhood trauma and psychological resilience.	Childhood Trauma - Childhood Trauma Questionnaire (CTQ) Family Resilience- Family Resilience Assessment Scale (FRAS) Resilience- Connor-Davidson Resilience Scale (CD-RISC 25)	74.12±15.96	Moderate	Higher childhood trauma levels are related to lower psychological resilience ($r = -0.37$, $p < 0.001$). Family resilience partially mediates the relationship between childhood trauma and psychological resilience ($r = -0.23$; $p < 0.001$). Additionally, family resilience is significantly associated with higher psychological resilience ($r = 0.47$; $p < 0.001$).
7	To evaluate the comparative role of resilience, self-efficacy, optimism, and perceived stress in academic performance.	Self-Efficacy - General Self-Efficacy Scale (G-SES) Resilience- Brief Resilience Scale (BRS) Stress- Perceived Stress Scale (PSS) Life Orientation - Revised Life Orientation Test (LOT-R)	18.11±1.87	Moderate	Resilience positively correlates with academic performance, particularly in low-GPA students ($r = 0.307$; $p < 0.05$). Higher resilience is associated with lower levels of perceived stress ($r = -0.342$; $p < 0.05$). Additionally, resilience correlates positively with optimism, suggesting shared protective effects ($r = 0.278$; $p < 0.05$).
8	To examine the relationship between psychological resilience, perceived social support, loneliness, and internet addiction.	Resilience-Brief Resilience Scale (BRS) Loneliness -UCLA Loneliness Scale Social Support - Multidimensional Perceived Social Support Scale Internet addiction- DSM-IV scale	18.49±5.40	Moderate	Higher resilience correlates with lower levels of internet addiction ($r = -0.498$; $p < 0.001$). Resilience negatively predicts loneliness levels ($r = -0.528$; $p < 0.001$). No significant relationship was found between resilience and perceived social support ($r = -0.003$; $p = 0.916$).
9	To explore the contribution of different levels of resilience in reducing stress symptoms and enhancing well-being during COVID-19.	Resilience- Connor-Davidson Resilience Scale (CD-RISC 10) Stress- NASA Task Load Index Coping- Coping Strategies Inventory Short Form (CSISF)	2.42±0.94	Moderate	Higher trait resilience is linked to lower strain symptoms during the COVID-19 pandemic ($\beta = -0.12$; $p < 0.05$).
10	To evaluate the relationship between psychological resilience and levels of depression, anxiety, and stress during COVID-19 lockdowns.	Anxiety, Stress and Depression- Depression, Anxiety, and Stress Scale (DASS-21) Resilience- Brief Resilience Scale (BRS)	NA	Low	High resilience is linked to a 40% lower likelihood of depression ($p < 0.00001$). Similarly, high resilience protects against anxiety ($p < 0.00001$) and significantly reduces stress during lockdowns ($p < 0.00001$).
11	To explore clinical factors correlated with borderline personality disorder symptoms.	Resilience- Resilience Inventory (RI-9) Stress- Perceived Stress Scale (PSS-10) Meaning in Life - Meaning in Life Questionnaire (MLQ) Borderline personality disorder- Borderline personality disorder Scale (SI-Bord) Experience in Close Relationships - Experience in Close Relationships Revised (ECR-R) Depression- Patient Health Questionnaire (PHQ-9)	NA	Low	Higher resilience is associated with fewer borderline personality disorder (BPD) symptoms ($r = -0.238$; $p < 0.001$). Students with higher resilience experienced lower perceived stress ($r = -0.466$; $p < 0.002$). Additionally, resilience is inversely related to depressive symptoms ($r = -0.356$; $p < 0.003$).
12	To explore the mediating effects of resilience and coping style between parenting style and academic procrastination.	Resilience-Connor-Davidson Resilience Scale (CD-RISC 10) Parenting Bonding - Parenting Bonding Instrument (PBI) Coping-Short Coping Style Scale (SCSS)	3.45±0.49	Moderate	Higher resilience reduced academic procrastination rates ($\beta = -0.259$; $p < 0.00$). Positive parenting fosters resilience in nursing students ($\beta = 0.284$; $p < 0.001$), while a negative parenting style lowered resilience levels ($\beta = 0.094$; $p < 0.001$).
13	To evaluate the impact of the COVID-19 pandemic on mental health (depression, anxiety) and resilience.	Resilience-Connor-Davidson Resilience Scale (CD-RISC 10) Anxiety- Generalized anxiety disorder-7 (GAD-7) Depression- Patient Health Questionnaire (PHQ-9)	21.28±9.68	Moderate	Higher resilience was linked to lower depression levels in students impacted by COVID-19 (Mean = 9.51, 6.80; $p < 0.001$). Similarly, students with higher resilience levels experienced fewer anxiety symptoms (Mean = 9.03, 8.54; $p < 0.001$).
14	To assess psychological resilience levels and coping strategies.	Resilience- Resilience Resource Scale (RRS) Coping- Coping Inventory for Stressful Situations (CISS-21)	3.39±0.68	Moderate	Task-oriented coping increased resilience by 1.046 units ($\beta = 1.046$; $p < 0.001$). Emotion-focused coping increased resilience by 1.936 units ($\beta = 1.936$; $p < 0.001$), and avoidance coping increased resilience by 2.881 units ($\beta = 2.881$; $p < 0.001$). Rural students were 2.042 units less resilient than urban students ($\beta = -2.042$; $p = 0.003$). First-year students scored 7.032 units lower in resilience compared to fifth-year students ($\beta = -7.032$; $p < 0.001$), and second-year students scored 3.082 units lower in resilience compared to fifth-year students ($\beta = -3.082$; $p < 0.001$).
15	To examine the relationship between lockdown fatigue, personal resilience, and coping behaviors during COVID-19.	Resilience-Brief Resilience Scale (BRS), Fatigue-Lockdown Fatigue Scale, Coping-Coping Behaviors Questionnaire	3.36±1.10	Moderate	Higher resilience significantly reduces lockdown fatigue ($r = -0.52$; $p < 0.001$). Resilience is strongly positively correlated with coping skills ($r = 0.74$; $p < 0.001$).
16	To evaluate the relationship between distressing rumination, resilience, depression, and self-harming behaviors.	Resilience- Mental Toughness Index (MTI) Depression- Patient Health Questionnaires (PHQ-9) Rumination- Ruminative Responses Scale (RRS) Health-Risk - Health-Risk Behavior Inventory (HBI) Resilience- Brief resilience scale (BRS)	67.77±20.92	Moderate	Higher resilience is linked to reduced distress rumination ($r = -0.28$; $p < 0.0$). Increased resilience is associated with lower depressive symptoms ($r = -0.55$; $p < 0.02$). Additionally, resilience reduces the likelihood of self-injurious behaviors ($r = -0.30$; $p < 0.03$).
17	To assess the level of resilience and explore its correlations with self-esteem, physical health, and perceived stress.	Self-esteem- Rosenberg Self-Esteem Scale (RSES) Psychological Well-being - World Health Organization well-being index (WHO-5)	2.99±0.78	Low	Regular sleep is positively correlated with resilience levels ($\beta = 0.04$; $p = 0.047$). Lower perceived stress is associated with higher resilience ($\beta = -0.041$; $p < 0.001$). Higher well-being scores are positively correlated with resilience ($\beta = 0.005$; $p = 0.006$; $\beta = 0.055$; $p < 0.002$). Additionally, students with higher GPA reported significantly greater resilience levels ($\beta = 0.474$; $p < 0.02$).
18	To explore the relationships between physical activity, psychological resilience, sleep quality, and social adaptation.	Resilience-Brief Resilience Scale (BRS) Sleep Quality-Pittsburgh Sleep Quality Index (PSQI) Physical Activity-Physical Activity Rating Scale (PARS-3) Social Adaptation -Social Adaptation Diagnostic Scale	16.5±4.29	Moderate	Physical activity significantly predicts higher psychological resilience ($\beta = 0.2145$, $t = -0.823$; $p = 0.01$). Higher resilience predicts better sleep quality ($\beta = -0.3374$, $t = 15.771$; $p = 0.01$). Additionally, resilience is positively correlated with social adaptation ($\beta = -0.5036$, $t = 23.961$; $p = 0.01$).
19	To evaluate resilience levels and their predictive factors.	Resilience-Trait Resilience Scale, State-Resilience Scale	1341.1±12.8	High	First-year students reported higher resilience compared to seniors ($\beta = 4.62$; $p = 0.003$). Chronic illnesses significantly reduce resilience scores ($\beta = -3.91$; $p = 0.04$). Daily study routines are associated with higher resilience ($\beta = -3.18$; $p = 0.001$). Urban residence predicted lower state resilience ($\beta = -1.87$; $p = 0.042$). Adequate housing positively affects combined resilience scores ($\beta = 3.68$; $p = 0.015$).
20	To explore the relationship between resilience and psychological well-being.	Resilience Connor-Davidson Resilience Scale (CD-RISC-10) Psychological Well-being - World Health Organization well-being index (WHO-5)	25.5±NA	Moderate	Higher resilience predicts better self-reported well-being ($r = 0.281$; $p < 0.001$). Senior students scored significantly higher in well-being than juniors ($\Delta = 1.4$; $p = 0.01$). Male students reported higher well-being than female students ($\Delta = 2.1$; $p = 0.008$).
21	To describe academic resilience, grit, and growth mindset.	Academic Resilience- Academic Resilience Scale (ARS-30) Grit- Short Grit Scale (Grit-S) Mindset- Dweck Mindset Instrument (DMI)	73.62±NA	Low	Resilience increases progressively with the years of study, with a mean score of 67.0 for 1st-year students and 76.5 for 4th-year students.
22	To analyze factors associated with resilience.	Resilience- Connor-Davidson Resilience Scale (CD-RISC 25) Social Support- Multidimensional Scale of Perceived Social Support (MSPSS) Learning Experience - Learning Experience Scale (PRO-SIDLS) Stress - Stressors in Nursing Students (SINS)	71.79±16.33	Moderate	Social support significantly improves resilience ($\beta = 0.354$; $p < 0.001$). There is a strong association between self-directed learning and resilience ($\beta = 0.787$; $p < 0.001$). Higher stress negatively affects resilience ($\beta = -0.044$; $p = 0.023$).
23	To explore the relationship between emotional intelligence, resilience, and academic procrastination.	Resilience- Connor-Davidson Resilience Scale Academic Procrastination - Academic Procrastination Scale Emotional Intelligence - Emotional Intelligence Scale	73.62±NA	Moderate	Higher resilience strongly reduces academic procrastination tendencies ($r = -0.69$; $p < 0.01$).
24	To evaluate factors associated with sleep quality in university students, including resilience and mobile phone usage.	Resilience- Connor-Davidson Resilience Scale (CD-RISC) Sleep Quality - Pittsburgh Sleep Quality Index (PSQI) Mobile Phone Addiction - Mobile Phone Addiction Index (MPAI)	60.14±17.85	Moderate	Poor sleepers had lower resilience scores across optimism, self-improvement, and tenacity (OR = 0.982; $p = 0.001$). Resilience is associated with lower levels of mobile phone addiction, with mean scores of 63.22 for good sleepers and 57.07 for poor sleepers ($p = 0.001$).
25	To examine how stigma moderates the relationship between depression and resilience in university students.	Resilience- Nicholson McBride Resilience Questionnaire (NMRQ) Depression- Patient Health Questionnaire (PHQ-9) Stigma- Stigma-9	36.62±8.27	Low/Moderate	Higher resilience is associated with conscientiousness and lower neuroticism ($r = -0.52$; $p < 0.001$). There is a strong positive correlation between resilience and professional identity ($r = 0.42$; $p < 0.001$).
26	To determine the factors influencing resilience.	Resilience- Adapted Resilience Questionnaire	3.40±1.6	Moderate	Lecturer support significantly impacts resilience through encouragement and motivation (Factor loading = 0.814). Students with adult role models and a safe environment show improved resilience (Factor loading = 0.873). Social connections on campus contribute to resilience (Factor loading = 0.856). Resilience improves as students achieve academic success (Factor loading = 0.718). An optimistic outlook on the future correlates with higher resilience (Factor loading = 0.784). Self-motivation and persistence enhance resilience (Factor loading = 0.875).
27	To examine factors associated with stress and resilience.	Resilience- Brief Resilience Scale (BRS) Stress - Kessler Psychological Distress Scale (K10) Family Affluence - Family Affluence Scale (FAS)	3.66±0.57	Moderate	Higher resilience significantly reduces perceived stress levels ($r = -0.511$; $p < 0.001$). More than 2 hours of social media use is associated with lower resilience (AOR = 1.251; $p = 0.038$). Higher socioeconomic status is positively associated with resilience (AOR = 0.945; $p = 0.004$). Suicidal ideation significantly reduces resilience (AOR = 2.066; $p < 0.001$). Female students were more likely to report low resilience than males (AOR =1.521; $p < 0.001$).
28	To examine the mediating role of resilience in the relationship between personality traits and professional identity.	Personality- NEO Five-Factor Inventory (NEO-FFI) Connor-Davidson Resilience Scale (CD-RISC 10) Professional Identity- Professional Identity Questionnaire	25.18±5.94	Moderate	Higher resilience is associated with conscientiousness and lower neuroticism ($r = -0.52$; $p < 0.001$). Strong positive correlation between resilience and professional identity ($r = 0.42$; $p < 0.001$).
29	To examine the mediating role of psychological resilience and perceived stress in the relationship between emotional intelligence and life satisfaction.	Resilience- Psychological Resilience Scale (PRSSS) Emotional Intelligence - Emotional Intelligence Scale (EISSS) Stress- Perceived Stress Scale (PSS) Life Satisfaction - Life Satisfaction Scale (LSS)	3.02±0.64	Moderate	Higher emotional intelligence strongly predicts greater resilience ($r = 0.404$; $p < 0.01$). Higher resilience is associated with higher life satisfaction ($r = 0.445$; $p < 0.01$). Greater resilience is linked to reduced perceived stress ($r = -0.648$; $p < 0.01$).
30	To analyze how resilience and social support mitigate the impact of adverse pandemic conditions on depression and suicidal ideation.	Resilience- Connor-Davidson Resilience Scale (CD-RISC-10) Social Support - Oslo Social Support Scale (OSSS-3) Depression and Suicidal ideation- Patient Health Questionnaire (PHQ-9) Resilience- Chinese version of Connor-Davidson Resilience Scale (CD-RISC 19)	23.67±7.36	Moderate	Higher resilience significantly lowers depression scores ($r = 0.315$; $p < 0.001$). A one-point increase in resilience reduces suicidal ideation likelihood by 9% ($r = 0.908$; $p < 0.001$).
31	To investigate predictive factors of stress response in students repeating academic courses.	Stress - Stress Response Questionnaire (SRQ) Self-Control - Self-Control Scale (SCS) Academic Self-Efficacy - Academic Self-Efficacy Questionnaire	86.97±7.12	High	Higher resilience predicts lower stress response ($r = -0.497$; $p < 0.001$).
32	To describe the resilience profile and analyze the sociodemographic, economic, and academic factors associated with resilience.	Resilience- Connor-Davidson Resilience Scale (CD-RISC-10)	19.86±8.15	Low/Moderate	Male students reported higher resilience than females ($\beta = 0.190$; $p < 0.001$). Students with religious beliefs had higher resilience ($\beta = -0.094$; $p < 0.001$). Higher family income was linked to greater resilience ($\beta = 0.066$; $p < 0.001$). Heterosexual students had higher resilience ($\beta = -0.064$; $p < 0.001$). Health science students showed higher resilience ($\beta = -0.053$; $p < 0.001$). Greater enrollment load was associated with higher resilience ($r = 0.05$; $p < 0.002$).
33	To compare depressive symptoms and socioemotional factors, including resilience, during the pandemic.	Resilience-Connor-Davidson Resilience Scale (CD-RISC-10) Depression- Patient Health Questionnaire (PHQ-9)	2.75±0.87 3.04± 0.77	Low (BR) Moderate (GER)	German students reported lower perceived stress levels compared to Brazilians (n^2=0.008, $p < 0.001$). They also reported higher loneliness levels than Brazilians (n^2=0.005, $p < 0.001$). Additionally, German students reported significantly higher social support than Brazilians (n^2=0.064, p <0.002).

Risk of Bias Assessment

The 33 included studies were evaluated using the AXIS tool. Overall, methodological quality was rated as moderate. Most studies clearly reported their objectives, applied appropriate study designs, used validated instruments, and described data analysis adequately. Ethical approval was reported in all cases.

However, several methodological weaknesses were consistently observed. Only 12% of the studies provided a justification for sample size, and only 3% demonstrated representativeness of the sampling frame. Participant selection processes were insufficiently described in 12% of studies. None of the studies analyzed non-responders, which raises concerns about potential non-response bias. In addition, only 18% adequately addressed confounding factors. These limitations restrict the external validity of

the findings and highlight the need for stronger methodological designs in future research. The detailed item-by-item evaluation of each study is presented in *Supplementary Table 2*.

Discussion

This systematic review of 33 cross-sectional studies with 49,868 participants reaffirms the central role of resilience as a protective factor in academic, personal, and health contexts. Conducted between 2019 and 2024, the studies reveal that resilience mitigates psychological distress, promotes well-being, and fosters adaptive behaviors, particularly during challenges such as the COVID-19 pandemic. Moderate resilience was the most prevalent category (70.6%), followed by low (14.7%) and high resilience (8.8%). While these findings confirm the importance of resilience, critical interpretation is required to better understand the strength, variability, and implications of these associations. Studies such as the ones conducted by Fisher et al. (2023) and Chua et al. (2023) reported lower resilience levels among university students, attributed to limited life experience, emotional maturity, and practical resources (Arnett, 2015). This highlights the potential for improvement through targeted interventions to address these barriers and enhance resilience capacity.

Discrepancies across studies may be partly explained by differences in measurement tools. For example, the CD-RISC captures resilience as a trait-like construct, whereas the BRS emphasizes the capacity to "bounce back" from stress. Such differences affect prevalence estimates and correlations with mental health outcomes (Chua et al., 2023; Brewer et al., 2019). This highlights the importance of selecting instruments aligned with the conceptual framework of resilience being studied.

Studies consistently demonstrate a strong negative correlation between resilience and mental health challenges, including stress, depression, and anxiety. Higher resilience levels are associated with lower perceived stress (Drach-Zahavy et al., 2022; Ghogare et al., 2022; Hassan et al., 2022; Huang et al., 2022; Luibl et al., 2021; Vajpeyi Misra et al., 2022; Popa-Velea et al., 2021; Zhao et al., 2023), reduced depressive symptoms (Aryuwat et al., 2024; Ghogare et al., 2022; Vajpeyi Misra et al., 2022; Popa-Velea et al., 2021; Rometsch et al., 2024; Zhao et al., 2023), and lower anxiety (Ghogare et al., 2022; Hassan et al., 2022; Vajpeyi Misra et al., 2022; Popa-Velea et al., 2021; Rometsch et al., 2024; Zhao et al., 2023). Resilient individuals also report greater psychological satisfaction and well-being, reinforcing the role of resilience as a critical protective factor (Alkaissi et al., 2023; Popa-Velea et al., 2021).

Resilience also serves as a buffer against burnout, characterized as physical, emotional, and mental exhaustion caused by prolonged stress. Studies have shown that resilience reduces emotional exhaustion, enhances emotional regulation, and prevents burnout syndrome in academic settings (de la Fuente et al., 2021; Feyisa et al., 2022; Öztürk & Kundakçi, 2021). Students with higher intrinsic motivation often exhibit greater resilience, enabling them to overcome academic pressures and reduce vulnerability to burnout (Mostafa & Lim, 2020). Moreover, resilience positively impacts sleep quality—a critical factor for mental and physical health. A meta-analysis of 63 studies demonstrated a strong link between resilience and healthier sleep patterns, suggesting that resilience reduces intrusive thoughts and worries that disrupt rest (Palagini et al., 2022). Students with higher resilience levels are more likely to maintain regular sleep schedules, reducing risks of insomnia and fatigue, which enhances overall well-being (Lo-Martire et al., 2024). During the COVID-19 pandemic, resilience emerged as a key predictor of sustained academic engagement, even in the face of significant educational disruptions (Ojo et al., 2021).

Resilience levels vary by demographic and contextual factors. Male students often report higher resilience than females, possibly due to cultural norms emphasizing independence and problem-solving (Luibl et al., 2021; Rayani et al., 2024; de Andrade et al., 2024). Female

students, who face compounded academic and social pressures, tend to report lower resilience (Gefen & Fish, 2019; Ahmed et al., 2022). First-year students exhibit lower resilience, reflecting transitional challenges (Alkaissi et al., 2023; Feyisa et al., 2022). Socioeconomic and geographical factors also play a role, with urban students and those from higher socioeconomic backgrounds reporting greater resilience due to better access to resources and support (Qiu et al., 2021; Zhang et al., 2024). Social and environmental factors, including family resilience, teacher support, and positive parenting, are pivotal in building resilience (Dong et al., 2021; Huang et al., 2022; Feyisa et al., 2022). Supportive environments enhance students' emotional security and motivation, enabling them to manage adversity effectively. Tailored strategies that address unique group contexts can further strengthen resilience in students, promoting well-being and success.

The findings of this review underscore the critical need for comprehensive interventions aimed at bolstering resilience among university students, particularly those in vulnerable groups such as first-year students and individuals from disadvantaged backgrounds. Resilience plays a pivotal role in enhancing students' mental health by equipping them to manage stress, mitigate anxiety, and prevent depression. These outcomes are achieved through the development of adaptive coping strategies and emotional regulation, both essential for fostering well-being and academic success.

Effective interventions should incorporate mentoring programs, training in coping skills, and the establishment of supportive educational environments that strengthen social networks and ensure access to mental health resources. Additionally, resilience can be integrated into academic programs through practical workshops and activities promoting healthy sleep habits, regular physical activity, and a positive mindset. Tailoring these initiatives to address demographic and contextual differences will further enhance their effectiveness, enabling students to navigate challenges more effectively. By implementing these strategies, educational institutions can cultivate resilience, leading to improved mental health, holistic well-being, and sustainable academic success for university students, irrespective of their background or circumstances.

Practical applications may include short workshops (4-6 sessions) focused on coping strategies and mindfulness practices, peer mentoring systems that support first-year students during their transition, and curriculum-based activities such as reflective journals or service-learning projects. Institutions can also promote digital well-being by implementing campaigns focused on healthy mobile phone use and providing dedicated spaces for physical activity and relaxation on campus.

Strengths and Limitations

This review presents several strengths that enhance the reliability and relevance of its findings. It incorporates a broad range of cross-sectional studies across diverse university student populations, providing a comprehensive view of the role of resilience in academic and psychological outcomes. The focus on recent studies ensures the findings are current and reflect contemporary challenges, particularly during critical periods like the COVID-19 pandemic. The use of validated instruments adds methodological rigor, while prioritizing open-access publications ensures transparency and accessibility for further research.

Consistent findings—particularly the strong links between resilience, mental health, coping strategies, and academic engagement—affirm resilience as a robust protective factor. Moreover, the identification of demographic and contextual variations offers actionable insights for designing tailored interventions.

Nevertheless, several limitations should be acknowledged. The cross-sectional design of the included studies restricts causal inferences and prevents assessment of long-term effects. The reliance on self-reported data introduces potential biases, including social desirability. Sample heterogeneity and the absence of

standardized comparisons may further limit generalizability. Cultural and geographical concentration of studies, particularly in Asia, restricts extrapolation to underrepresented contexts. In addition, the inclusion of only open-access publications may have excluded relevant studies published in subscription-based journals.

The focus on university students means the findings cannot be generalized to other groups like younger students or older adults. External factors, such as the COVID-19 pandemic, may also have influenced the results. Additionally, the lack of longitudinal studies hinders understanding of how resilience develops over time.

These limitations highlight the need for future research to address gaps and deepen understanding of resilience in educational contexts.

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Appendix

Supplementary Table 1.
Summary of search strategies for systematic review

MeSH terms	**Resilience**	Psychological Resilience; Resiliency, Psychological; Psychological Resiliency; Resilience; Resiliences; Resiliency; Resiliencies; Resilient Responses, Psychological; Psychological Resilient Response; Resilient Response, Psychological, Response, Psychological Resilient; Psychological Resilient Responses
Key terms for university students		"University students"; "College students"; Universitarians; Undergraduates
Key terms for Resilience **Use of Boolean operators**		Resilience; "Resilient capacity"; "Psychological resilience"; Resilien* OR: between related terms to include synonyms AND: to combine the concepts
Truncator		*to include variants of the term "resilien".
SCOPUS	**Search fields**	TITLE-ABS-KEY: limits the search to terms that appear in the title, abstract or keywords of the article.
	Search strategy	(TITLE-ABS-KEY("university students" OR "college students" OR undergraduates OR universitarians) AND TITLE-ABS-KEY("resilience" OR "psychological resilience" OR "resilient capacity" OR resilien*) AND TITLE-ABS-KEY("cross-sectional" OR "descriptive study"))
WEB OF SCIENCE	**Search fields**	TS: search for terms in the title, abstract and key words of the articles
	Search strategy	TS=("university students" OR "college students" OR undergraduates OR universitarians) AND TS=("resilience" OR "psychological resilience" OR "resilient capacity" OR resilien*) AND TS=("cross-sectional" OR "descriptive study")
PUBMED	**Search fields**	[Title/Abstract]: Search for terms in the title and abstract of articles.
	Search strategy	[Title/Abstract] ((("university students"[Title/Abstract] OR "college students"[Title/Abstract] OR undergraduates[Title/Abstract] OR universitarians[Title/Abstract]) AND ("resilience"[Title/Abstract] OR "psychological resilience"[Title/Abstract] OR "resilient capacity"[Title/Abstract] OR resilien*[Title/Abstract]) AND ("cross-sectional"[Title/Abstract] OR "descriptive study"[Title/Abstract]))
PICOS strategy		Population (P): University students, higher education students Intervention/Condition studied (I): Resilience Comparison (C): Not applicable Outcomes (O): Improvements in mental health and well-being, and the identification of associated factors such as socio-demographic variables or academic stressors. Study Design (S): Cross-sectional studies
Inclusion criteria		Cross-sectional studies: Descriptive and analytical Studies published in the last 5 years Languages: English and Spanish Studies related to resilience in university students Publications in open access
Exclusion criteria		Studies focusing on unrelated psychological constructs or conditions Non-cross sectional studies Review and meta-analyses, or theoretical papers Studies with incomplete or unclear data on resilience

Supplementary Table 2.
Risk of bias domain

Appraisal tool for Cross-Sectional Studies (AXIS)																			
Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Wu et al. (2020)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y
Koob et al., (2021)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y
De la Fuente et al. (2021)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y
Luibl et al. (2021)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y
Awoke et al. (2021)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y
Dong et al., (2021)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y
Popa-Velea et al. (2021)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Öztürk & Kundakçı (2021)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Drach-Zahavy et al. (2022)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Ghogare et al. (2022)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Jia et al. (2022)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Huang et al. (2022)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Misra et al. (2022)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Feyisa et al. (2022)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Hassan et al. (2022)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Zhao et al. (2023)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Al Omari et al. (2023)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Li y Guo (2023)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Alkaissi et al. (2023)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Rayani et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Setlogelo y Nyoni (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Aryuwat et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Zhang et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
Hu et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Rometsch et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Gause et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Mohammed et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Wu et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Kartol et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Selak et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Luo et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
de Andrade et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Prado et al. (2024)	Y	Y	N	Y	Y	NC	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Note: Y=yes; N=no; NC=not clear																				

Notes

* Research article

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