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2024

European Journal of Engineering Education

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ceee20

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To cite this article: J. E. Tait, L. A. Alexander, E. I. Hancock & J. Bisset (2024) Interventions to support the mental health and wellbeing of engineering students: a scoping review, European Journal of Engineering Education, 49:1, 45-69, DOI: 10.1080/03043797.2023.2217658

To link to this article: https://doi.org/10.1080/03043797.2023.2217658

Published online: 10 Jun 2023.

EUROPEAN JOURNAL OF ENGINEERING EDUCATION
2024, VOL. 49, NO. 1, 45–69
https://doi.org/10.1080/03043797.2023.2217658

Interventions to support the mental health and wellbeing of engineering students: a scoping review

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ABSTRACT

Engineering students enter a challenging sector in higher education and are potentially at risk of poor mental health and or mental wellbeing and less likely to seek help when experiencing poor mental health or wellbeing. We carried out a scoping review using Joanna Briggs Institute scoping review methodology. Ten databases were searched over a three-year period. Searches identified 191 sources of evidence after title screening and 33 sources of evidence were included for final extraction following full-text screening. Included studies represented over 4000 engineering students from 10 countries. Studies were mostly pilots, suggesting a lack of diverse research methods in the existing research base. Studies also varied in approaches to reporting. Interventions included training, relaxation, technology use, alternative teaching models, support services and a study break with a range of outcome measures used to evaluate intervention effects. Study results indicated reduced stress and anxiety, improved academic achievement, improved communication, motivation, physiological responses, attitude, and increased physical activity, health awareness, and confidence. Mindfulness activities appear to be helpful to engineering students. The review mapped interventions to support mental health and wellbeing in engineering students but identified a need for further high-quality robust studies that are transparently reported using reporting guidelines.

ARTICLE HISTORY
Received 19 October 2022
Accepted 19 May 2023

KEYWORDS
Engineering students; mental health; mental wellbeing

Introduction

Internationally, mental health and wellbeing in higher education student populations have been reported to be poorer than the general population and worsening (Storrie, Ahern, and Tuckett 2010; Education Policy Institute 2018; Shackle 2019; Bonsaksen et al. 2022; Limone and Toto 2022; Campbell et al. 2022; World Economic Forum 2022). It has also been widely acknowledged that higher education students can face challenges in the move from school to university. The transition to higher education requires navigation of academic workloads, managing exam anxieties, adopting successful time management strategies and managing financial implications of higher education (Universities UK 2015).

Being at university can lead to greater exposure to poor health behaviours such as poor sleep patterns, poor dietary intake, increased alcohol use, smoking, drug use, and being less physically active as well as isolation and cultural challenges (Deasy et al. 2015; Skromanis 2018; Whatnall 2019). As a result of these challenges, students can suffer poor mental wellbeing, anxiety, stress,

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/03043797.2023.2217658

and mental health problems which can also contribute to discontinuation of studies for students and course dropout rates (Pereira et al. 2018). Reported mental health conditions by students have risen globally from 1.4% to 3.5% between 2012 and 2018 in the UK (Office for Students 2019), and affecting one in four people aged between 15 and 24 in Australia (Orygen 2017). In the USA, Lipson et al. (2022) reported a 50% increase in mental health conditions in American students from 2013 to 2021 and the Healthy Minds Network 2021–2022 (2022) reported that 60% of students in the study had a mental health problem in the past year. This was an increase from the 52% highlighted in the Healthy Minds Network Winter 2021 report. Therefore, there is a need to ensure positive mental health and wellbeing approaches are available to support students as required.

Global definitions of mental health and mental wellbeing vary widely including interchangeable use of the terms. 'Mental health' can be considered an absence of illness or disease (Felman 2020), whereas for others the term is more inclusive (MIND 2017; Mental Health 2020; WHO 2022). Similarly, there is no one accepted definition of mental wellbeing (WHO 2004; Department of Health 2010). However, mental health has been considered as one aspect within overall mental wellbeing (Universities UK 2015). It is important to recognise that the term mental health has different connotations for different people and people's attitudes to mental health may depend on the culture of the population who are defining the term (WHO 2004). For the purpose of this review, the term 'mental health and wellbeing' has been used to ensure inclusivity for mapping literature and for the reader.

In recognition of the increasing awareness of poor mental health and wellbeing in student populations, the impact on student success, mental health, and economic impacts (to institutions, students, and society), higher education institutions have moved to address these issues. This has been actioned through development of wellbeing strategies and mental health awareness initiatives for students as well as international Health Promoting University approaches (Universities UK 2015; Swannell 2016; Baik et al. 2016; Holt and Powell 2017; UCL 2020).

Traditionally, mental health and wellbeing for higher education students has been reported as a group. More recently, this has started to be broken down in some countries to academic disciplines such as engineering. The impact of gender and cultures on mental health and wellbeing needs of higher education students has been reported in the USA but this still requires greater reporting globally (Lipson et al. 2016; Browning et al. 2021).

While poor mental health and wellbeing has been reported for higher education students, there have been specific reports on the perceived stress (Balaji et al. 2019; Jensen and Cross 2021), difficulty of an engineering degree (Engineering UK 2020) and an increasing body of evidence highlighting significant mental health and wellbeing problems experienced by engineering students. However, in terms of reported interventions to improve mental health and wellbeing in engineering students, the evidence is sparse.

Investigating the mental health and wellbeing of engineering students specifically is important due to a global lack of engineers and increased need for engineering graduates (Pozniak 2017; Donelly 2018; Engineering X 2020). While the reasons for this deficit are as yet not clear, calls for education reform to address the problem have been growing (RAENG and MIT 2012; Das, Kleinke, and Pistrui 2020; Poole 2022). Internationally, more engineers are leaving the sector due to burnout (Phillips 2022) and aging workforces (Quantum Marketing 2022) and in the USA it has been noted that students are increasingly moving towards computer science over electrical engineering (Atwell 2022). Bergman and Ogunshakin (2022) describe the European engineering skills gap as a massive barrier to addressing global challenges. Moreover, concerns are being raised about the mental health of engineering professionals in the UK following a survey by the IMechE (Institution of Mechanical Engineers). The results of the survey reported over half of engineers experiencing negative effects of workplace stress on their mental health or wellbeing, and two-thirds reported going to work despite feeling mentally unwell (Flaig 2022).

The annual deficit caused by retirements and engineers leaving the sector is compounded by fewer school leavers selecting engineering as a degree, and even further by fewer school pupils undertaking the subjects needed to gain entry to an engineering degree (Engineering UK 2020).

Engineering student life

Engineering is widely perceived to be one of the most challenging subjects to undertake at university (Fleming, Engerman, and Williams 2006; Think Student 2020; Maples 2021; World Scholars Hub 2022; Chidera 2022). Engineering requires mathematical competence and as such, engineering programs focus heavily on mathematical concepts and principles in the early years (Metje, Frank, and Croft 2007; Chron 2021) in the form of entire modules or courses in mathematics (Moran and Benson 2016). Additionally, engineering programs still use traditional forms of teaching with a lecture-based approach (Mills and Treagust 2003; Nyamapfene 2019; McGowan and Bell 2020). In some countries, the phenomenon of 'weeding out' is also prevalent in engineering programs (Seymour and Hewitt 1997; Seymour and Hunter 2019). This process is used to 'weed out' students by creating academic barriers but this also can induce stress for students.

Engineering students

Globally, most engineering students are male (Imasogie, Oyatogun, and Taiwo 2018; Martin 2021; Bosworth 2022; Catalyst 2022), and young men (typically aged 18-25) have been recognised to have higher risk factors for mental illness (SPHO 2017). Suicide in males (ONS 2016; SPHO 2017) and the incidence of schizophrenia in males is significantly higher than in females (McGrath 2006) and young adult males are at higher risk of developing serious mental illnesses (Royal College of Psychiatrists 2011).

Andrews and Clark (2017) discovered that around 65% of 96 engineering students who had failed one module or more perceived their poor mental health was the underlying reason for failing. In addition to the small amount of research that has been published in relation to the mental health and wellbeing of engineering students, which highlights worrying data (Deziel et al. 2013; Vats and Sharma 2017; Danowitz and Beddoes 2018), it has been noted that female engineering students report poorer mental health and wellbeing than their male counterparts (Deziel et al. 2013; Negi, Khanna, and Aggarwal 2019; Jensen and Cross 2021).

Help-seeking for mental health and wellbeing issues may also be a challenge for male engineering students as men are considerably less likely to seek help (Moller-Leimkuhler 2002; Galdas, Cheater, and Marshall 2005; Yousef, Grunfeld, and Hunter 2015; Bork and Mondisa 2022).

A correlation between high levels of anxiety and low academic performance among engineering students has also been reported (Vitasari 2011). Stress-related mental health and wellbeing issues in engineering students have been identified. Stress has been attributed to long hours sitting in front of computers, worries about future prospects, financial worries, health concerns, and concerns about academic performance (Vitasari 2011). Engineering students' coping mechanisms have been reported to include the use of music or movies, physical activity, reading, meditation, yoga, and motivational lectures however; the most effective strategies to support good mental health and wellbeing have not been identified (Negi, Khanna, and Aggarwal 2019).

Mapping the literature

To inform engineering education reform and support engineering students' mental health and wellbeing, mapping of the current evidence base on mental health and wellbeing interventions using scoping review methodology was required. Mapping of the evidence on mental health and wellbeing interventions for engineering students will detect research gaps for subsequent studies and identify effective interventions to inform engineering education practice. Before identifying the effectiveness of interventions to support good mental health and wellbeing it is important to establish what evidence is available for synthesis.

Scoping review methodology is a robust and inclusive method involving a comprehensive search strategy to map the evidence base on this topic. Although a recent systematic review of higher

education student wellbeing has been conducted (Worsley, Pennington, and Corcoran 2020), an initial search for existing scoping reviews and/or systematic reviews on engineering student wellbeing interventions published in JBI Evidence Synthesis, Cochrane Database of Systematic Reviews, International Prospective Register of Systematic Reviews (PROSPERO), Medline and CINAHL did not identify any reviews specific to engineering students (published or in progress). Therefore, this scoping review aimed to map the global evidence on interventions supporting good mental health and wellbeing in engineering students.

Review question(s)

The focus of this scoping review was to identify and map what mental health and wellbeing research has been conducted in engineering student populations. More specifically, the scoping review focused on the following questions:

- What types of mental health and wellbeing research designs have been conducted in engineering student populations?
- What mental health and wellbeing interventions have been carried out with engineering students?
- What outcomes have been reported for mental health and wellbeing interventions among engineering students?

Inclusion criteria

Participants

This review considered mental health or mental wellbeing intervention studies that included participants over the age of 17 who were engineering students at any stage of higher education. Where possible, the types of engineers were assessed for inclusion using the principal subject codes outlined by HESA (Higher Education Statistics Agency 2013):

(H0) Broadly-based programs within engineering & technology
(H1) General engineering
(H2) Civil engineering
(H3) Mechanical engineering
(H4) Aerospace engineering
(H5) Naval architecture
(H6) Electronic & electrical engineering
(H7) Production & manufacturing engineering
(H8) Chemical, process & energy engineering
(H9) Others in engineering

The search strategy included the term engineer in addition to 'engineering student' to ensure all available literature was identified. The focus of the review however is engineering students or student engineers and therefore papers only looking at professional engineers were excluded.

Concept

Sources with a focus on mental health and wellbeing in the engineering student population were included in this review. The focus of this scoping review was on mental wellbeing rather than a diagnosed mental health disorder. As there can be overlap in the use of terminology, particularly where it is likely research has been conducted by an engineering academic rather than a health professional; a variety of terms relating to mental health and wellbeing were utilised to capture all literature that may be relevant.

Context

This scoping review included literature within the context of engineering student populations in any country.

Types of sources

Published and unpublished sources of evidence were to be considered for this review including both experimental and quasi-experimental study designs such as randomised controlled trials and non-randomised controlled trials. In addition, descriptive and analytical observational studies including prospective and retrospective cohort studies and descriptive cross-sectional studies were considered for this review. Qualitative study designs were also considered for inclusion. Protocols for studies or systematic reviews were not included as they did not present any data to extract.

Methods

This scoping review was conducted in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews (Peters et al. 2020). JBI has published the most recent framework for scoping reviews (Peters et al. 2020), which has updated and developed the seminal work by Arksey and O'Malley (2005) and Levac, Colquhoun, and O'Brien (2010). An *a priori* protocol was registered in Open Science Framework (Tait et al. 2020) and reporting was guided by the PRISMA Extension for Scoping Reviews (Tricco 2018). All reviewers are trained in JBI scoping review methods with one being a member of the international JBI Scoping Review Methodology Group.

Search strategy

A three-step search strategy was undertaken to identify published and unpublished sources of evidence in line with JBI Scoping Review Methodology (Peters et al. 2020). Initially, a limited search was conducted in Medline, CINAHL, JBI Evidence Synthesis, and Cochrane Library using the terms 'engineers AND mental health' and 'engineering students AND mental health'. Following analysis of text words from titles identified in the initial search, a full search strategy was developed in line with the PCC (Population, Concept, and Context) requirements, discussed by the review team, piloted, and the finalised search was then applied across all included databases (Tait et al. 2020). Additionally, the institutional librarian supported the development of the search strategy.

Finally, a search of the reference lists of all included sources of evidence was conducted to identify any additional evidence. The databases searched included: MEDLINE, CINAHL, PsycARTICLES, Emerald, Epistemonikos, ERIC, Compendex, SocINDEX, JBI Database, Cochrane Central Register of Controlled Trials and Systematic Reviews, Compendex, Web of Science, and Business Source Complete. Databases were accessed via the authors' institutional access to EBSCoHost or direct link.

The search for unpublished sources of evidence included Google, Google Scholar, the British Library Thesis Index (EThOS), World Health Organization's library database (WHOLIS), The System for Information on Grey Literature in Europe (SIGLE), ProQuest Digital Dissertations, OpenGrey, and The Conference Papers Index using modified search terms (engineers AND 'mental health' OR 'mental wellbeing', 'engineering students' AND 'mental health' OR 'mental wellbeing).

The full search strategy for all sources is presented in Appendix I. Search strings were modified where required for each database. Searches included English language studies only due to lack of financial support for translation. No date range was imposed, and all study designs were considered for inclusion to enable a thorough mapping of the area. All search results were uploaded to RefWorks ProQuest and following de-duplication were exported to Microsoft Excel for screening. Two authors independently screened all titles and abstracts and full-text sources in this review. Due to the variety of terminology and sometimes misleading titles, a screening at the abstract stage was carried out between title screen and full-text screen. Any conflicts between reviewers were resolved via

discussion with a third author. The main conflicts related to identifying the correct population of interest and classifying the interventions. The search was carried out in January 2019, with updated searches completed in January 2020, and March 2022. Sources of evidence that were excluded at full text were reported and the reasons for exclusion noted (Figure 1).

Authors of studies included for full-text review were contacted to obtain papers that were not freely available or fully accessible via the authors' institutional access. Full-text papers that did not meet the inclusion criteria were excluded and reasons for their exclusion are reported in the results.

Data extraction

Two authors independently extracted data from included sources of evidence using a pre-determined extraction form developed for this review (Tait et al. 2020). Any disagreements that arose during data extraction were resolved via discussion. The data extraction forms were uploaded onto a Microsoft Excel spreadsheet for subsequent analysis and tabulation. The data relevant to this scoping review that underwent extraction were author(s), year of publication, country of origin, aims of study, study population, methodology/study design, context, intervention (delivery method, content, frequency, length, who delivered it), outcomes, and conclusions.

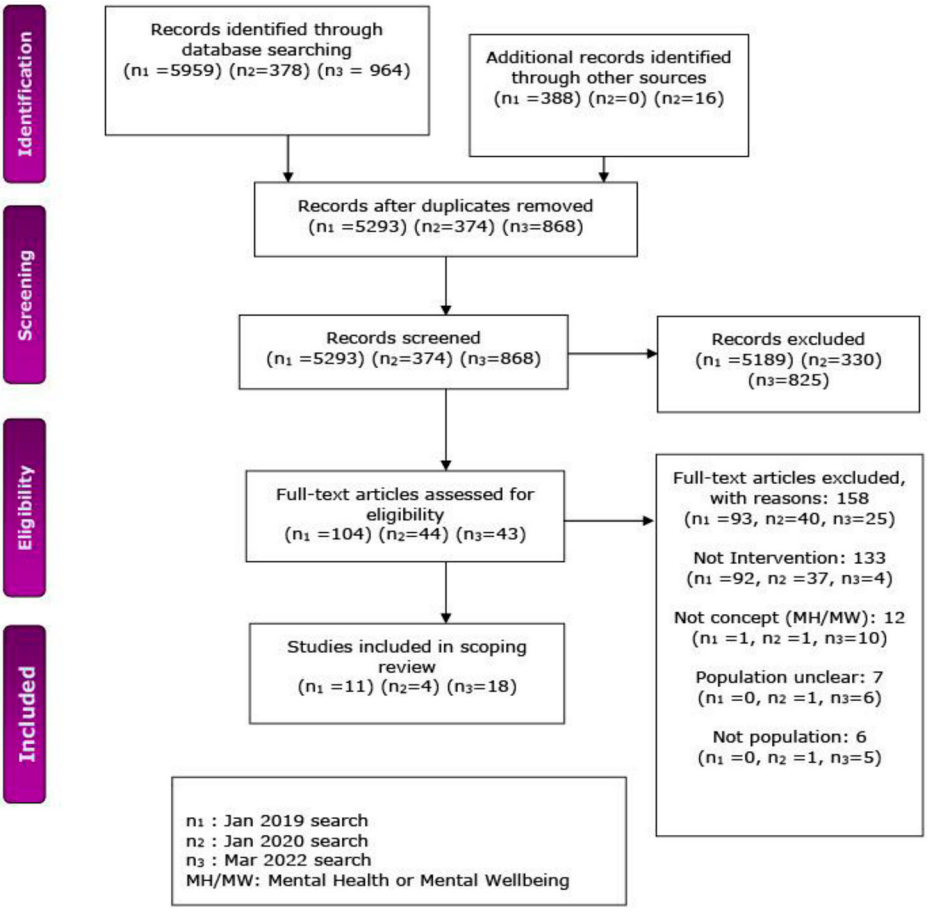


Figure 1. PRISMA flowchart.

As per methodological guidance for JBI scoping reviews, no critical appraisal of included sources of evidence was conducted (Peters et al. 2020), however a quality evaluation of intervention reporting was carried out and is presented in the results section.

Results

Included studies

As presented in the PRISMA flowchart (Moher et al. 2009), (Figure 1), the searches identified 7301 sources of evidence (after de-duplication). After title and abstract screening, which excluded many sources related to stress as an engineering concept rather than the experience of stress, 191 full texts were assessed for eligibility. Reasons for exclusion at full text included: No intervention stated (133), not the concept of interest (12), population the population of engineering students unclear (7), and not the population of interest (6). Thirty-three sources of evidence relating to 30 studies were then included for final data extraction and analysis.

Table 1 is the list of included sources of evidence. To enhance readability, the reference number for each source will be referred to in the results and discussion sections.

The included studies represented over 4000 engineering students from ten countries (Figure 2).

Six sources related to 3 studies (15 & 27, 25 & 26, and 20 & 21). Sample sizes ranged from 1 to 809 participants. The majority (22 sources) of included evidence focused on undergraduate students rather than postgraduate students, with at least 10 studies on first year students. Not all sources stated the level of academic study, however. Engineering subdisciplines were reported in some sources. While the protocol of this scoping review had planned to map participant groups as per UK HESA categories, the lack of use of the HESA categories by international study authors did not enable this grouping to be conducted.

The characteristics of included sources of evidence is presented in Appendix II and provides a broad overview of the aims of the study, a short description of the target population, the study design, outcome measures, results, and conclusions.

Types of mental wellbeing research

Table 2 shows the types of mental health and wellbeing studies conducted varied across sources.

The majority of studies were in the form of a pilot, and there was only one RCT (Randomised Controlled Trial). Most studies were conducted in the last five years.

Mental wellbeing interventions for engineering students

Interventions to support good mental wellbeing in engineering students were reported across all included sources of evidence. The included sources were categorised into psychological (14), physiological (5), and educational (15) interventions.

Psychological interventions included mindfulness training (7 studies), enhanced counselling support, and listening to music. Physiological interventions included specific breathing exercises and body awareness exercises. Educational interventions related to mental health and wellbeing awareness, changes to teaching approaches, and changes to curriculum timetabling.

Table 3 describes the interventions and outcome measures in more detail. While many of the sources developed their own surveys to measure outcomes, some made use of existing outcome measures.

The reported interventions were mapped against the template for intervention description and replication (TIDieR) checklist (Hoffmann et al. 2014) to identify the components of interventions reported across the included sources of evidence. While no critical appraisal was conducted on

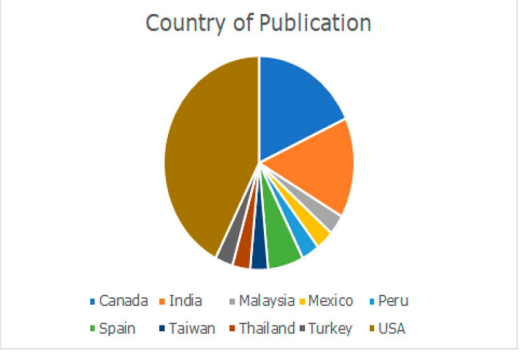
Table 1. List of included sources.

No.	Database	Author, Year	Title
1	Compendex Engineering Village	Abiade and Moliski (2020)	Work in Progress: Identity and transitions laboratory: Utilizing acceptance and commitment therapy framework to support engineering student success
2	CINAHL	Altun (2008)	Effect of a health promotion course on health promoting behaviours of university students
3	Compendex Engineering Village	Aree et al. (2020)	An approach for mental preparation for first-year college students: A case study of engineering students
4	Compendex Engineering Village	Berger, Lampe, and Caruccio (2015)	Just-in-time support: An evidence-based academic-student affairs partnership to enable engineering student success
5	Internet Search	d'Entremont et al. (2019)	Student Mental Wellbeing Interventions with a Second-Year Engineering Cohort
6	ERIC	Eren-Sisman, Cigdemoglu, and Geban (2018)	The effect of peer-led team learning on undergraduate engineering students' conceptual understanding, state anxiety, and social anxiety
7	Internet Search	Estrada and Dalton (2019)	Impact of Student Mindfulness Facets on Engineering Education Outcomes: An Initial Exploration
8	Compendex Engineering Village	Grasty et al. (2021)	Benefits of Utilizing Counseling Services Among Doctoral Women of Color in STEM
9	Internet Search	Huerta (2021)	Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students
10	Compendex Engineering Village	Johnson-Glauch, Cooper, and Harding (2020)	Goal setting as a means of improved mental health outcomes for materials and mechanical engineering students
11	Cochrane	Joshi and Kiran (2020)	Gauging the effectiveness of music and yoga for reducing stress among engineering students: An investigation based on Galvanic Skin Response
12	CINAHL	Joshi, Kiran, and Sah (2017a)	An Experimental Analysis to Monitor and Manage Stress Among Engineering Students Using Galvanic Stress Response Meter
13	CINAHL	Joshi, Kiran, and Sah (2017b)	Stress monitoring through non-invasive instrumental analysis of skin conductivity
14	CINAHL	Joshi et al. (2016)	Stress management through regulation of blood pressure among college students
15	ERIC	Khan, Poole, and Beaton (2018)	Measuring the Impact of a Weeklong Fall Break on Stress Physiology in First Year Engineering Students
16	Internet Search	Lal et al. (2019)	Effect of Dispositional Mindfulness on Perceived Stress Scores of Engineering Students: An Empirical Study
17	Compendex Engineering Village	Maxson and Tomasko (2020)	Supporting the Mental Health and Wellness of Chemical Engineering Students at the Department and College Levels June 2020
18	ERIC	Mazumder (2012)	Improvement of Confidence and Motivation Using Online Metacognition Tool
19	Internet Search	Miller et al. (2021)	WIP: Supporting Student Mental Health: Understanding the Use of Biometrics Analysis in an Engineering Design Project to Promote Wellness
20	ERIC	Miller and Jensen (2020)	Introduction of Mindfulness in an Online Engineering Core Course During the COVID-19 Pandemic
21	Epistemonikos	Miller et al. (2022)	Development and Implementation of a Biometrics Device Design Project in an Introductory BME Course to Support Student Wellness.
22	Compendex Engineering Village	Moran and Benson (2016)	Effects of an intensive mathematics course on freshmen engineering students' mathematics anxiety perceptions
23	Compendex Engineering Village	Nolte, Huff, and McComb (2022)	No time for that? An investigation of mindfulness and stress in first-year engineering design
24	Compendex Engineering Village	Paniagua et al. (2019)	Study of Binqui. An application for smartphones based on the problems without data methodology to reduce stress levels and improve academic performance of chemical engineering students
25	Internet Search	Paul et al. (2021)	Impact of integrating mental wellness and personal learning reflections into first-year undergraduate engineering courses.
26	Linked from updated paper	Paul et al. (2020)	The 'Engineers have feelings' Project: Integrating Mental Wellness and Lifelong Learning Skills in First-Year Undergraduate Engineering Courses

(*Continued*)

Table 1. Continued.

No.	Database	Author, Year	Title
27	ERIC	Poole, Khan, and Agnew (2017)	One Week, Many Ripples: Measuring the Impacts of the Fall Reading Week on Student Stress
28	SCOPUS	Rodríguez-Jiménez (2022)	Embodied Learning for Well-Being, Self-Awareness, and Stress Regulation: A Randomized Trial with Engineering Students Using a Mixed-Method Approach
29	Compendex Engineering Village	Su (2016)	The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study
30	Compendex Engineering Village	Tragodara (2021)	Virtual tutoring from the comprehensive training model to Engineering students during the COVID-19 pandemic
31	Web of Science	Vitasari (2011)	A pilot study of pre–post anxiety treatment to improve academic performance for engineering students
32	Web of Science	Walton (2015)	Two brief interventions to mitigate a 'chilly climate' transform women's experience, relationships, and achievement in engineering
33	Compendex Engineering Village	Yanik (2016)	Sources of anxiety among engineering students: Assessment and mitigation



Country	Source Reference
Canada	5, 15, 25-27, 32
India	11-14, 16
Malaysia	31
Mexico	22
Peru	30
Spain	24, 28
Taiwan	29
Thailand	3
Turkey	2
USA	1, 4, 6-10, 17-21, 23, 33

Figure 2. Chart showing proportion of included studies by country, and source reference.

individual study quality, the TIDieR checklist was used to identify the quality of intervention reporting. Poor reporting of interventions hinders their replicability in practice.

Table 4 maps the interventions to the TIDieR checklist, which comprises 10 criteria that are recorded 'X' if the criteria are reported in the article and left blank if it is not reported. The majority of sources reported when and how many interventions were delivered (31). Most sources included some of the required criteria. Three studies were published prior to the TIDieR checklist, so the reviewers acknowledge this would not have guided their reporting, however the checklist is a useful tool to evaluate reporting quality and therefore evaluate replicability.

Table 2. Types of study included sources.

Study design	Source reference
Case Study	8, 18
Case Study/Pilot	3
Experimental	11–14, 16, 17, 28
Pilot	1, 4, 5, 7, 9, 10, 15,19–23, 25,26, 29–31, 33
Quasi-experimental non-equivalent pilot	2
RCT	32

Table 3. Interventions and outcome measures reported.

No.	Author, year, country	Intervention	Category	Outcome measures
1	Abiade and Moliski (2020). USA	6-week program (Identity and Transitions Laboratory) including information on Acceptance and Commitment Therapy, imposter syndrome, stress management, and identifying signs of a mental or emotional disorder.	Educational	Written feedback, follow-up survey, grades, and retention. Cohort 2 anonymous feedback, 3 end of program assessments and follow-up survey.
2	Altun (2008), Turkey	15-week course which included 30 h of classroom lectures, group discussions, and demonstrations – included definition and purpose of health promotion, concepts of health promotion, disease, lifestyle, stress management.	Educational	Exercise of Self-care agency scale and Health Promotion Lifestyle Profile II Scale
3	Aree et al. (2020), Thailand	3-hour mindfulness training course	Psychological	Survey
4	Berger, Lampe, and Caruccio (2015), USA	New partnership fully contextualised to engineering and located within the engineering school providing academic and pastoral support. This was different from the standard centralised services	Psychological	Data from handwritten notes at staff meetings where student situations discussed, student demographics (gender, academic major) & academic outcomes – progress towards graduation
5	d'd'Entremont et al. (2019), Canada	1 information session, 1 reflection exercises based on a video about stress, 1 workshop on stress and stress reduction methods, deployed consecutively over a term.	Educational	4 surveys (including MSLQ, Academic Buoyancy) analysis of reflection responses, pre–post intervention surveys
6	Eren-Sisman, Cigdemoglu, and Geban (2018), USA	Introduction of peer-led team learning. **Control group**: instructed using traditional college instruction. **Experimental group**: instructed using the PLTL model.	Educational	General Chemistry Concept Test, State Trait Anxiety Inventory, Social Anxiety Questionnaire for Adults
7	Estrada and Dalton (2019), USA	4-week mindfulness-based stress reduction intervention	Psychological	Survey – Five Facet Mindfulness Questionnaire (FFMQ) and ABET Outcomes
8	Grasty et al. (2021), USA	Impact of Counselling services	Psychological	Interview data
9	Huerta (2021), USA	4-session mindfulness-based program	Psychological	Survey and Interview data
10	Johnson-Glauch, Cooper, and Harding (2020), USA	Pilot mental health action plan assignment	Psychological	Pre and post surveys including a 17-item validated self-efficacy instrument, content analysis of the action plans and of the free text areas on the survey
11	Joshi and Kiran (2020), India	Experimental group underwent yogic breathing and listening to religious and flute music. The Control group did not.	Physiological, Psychological	Skin conductivity
12	Joshi, Kiran, and Sah (2017a)	Experimental group listened to hymns, the Control group did not.	Psychological	Skin conductivity
13	Joshi, Kiran, and Sah (2017b)	Experimental group underwent yogic breathing, the Control group did not.	Physiological	Skin conductivity
14	Joshi et al. (2016) India	Experimental group carried out deep breathing	Physiological	Blood pressure
15	Khan, Poole, and Beaton (2018), Canada	A weeklong break during 1st semester, intervention group and control group (Same intervention as 27)	Educational (Same intervention as 27)	DHEA levels in saliva measuring cortisol

(*Continued*)

Table 3. Continued.

No.	Author, year, country	Intervention	Category	Outcome measures
16	Lal et al. (2019), India	Meditation	Psychological	Perceived stress scale [PSS] and Mindfulness Attention Awareness Scale [MAAS] was administered on both groups of students.
17	Maxson and Tomasko (2020), USA	Introduction of a Wellness Committee with a number of activities aiming to improve mental wellbeing	Educational	Questionnaires and academic performance
18	Mazumder (2012), USA	Metacognition-based software Lecture Tools (http://www.lecturetools.com) providing interactive environment for the students.	Educational	Engagement and feedback
19	Miller and Jensen (2020), USA	16 mindfulness sessions after online lessons	Psychological	Course evaluation
20	Miller et al. (2021), USA	A design exercise for students focusing on the measurement of physiological changes through mindfulness. (same intervention as 21)	Educational (same intervention as 21)	Surveys
21	Miller et al. (2022), USA	Introduction of a biosensor project with experiments to reduce stress. (same intervention as 20)	Educational (same intervention as 20)	Pre–post survey and feedback
22	Moran and Benson (2016), Mexico	Four-week maths course designed to standardise maths knowledge. Students met 5 x per week for 2 h duration to review basic maths knowledge. Completed 3 weekly tests and a final test at the end of week 4.	Educational	Items from the Mathematics Anxiety Rating Scale 30 and other items not relating to the paper – pre and post.
23	Nolte, Huff, and McComb (2022), USA	First-year engineering design students completed three 30-minute experimental sessions during an engineering design course, where their stress and mindfulness during three principal stages of the design process were investigated. Each session consisted of a short video followed by a 10-minute design task.	Educational, psychological	Pre and post surveys including Toronto Mindfulness Scale, Short Stress State Questionnaire, modified NASA-RTLC, and author developed stress questions
24	Paniagua et al. (2019), Spain	Use of gamification software for teaching. Group A: elements of gamification were incorporated into the teaching Group B: control group no gamification incorporated	Educational	Hamilton Anxiety Scale and academic performance
25	Paul et al. (2020), Canada	A mental health promotion program integrated into the 1st year engineering curriculum (same intervention as 26)	Educational (same intervention as 26)	Analysis of feedback
26	Paul et al. (2021), Canada	A mental health promotion program integrated into the 1st year engineering curriculum.	Educational (same intervention as 25)	End of year survey with additional wellness and identity validated scales
27	Poole, Khan, and Agnew (2017), Canada	A weeklong break during 1st semester with survey before and after and text message during. (Same intervention as 15)	Educational (same intervention as 15)	Survey (Perceived Stress Scale) and Focus Groups, and DHEA levels in saliva
28	Rodríguez-Jiménez (2022), Spain	A body awareness program based on Dance Movement Therapy Experimental. Group attended 10 sessions of 90 min twice a week.	Physiological	Satisfaction with Life Scale SWLA, Perceived Stress Scale, the TECA (Cognitive and Affective Empathy Test), WHO-5, Body Awareness Questionnaire (BAG) Scale Body

(*Continued*)

Table 3. Continued.

No.	Author, year, country	Intervention	Category	Outcome measures
				Connection, Heart Rate Viability. Saliva cortisol, D2 test (selective attention and mind concentration), RP 30 – problem-solving cognitive abilities, reflective diary
29	Su (2016), Taiwan	Introduction of gamification software	Educational	Gamification Learning Scale, Learning Motivation Scale, Cognitive Load Scale, Learning Anxiety Scale, Academic Performance Scale
30	Tragodara (2021), Peru	Online personal tutoring during Covid including positive psychology sessions, flow sessions	Psychological	Interview data and questionnaires, attendance monitoring
31	Vitasari (2011), Malaysia	6 sessions of treatment each for 2 h to include Breathing exercises Relaxation Study skills	Physiological, psychological, educational	BPM and GPA. Breath per minute measured using stress sweeper device.
32	Walton (2015), Canada	Intervention included social belonging intervention and affirmation training intervention	Psychological	Pre-Intervention Survey – belonging/confidence. Post – GPA, diaries, survey
33	Yanik (2016), USA	Control group – cohort 1 study skills and cohorts 2 and 3 outcomes related to attention and effort. Periodic vertically integrated discussion groups with faculty mentors and their peers at multiple levels of seniority, introduced to university resources designed to address specific student needs.	Educational	Analysis of journals and discussions

Outcome measures

Heterogeneity was noted across outcome measures reported in the included sources of evidence. The tools adopted included physiological measurements (11, 12, 13, 14, 15, 27, 31), and self-administered surveys (1-3, 5-7, 9,10, 16, 25-30 18, 20-24, 25-30, 32). There were a variety of survey types administered in the studies (Table 3).

Academic performance was measured through grades (1, 18, 24), Grade Point Average (GPA) (1, 18, 24), graduation and dropout rates (4), and ABET (American Board of Engineering and Technology) outcomes (7). ABET outcomes are the accreditation educational criteria for engineering programs in the USA (ABET 2022). Physiological measurements were made through Galvanic Skin Response (skin conductivity), (11, 13, 14), Breaths Per Minute (31), blood pressure (12), and cortisol measurements through DHEA levels in saliva (15).

Qualitative measures were also used in the research projects. This included analysis of student feedback, student reflection or journals, and interviews and discussions (Table 5).

Reported outcomes

The main outcomes reported from the included sources of evidence related to academic achievement, stress, and anxiety, with a range of outcome measures used across studies (Table 4). Study outcomes focussed on reduced stress (5, 7, 16, 24, 25, 27, 28), improved academic achievement (1, 3, 4, 6, 18, 25, 29, 31, 32), reduced anxiety (3, 5, 6, 9, 24, 29, 33), improved communication (18, 33), improved

Table 4. Engineering student interventions mapped to the TIDieR checklist.

No. Author, Year, Country	Materials Used	Procedures & processes used	Who provided	How – Mode of delivery	Where – location of intervention	When & how much – number of interventions, duration etc.	Tailoring – any adaptions	Modifications during the course of study	How well planned	How well actual
1. Abiade and Moliski (2020). USA	X	X	X	X	X	X	X			
2. Altun (2008), Turkey		X	X	X	X	X				
3. Aree et al. (2020), Thailand	X	X	X	X	X	X				
4. Berger, Lampe, and Caruccio (2015), USA			X		X	X	X			
5. d'd'Entremont et al. (2019), Canada	X	X	X	X	X	X				
6. Eren-Sisman, Cigdemoglu, and Geban (2018), USA		X	X	X	X	X				
7. Estrada and Dalton (2019), USA	X	X	X	X	X	X				
8. Grasty et al. (2021), USA		X								
9. Huerta (2021), USA	X	X	X	X	X	X				
10. Johnson-Glauch, Cooper, and Harding (2020), USA	X	X	X	X	X	X				
11. Joshi and Kiran (2020), India	X	X		X	X	X				
12. Joshi, Kiran, and Sah (2017a), India		X		X		X				
13. Joshi, Kiran, and Sah (2017b) India		X		X		X				
14. Joshi et al. (2016) India						X				
15. Khan, Poole, and Beaton (2018), Canada						X				
16. Lal et al. (2019), India		X			X					
17. Maxson and Tomasko (2020), USA	X	X	X	X	X	X				
18. Mazumder (2012), USA	X		X		X	X				

(*Continued*)

Table 4. Continued.

No. Author, Year, Country	Materials Used	Procedures & processes used	Who provided	How – Mode of delivery	Where – location of intervention	When & how much – number of interventions, duration etc.	Tailoring – any adaptions	Modifications during the course of study	How well planned	How well actual
19. Miller and Jensen (2020), USA	X	X	X	X	X	X				X
20. Miller et al. (2021), USA	X	X	X	X	X	X				X
21. Miller et al. (2022), USA	X	X	X	X	X	X				
22. Moran and Benson (2016), Mexico						X				
23. Nolte, Huff, and McComb (2022), USA	X	X	X	X	X	X				
24. Paniagua et al. (2019), Spain	X		X		X	X				
25. Paul et al. (2020), Canada	X	X	X	X	X	X				
26. Paul et al. (2021), Canada						X				
27. Poole, Khan, and Agnew (2017), Canada						X				
28. Rodríguez-Jiménez (2022), Spain	X	X	X	X	X	X				
29. Su (2016), Taiwan	X	X	X	X	X	X				
30. Tragodara (2021), Peru		X	X	X	X	X				
31. Vitasari (2011), Malaysia						X				
32. Walton (2015), Canada					X	X				
33. Yanik (2016), USA		X		X		X				
Total	12	23	20	21	23	31	2			2

Table 5. Types of qualitative measure.

Qualitative measure	Source
Written feedback/course evaluation	1, 10, 19
Survey comments	3, 5, 20
Analysis of reflection responses	5
Interview transcript	8, 30
Feedback	17, 21, 25, 26
Reflective diary, diaries, journals	28, 32, 33
Discussions	33

motivation (18, 29), participant acceptability of mindfulness interventions (19, 21, 23, 26) and improved physiological markers (11-15, 27). Table 6 outlines the results and author conclusions from the included sources. Of particular note are the interventions using mindfulness training (3,7,9,19,23). For the six mindfulness training interventions five studies reported positive impacts of mindfulness training on students' mental wellbeing and one (23) reported that while stress was not reduced, participants reported benefitting from the training. Source 7 reported statistically significant improvements to trait mindfulness following the intervention. All sources recommended further research into mindfulness training with engineering students. The full data extraction can be found in Appendix III.

Discussion

This scoping review aimed to map the evidence on mental wellbeing in engineering students and specifically identify the types of study designs, mental wellbeing interventions and outcomes in relation to this population.

Types of study design reported

This review identified mainly quantitative studies, with some studies adopting a mixed-method approach. One study (8) was fully qualitative. There is a need for qualitative studies to probe engineering students' lived experience of this topic in higher education and their experience of strategies to maintain their mental health and wellbeing.

From the quantitative study designs reported, the majority were positioned lower on the evidence hierarchy (Physiopedia 2021) with mainly pilot studies, and only one RCT. To enable researchers to identify effective interventions by conducting prospective quantitative systematic reviews and meta-analysis, there is a need for more high-quality, adequately powered, robust studies (such as RCT) to be conducted so results can be pooled for analysis. According to the Medical Research Council (MRC 2008), robust research studies following a complex intervention approach are needed; they can help establish feasibility, acceptability, fidelity and finally effectiveness of these interventions. With the updated literature searches it was noted there has been an increase in interest in the topic of mental health and wellbeing of engineering students and that with this increase there may be an increase in quality as the research area is explored more fully.

Mental health and wellbeing interventions

There were 33 interventions that were considered to have met the inclusion criteria for this review. There is a growing body of evidence in this area with most studies conducted in the last two years (13 out of the 33 included sources). This demonstrates the increasing awareness of this topic within engineering education. Most studies were conducted in North America or Asia, with only one study conducted in Europe. Whilst student mental health and wellbeing is regarded as important within the higher education setting (De Pury and Dicks 2020), this review has identified a research gap

Table 6. Result and conclusions of included sources.

No. Author, Year	Results	Conclusions
1. Abiade and Moliski (2020)	Improvement in GPA, other results ongoing	Positive responses and improved GPA indicate the program is helpful, authors will continue to monitor both cohorts.
2. Altun (2008)	Statistically significant improvement in health responsibility and health promoting behaviours on both scales. ESCA increase statistically significant suggesting increased self-care abilities.	Course was beneficial to students as it helped improve self-care behaviour. Health promotion courses should be more widely used. Recommended that this type of course becomes a part of curriculum.
3. Aree et al. (2020)	Improvement in knowledge, and decrease in anxiety and depression	Stress management through medication/ mindfulness could reduce anxiety in engineering students.
4. Berger, Lampe, and Caruccio (2015)	Outcomes achieved by students in different Cohorts were 'similar or improved'. Physical location and training in engineering issues key to providing support. Merging support benefited students in terms of success rates (graduation). Women better served by the new model in particular African American women.	Bringing student support services into a School of Engineering can improve achievement rates and may benefit women and women of colour in particular most.
5. d'd'Entremont et al. (2019)	8/18 respondents felt wellness interventions had a positive effect on their student experience, 4/ 8 indicated interventions provided tools to deal with stress. 8/18 felt interventions were not helpful. Anecdotally, faculty and staff saw a decrease in number of visits from students in emotional distress.	Good preliminary evidence that the intervention helped to dampen the effects that entering the program has on wellbeing.
6. Eren-Sisman, Cigdemoglu, and Geban (2018)	PLTL approach had significant effect on performance (not as much as was expected) but STAI was significantly improved in the PLTL group. Social anxiety was not affected and remained high in both groups.	Model may be helpful in improving learning and alleviating state anxiety. It was not as effective in reducing social anxiety when compared to traditional college instruction.
7. Estrada and Dalton (2019)	Significantly increased engineering students' trait mindfulness, engagement in mindfulness outside of sessions and intellectual curiosity and exploration but not perceived stress	Supports the feasibility of further mindfulness-based intervention for engineering students.
8. Grasty et al. (2021)	Engineering student continued studies and felt counselling contributed to this. The benefit of feeling heard was noted and counselling helped to set boundaries and improve interpersonal skills	Counselling proved effective for this student.
9. Huerta (2021)	Improvements in confidence and reduced anxiety.	Mindfulness training can support self-efficacy and improve aspects of mental wellbeing.
10. Johnson-Glauch, Cooper, and Harding (2020)	No statistically significant difference in self-efficacy overall. Those with large gains had scored low initially.	Result suggests that these types of assignments may preferentially benefit students with low self-efficacy.
11. Joshi and Kiran (2020)	Experimental group reported reduction in mean value in Galvanic Skin Response (GSR) from deep yogic breathing, listened to religious hymns and listening to flute music.	Listening to flute music emerged from these three drills as the most effective stimulus for stress management.
12. Joshi, Kiran, and Sah (2017a)	Statistically significant improvement in skin conductivity post session for both the control and the experimental group. Results reflected yogic breathing had a significant effect on skin conductivity.	Deep breathing techniques can reduce skin conductivity and in turn stress levels of engineering students. Basic yogic breathing could be included in core curriculum to reduce and manage stress among engineering students.
13. Joshi, Kiran, and Sah (2017b)	Statistically significant increase in GSR for the control group after 300 s ($p < 0.01$), whereas significant reduction ($p < 0.01$) in GSR after listening to hymns in the experimental group.	Listening to hymns could provide a strategy to manage stress in educational institutions for student with high levels of self-reported stress
14. Joshi et al. (2016)	Deep breathing technique had a statistically significant reduction on systolic and diastolic blood pressure in engineering students with high academic stress.	Deep breathing techniques could be beneficial in improving students learning and efficiency.

(*Continued*)

Table 6. Continued.

No. Author, Year	Results	Conclusions
15. Khan, Poole, and Beaton (2018)	Students without a break had marginally higher cortisol and DHEA levels. Engineering students that did not have a break (control group) had slightly greater output of cortisol to DHEA than those that experienced time away from school (experimental group).	A break may be helpful in reducing stress, but the sample size was small and more research needed
16. Lal et al. (2019)	Significant decreases in stress perception level among those students who are practicing meditations and high level of stress perception level among those who are not practicing any techniques to cope with stress respectively.	Meditation showed promise in reducing stress among college students.
17. Maxson and Tomasko (2020)	Improved MH and MW awareness, improved pastoral skills, improved perception	Publication is a work in progress, but the overall intervention has been received positively
18. Mazumder (2012)	Interaction positively contributed to students paying more attention. Increased interactions resulted in higher exam scores. Communication apprehension reduced. Use of interactive technology followed by group discussions and class assignments greatly enhanced students' comprehension of scientific facts and their ability to explain them.	Interactive software in modules may help with motivation and communication apprehension. Increased interactions improved their level of understanding of the subject matter, which resulted in higher exam scores. It is possible that clarification and further understanding of any questions could have resulted from the group discussion and not necessarily from the use of technology.
19. Miller et al. (2021)	20 students that participated self-reported improved relaxation as a benefit.	Mindfulness training embedded in a design project may benefit students' wellbeing.
20. Miller and Jensen (2020)	Positive responses to the addition of mindfulness activities.	Introduction of wellness activities may promote cultures of student wellness.
21. Miller et al. (2022)	Students noted collecting their own biometric data was convincing of the effectiveness of wellness practices. Students noted the project applied engineering principles while also providing students with valuable life skills. At the end of the, 88% of students voted to continue meditating daily at the start of class.	Integration of wellness into the core curriculum can normalise the use of these resources in engineering departments and equip students with stress management tools for their careers.
22. Moran and Benson (2016)	Math anxiety increased after the 4-week course. Females reported higher anxiety than males. Gender, type of high school, and students' origin increased math anxiety for both math test and math activities. Math test anxiety was higher than math activities showing most of the stress is related to the tests. Math anxiety increase was significant for males and females but effects > for females post course ($p < 0.05$). Outcomes achieved across 3 cohorts were similar or improved	Fast-paced maths courses could increase anxiety levels and lead to maths avoidance and negative affective reactions performing maths activities. This may be more problematic for women engineering students. Significant increase in maths anxiety measurements from before to after an intensive course particularly for maths test anxiety. Females also experienced higher levels of maths test anxiety but not maths activities anxiety. Educators should therefore be aware of designing maths courses acknowledging the stress related to maths tests.
23. Nolte, Huff, and McComb (2022)	Mindfulness-based video increased students decentreing overall, but effect is small. Written feedback: five students would do this type of activity again in the future or would like to incorporate more mindfulness into their lives. Results indicate experiencing a mindfulness-based video did not noticeably impact perceived sources of stress during design tasks. Students' top perceived source of stress was time limitation. Overall, mindfulness-based body scan video increased students' decentreing. However, students' total TMS scores and curiosity were not affected.	Increase in students' state mindfulness was not found to have an observable impact on students' stress experience. Students were receptive to completing a mindfulness-based activity in-class and perceived multiple benefits. While students currently utilise many mechanisms for coping with task-induced stress, teaching engineering students mindfulness is still a promising avenue for helping students manage the stress of engineering and design.
24. Paniagua et al. (2019)	Using the app improved comfort and stress levels significantly. Academic results also showed improvement.	Reduction in perceived stress and improvement of academic performance showed the introduction of the PWD model app was beneficial to the course.

(*Continued*)

Table 6. Continued.

No. Author, Year	Results	Conclusions
25. Paul et al. (2021)	Stress was a significant predictor of overall GPA after first year. Negative relationship between stress and overall GPA was buffered by resilience but enhanced by student engagement (i.e. resilient students seemed to manage stress better). Students also prioritise academics first and social life second, physical activity comes third, while mental health was mentioned least, it is also a factor to consider for responses from social wellness.	Personal reflection in the curriculum provided several benefits.
26. Paul et al. (2020)	Students preferred shorter sessions, but there was acknowledgement this wasn't their top priority.	Study highlighted some benefits to incorporating concepts of student wellness and lifelong learning into the engineering curriculum. Further results will be reviewed in Paul et al. (2021). (Ref 25)
27. Poole, Khan, and Agnew (2017)	Students with fall break demonstrated lower ratio of cortisol to DHEA after the break suggesting students with a break had less stress on their return to class ($p = 0.052$).	Break may be beneficial from stress hormones data, but these results are limited due to small sample size and no significant statistical effect.
28. Rodríguez-Jiménez (2022)	Results showed improvements in stress levels, well-being, and life satisfaction, along with an increase in the levels of self-awareness and self-knowledge	Dedicating time and resources to interventions can help students to increase their level of awareness and health and generate healthier educational environments.
29. Su (2016)	Software had significant positive effect on learning motivation, academic achievement, and decreased cognitive load. Decreased cognitive load associated with decreased learning anxiety. Decreased learning anxiety is associated with strong learning motivation.	Improvements to motivation cognitive load and learning anxiety were statistically significant and may be useful in course enhancement.
30. Tragodara (2021)	Main demand of students related to the academic subject time management and study techniques. Main reason students requested counseling was anxiety, followed by demotivation.	Virtual tutoring supported the wellbeing of the students
31. Vitasari (2011)	Breath per minute significantly reduced post intervention, Grade Point Average improved but not statistically significant. Anxiety reduced significantly ($p < 0.05$).	Intervention was effective in reducing anxiety levels – but 6 sessions were not enough to significantly improve academic performance. Subjects improved GPA as compared to pretreatment.
32. Walton (2015)	Both interventions raised women's engineering grade-point-average (GPA) eliminating gender differences. Both led women to view daily adversities as more manageable and improved women's academic attitudes. The 2 interventions had divergent effects on women's social experiences. Gender differences and intervention effects were concentrated in male-dominated majors (~20% women).	Results highlight how social marginalisation contributes to gender inequality in quantitative fields and 2 potential remedies. Social belonging intervention helped women integrate into engineering. Affirmation training helped women develop external resources, deepening their identification with their gender group.
33. Yanik (2016)	Identified 3 themes: anxiety related to time management (procrastination and effect on work, having a balanced life with studies and other roles), anxiety related to success and completion of their degree (lack of confidence in academic ability, deficits in academic preparation) and anxiety related to life post-graduation (concerns about finding a job, uncertainty on ability for employer). Other sources in isolated cases included accumulation of debt, loneliness, and inability to take full advantage of opportunities available through the college experience. Group discussions had greatest perceived value, with time management practices, completion strategies and what comes after graduation of most benefit.	Reflection had a positive effect on students' understandings of the courses and possible remedies for commonly occurring anxieties. Activities were easily implemented and fostered both self-awareness among individuals and cohesion among the larger group.

in engineering student mental health and wellbeing interventions in UK settings as no studies were identified for this review. This reflects findings in a recent review of UK higher education students (Worsley, Pennington, and Corcoran 2020). There may be interventions being delivered in UK settings, but these are not easily identified despite a comprehensive search of published and unpublished literature. There is an urgent need for focused research in this area, including co-production work to identify and create interventions to support good mental health and wellbeing. As most included sources focused on undergraduate students there is also a need to explore suitable interventions for postgraduate engineering students.

The main interventions reported in this review involved training and the use of relaxation methods. More recently, research on mindfulness interventions for engineering students has begun to emerge, (3, 7, 9, 16, 19-21, 23), with encouraging results (Nolte, Huff, and McComb 2022).

In terms of reporting, none of the sources fully adhered to the TIDieR guidelines (Hoffmann et al. 2014), with key items missing that limit the uptake and replication of interventions in practice. From the findings of this review, future research to investigate wellbeing interventions for engineering students should ensure authors adhere to transparent reporting using tools such as the TIDieR guidance and other reporting guidance available from the Equator Network (Equator 2022).

From the interventions reported in this review there was similarity to mental health and wellbeing interventions that are used in general higher education student populations such as introducing mindfulness and health promotion (Hassed et al. 2009), coaching, (Larcus, Gibbs, and Hackman 2016) and breathing exercises (Cho et al. 2016) although specific engineering mental health and wellbeing interventions should also be considered to address issues that are more common to engineering students such as mathematics anxiety (Vitasari 2010) and delayed help-seeking (Deziel et al. 2013).

Outcomes reported

The outcomes mapped in this review present evidence for mental health and wellbeing interventions to improve a range of factors, some of which are also similar to general student population wellbeing interventions outcomes such as academic achievement, reduced stress and anxiety, improved motivation, attitude, physical activity, spirituality health awareness, confidence, and communication (Universities UK 2015; Baik et al. 2016; Worsley, Pennington, and Corcoran 2020). Due to the variety of interventions and heterogeneity between outcomes and outcome measures reported, recommendations for subsequent systematic reviews of effectiveness cannot be made at this time. Future research should focus on considering a core outcome set to be used across studies of interventions in this area to enable future systematic reviews.

Limitations

The authors acknowledge limitations within this review where only sources of evidence in English were included. The authors acknowledge this may have excluded some sources of evidence and may have impacted on the results. However, some sources included in this review were from non-English-speaking countries. There was a deviation from the a priori protocol as it was anticipated to map participant groups as per UK HESA categories, but the international evidence mapped by this review did not use this categorisation. The search and screen phase was updated due to delays as a result of the global pandemic. This review included pre-Covid literature. With the pandemic impact there has rightly been greater recognition of mental health and wellbeing issues within students and more availability of evidence in this area. This is demonstrated through the increase in publications in the past two years (13 of the 33 sources included).

Conclusions

This scoping review has identified and mapped various sources of evidence for interventions on mental health and wellbeing for engineering students and the intervention components, outcomes and outcome measures utilised in this area. The key interventions focused on introducing positive mental health and wellbeing behaviours. The research designs most frequently used are quasi-experimental, quantitative, and have used a variety of outcome measures. The main results indicated reduced stress and anxiety, and improvement of all of the following: academic achievement, communication, motivation, physiological responses, attitude, physical activity, spirituality, health awareness, and confidence.

Research recommendations

In accordance with scoping review methodology, this review cannot provide recommendations for practice. However, the following recommendations have been identified:

- Robust and transparent reporting of research adhering to reporting guidelines is needed;
- Research is required in higher education settings to identify effective interventions using robust experimental study designs;
- An increase in qualitative or mixed-methods study designs is needed to explore the lived experience, impact, and acceptability of interventions to support mental health and wellbeing of engineering students;
- There is a need to establish the effectiveness of interventions via systematic review and meta-analysis.

Acknowledgements

This review contributes in part towards a PhD thesis.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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