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Training and Educational Pathways for Clinicians (Post-graduation) for the Assessment and Diagnosis of Autism Spectrum Disorders: A Scoping Review

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Abstract

This review aimed to identify the post-graduation training pathways available for both clinicians and trainers in the assessment and diagnosis of Autism Spectrum Disorder (ASD). The study was guided by two research questions: What is known about ASD-specific educational, training, or other pathways available to support clinicians of any discipline, post-graduation, to meet the required expertise relevant to assessments of ASD concerns? What is known about the educational pathways available to clinicians seeking to provide training to other clinicians, post-graduation, in the assessment of ASD concerns? A scoping review was undertaken with searches completed across five databases (PubMed, PsycINFO, PsycEXTRA, ERIC and CINAHL). A Google search strategy was also executed using the "advanced" search function. Eligible records were literature, written in English, that examined post-graduation training and/ or education of clinicians to assess and/ or diagnose ASD. Fourteen relevant records were identified. Post-graduate training has the potential to enhance clinician confidence and service provision in ASD assessment and diagnosis. System-wide training approaches show promise in building large-scale, diagnostic capacity and the use of tele-mentoring offers a cost-effective, convenient mode of training delivery. A lack of evidence to support ASD diagnostic training pathways was found and may pose a challenge for clinicians and service users. The limited evidence found suggests that high quality research will be fundamental in determining how to build clinician capacity in ASD assessment and diagnosis and to ascertain whether training pathways are a necessary component.

Keywords Autism spectrum disorder · Healthcare professional training · Adult education · Assessment and diagnosis · Train the trainer

Early diagnosis of Autism Spectrum Disorder (ASD) allows for access to early intervention, supporting developmental gains during a period of optimal neuroplasticity and resulting in benefits at the individual, family, and society level (Fuller & Kaiser, 2019; Horlin et al., 2014; Klaiman et al., 2015). Currently, ASD can be reliably identified as early as infancy (Klaiman et al., 2015; Zwaigenbaum et al., 2013).

However, the US national average age of ASD diagnosis is four to five years (Baio et al., 2018) and older for children from lower income, minority, and rural backgrounds (Mandell et al., 2002, 2005). Experienced clinicians may assist in early identification as one study found that their judgement of early ASD at age two years was a better predictor of later diagnosis than either standardised interview or observation (Lord et al., 2006). Nevertheless, in addition to issues such as poorly integrated models of care, a shortage of expert evaluators is associated with delays in referral and extended wait times for ASD evaluation (Gordon-Lipkin et al., 2016).

In addition, challenges in ASD diagnosis arise due to the variability in signs, symptoms and severity of ASD as well as the behavioral overlap with other disorders such as intellectual disability, language and anxiety disorders (Huerta & Lord, 2012). For example, individuals with ASD vary widely in their cognitive functioning with an inverse relationship found between level of intelligence and ASD

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symptoms (Lord et al., 2006). As such, there is a need to assess co-occurring intellectual disability to characterise the presentation of ASD (Rosen et al., 2021). Such challenges add to the complexity of ASD diagnostic assessments and speak to the importance of adequate training for clinicians undertaking such assessments.

Further, a systematic review of the diagnostic tests for ASD suggested that many lack a quality evidence-base (Falkmer et al., 2013). For example, only three diagnostic tools demonstrated a strong evidence base, the Autism Diagnostic Observation Schedule (ADOS), Autism Diagnostic Interview Revised (ADI-R) and the Childhood Autism Rating Scale (CARS; (Falkmer et al., 2013). Similarly, a systematic review by Randall and colleagues (2018) identified the ADOS, ADI-R and CARS as the only tests with available diagnostic test accuracy data, when assessing preschool children.

Controversy also surrounds the most accurate definition of ASD, adding further complexity to its assessment and diagnosis (Volkmar & McPartland, 2014). For example, publication of the fifth edition of the DSM enacted substantial change to the conceptualisation of ASD, replacing the previously held subcategories with a one-dimensional category (APA, 2013). Additionally, instead of three symptom categories, only two areas are now considered: social communication/interaction and restricted and repetitive interests.

Clinical guidance documents are integral in the establishment of best practice parameters for the assessment and diagnosis of ASD. However, recent reviews of the quality and content of such guidelines highlighted variation in all aspects of the ASD diagnostic assessment (Hayes et al., 2018; Penner et al., 2018). For example, discrepancies were found regarding whether a multi-disciplinary team or single clinician must be used for ASD assessment, the configuration of the multi-disciplinary team and key timeframes for assessment (Hayes et al., 2018; Penner et al., 2018). Notably, reviews to date have not focused on the recommendations for the training and educational pathways involved to support clinicians to meet the expertise required to assess ASD concerns and/ or to provide training in the assessment of ASD concerns.

Notwithstanding a lack of standardised best practice guidelines, there are widely accepted best practices in ASD assessment (Brian et al., 2019), which include obtaining a detailed developmental and medical history using interview and collateral review; direct interactions and client observation; and (depending on age and differential diagnoses) an assessment of developmental or cognitive abilities. However, it is important to note that appraisal of an individual's presenting behavior, a widely accepted component for accurately assessing ASD, remains a subjective task that relies on clinical experience and skill (Taylor et al., 2016). Given this understanding, gaining sufficient clinical expertise to competently assess, diagnose and consider differential diagnoses is essential. Indeed, current practice guidelines in the United States recommend screening children for symptoms of ASD through both developmental surveillance during all routine health care appointments and the use of standardised ASD-specific screening tests during primary care visits (Hyman et al., 2020). Additionally, the National Guideline for the Assessment and Diagnosis for Autism Spectrum Disorders in Australia (Whitehouse et al., 2018) recommends that clinicians involved in the assessment of ASD concerns should obtain and maintain required expertise through peer observation, peer supervision and peer mentoring. It is noted that training courses may supplement these peer learning approaches. As such, understanding the training and educational pathways available to assist clinicians is an imperative step to meeting these common guideline recommendations.

These recommendations raise the issue that the training of clinicians who work in health and community contexts does not consistently enable professionals to undertake ASD assessments. The level of training received while a student varies between professions and jurisdictions, (Vi et al., 2023) leaving many clinicians needing additional training post-graduation and while in the workplace. In addition, clinicians changing roles may need to upskill. Clinicians are often responsible for ensuring they achieve and maintain requisite professional training and expertise to competently deliver these clinical services (Taylor et al., 2016). Understanding the various training pathways available to obtain and maintain the required expertise relevant to the assessment of ASD concerns may contribute to understanding how workplaces can support training needs thereby assisting clinicians' pathways towards competency. Moreover, individuals involved in the assessment and diagnosis of ASD could benefit from this understanding to improve staff training protocols and efficiency, retain clinical expertise within workplaces, and ensure the maintenance of rigorous assessment.

To gain such understanding, a scoping review was chosen based on preliminary literature searches, which showed a lack of narrative reviews, systematic reviews or meta-analyses regarding targeted, ASD-specific education and training practices for clinicians assessing for the presence of an ASD. Searches of several key databases revealed that relevant results were likely to be fewer than 10 peer-reviewed journal articles. In such cases, a scoping review is the preferred research design (Arksey & O'Malley, 2005). Scoping reviews have been increasingly used to map broad topics (Pham et al., 2014) and can assist in identifying knowledge gaps, informing research agendas, and identifying implications for decision-making (Tricco et al., 2016).

To date, no review has focused specifically on ASD-specific training and educational pathways available for the assessment and diagnosis of ASD for clinicians in health and related settings post their basic professional training/

post-graduation. The present study aimed to clarify what kind of information is available in the literature about what ASD-specific training pathways exist to achieve competency to undertake the assessment and diagnosis of ASD. Further, it aimed to highlight what literature is available regarding pathways to achieving competency required as a trainer in the assessment of ASD concerns. The following research questions were formulated for the current study: What is known from both published and unpublished literature about ASD-specific educational, training, or other pathways available to support clinicians in health and related settings of any discipline, post-graduation, to meet the required expertise relevant to assessments of ASD concerns? What is known from both published and unpublished literature about the educational, training, or other pathways available to clinicians seeking to provide training to other clinicians, post-graduation, in the assessment of ASD concerns?

Method

The methodology for this scoping review was guided by the Joanna Briggs Institute Reviewer's Manual (Peters et al., 2020) and Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (Tricco et al., 2018; Fig. 1, suppl. materials). The protocol was registered prospectively with the Open Science Framework on 26 July 2022 (https://doi.org/10.17605/OSF.IO/24XTS). An amendment was made to note that studies were to be included when they examined the education and training *of clinicians* to assess or diagnose ASD. In line with Arksey and O'Malley's (2005) framework, the review consisted of five key phases: (1) identifying the research questions, (2) identifying relevant studies, (3) study selection, (4) data charting process, and (5) collating, summarising and reporting the results.

Fig. 1 *PRISMA flow diagram of literature selection process*
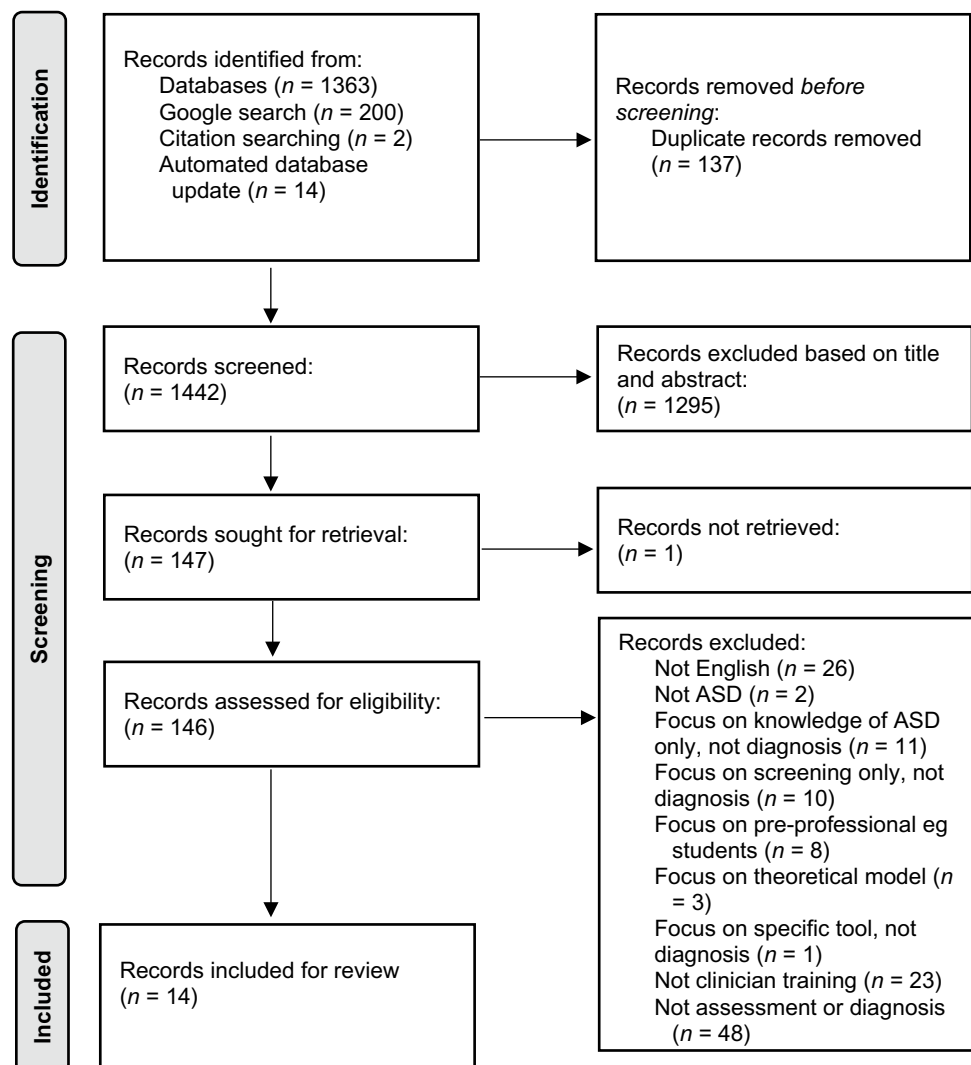
Search Strategy

In July 2022, an initial limited search for clinical training in ASD in two databases (PubMed and PsycINFO) was completed. The titles, abstracts, table of contents, and key words were analysed to construct the search terms with the assistance of a research librarian. Between 29 July 2022 and 6 September 2022, comprehensive and systematic searches were undertaken using PubMed, PsycINFO, PsycEXTRA, ERIC, and CINAHL. These databases were selected to ensure comprehensive coverage of literature available across disciplines in the medical and life sciences, behavioral and social psychology, allied health and nursing, and education as well as capturing grey literature (i.e., government guidelines, online advice from recognised healthcare professionals or health care companies and guidelines of healthcare and relevant professional organisations). The search query consisted of terms related to ASD diagnosis and continuing education for clinicians (see Table 1 for search strategy for the database PubMed).

A Google search was used to obtain difficult to locate or unpublished publicly available literature from government and other organisations. Google searches required the definition of a series of filtering criteria at the level of the search. The Google search strategy used the "advanced" function to search for sites containing the following five key terms: "training", "clinician", "autism", "ASD", and "diagnosis". As Google searches do not have limitations on the number of hits, a limit of 100 was set. The file type was set to "pdf" to target sites with documents available. To obtain documents from government and other organisations, separate searches were completed using ".gov" and ".org" site domains, respectively. The reference lists of literature included at the full text review were examined to identify any resources not yet included.

After the search execution and removal of duplicates, the primary author completed initial screening of titles and abstracts. Any literature that examined training and/or education of clinicians to assess and/or diagnose autism spectrum disorders (ASD), in any capacity was included. For example, literature that examined perceptions of clinician training and/or education in ASD diagnosis was included. To reflect the changing terminology over time, literature that referred to Asperger's Syndrome, Autism, and Autistic disorder were included. Details of inclusion and exclusion criteria for literature are presented in Table 2. The authors included articles with no empirical data to present perceptions and suggestions of professionals and/ or service users to understand and improve upon clinician training in ASD diagnosis.

A subset of documents (5%) was randomly selected and screened by an independent second reviewer, using Covidence (Veritas Health Innovation, 2015). Acceptable agreement was shown, with 85% agreement between reviewers, and all disagreements were resolved on discussion. The first author then screened full texts, with a subset of the final number of papers (10%) identified as suitable for inclusion, reviewed by an independent reviewer. Excellent agreement was shown, with 95% agreement between reviewers with disagreements resolved through consensus discussions by the full research team. Searches were undertaken from 29 July 2022, with records added until 6 September 2022.

Data Extraction

Extracted data included literature characteristics (training setting and country), participant details (profession and sample type), study design, training details (implemented training with and without training to train component, review of current practice, or training framework and plan), training testing and/or elicited feedback, and main findings. Data were extracted by the first author with consultation with the research team, as required.

Table 1 *Literature search terms*

Database	Search terms
PubMed	("education"[mh] OR adult education[tiab] OR adult education program*[tiab] OR education program*[tiab] OR continuing education[tiab] OR continuing medical education[tiab] OR adult training program*[tiab] OR adult learning[tiab] OR professional education[tiab] OR inservice training[tiab] OR inservice education[tiab] OR training pathway*[tiab] OR education pathway*[tiab] OR professional competenc*[tiab] OR clinical competenc*[tiab] OR train the trainer*[tiab] OR accredit*[tiab]) AND ("health personnel"[mh] OR clinician*[tiab] OR health personnel[tiab] OR clinical practice[tiab] OR clinical psych*[tiab] OR counselling psych*[tiab] OR counseling psych*[tiab] OR medical personnel[tiab] OR mental health personnel[tiab] OR physician*[tiab] OR psych*[tiab] OR allied health personnel[tiab] OR therapist*[tiab] OR health care professional*[tiab] OR nurse*[tiab] OR speech pathologist*[tiab]) AND ("Child Development Disorders, Pervasive"[mh] OR ASD assess*[tiab] OR ASD diagnos*[tiab] OR Autistic disorder[tiab] OR asperger*[tiab] OR autism spectrum disorder*[tiab] OR autis*[tiab] OR pervasive child development disorder*[tiab] OR pervasive development disorder*[tiab] OR autism spectrum condition*[tiab] OR ASC[tiab] OR early infantile autism[tiab])

Table 2 *Inclusion and exclusion criteria*

Inclusion criteria

  Any literature that examined training and/ or education of clinicians/professionals of any discipline, post-graduation, to assess and/or diagnose autism spectrum disorders (ASD), in any capacity. For example, literature that examined perceptions of clinician training and/or education in ASD diagnosis was included.

  To reflect the changing terminology over time, literature that referred to Asperger's Syndrome, Autism, and Autistic disorder were included.

  Published and unpublished, publicly available literature including any gender and age, set in any environment (e.g., schools, community services) and conducted in any country.

Exclusion Criteria

  General training and education in mental health or development.

  Literature that focused on students

  Literature that related to ASD but did not explore training or education.

  Literature that focused on training and/ or education for individuals with ASD, rather than for the assessment and/or diagnosis of ASD.

  Literature that only focused on specific tools or instruments, not ASD diagnosis

  Literature that only focused on screening for ASD, not diagnosis

  Literature not written in English

Synthesis of Results

Consistent with the Arksey and O'Malley (2005) framework, results are presented using a narrative account and tables of the existing literature. Literature was grouped by their scope and focus.

Results

Selection of Sources of Evidence

The literature search process is presented in Fig. 1. Following examination of the reference lists of the 12 included records, and other reviews within the field, a further 2 records were identified, producing a final set of 14 records included in the review. One of the identified records was comprised of two separate government documents, both detailing training components of the same national training framework. As such, for the purpose of the current research paper, these documents were dealt with as one record.

Characteristics of Sources of Evidence

Given the aim to clarify what training pathways exist in ASD diagnosis for clinicians and trainers, records were grouped according to focus: those that implemented training without a goal to train others ($n = 7$; 50%) and with a training-to-train component ($n = 3$; 21.4%), reviews of current training in practice ($n = 3$; 21.4%), and a training framework and plan (two documents dealt with as one record; 7.1%). A summary of key characteristics of included records can be found in Table 3. Where applicable, a summary of training features, report characteristics (training setting and country), participant details (profession and sample type), study design,

training testing and/or elicited feedback, and main findings were detailed.

Populations and Characteristics of Included Records

All records were published since 2009 and over half was from the USA (see Table 4). Primary care practitioners and medical specialists (including pediatricians, neurologists, and psychiatrists) were the most common participant groups. Eleven records implemented a research design while three implemented no research design or training testing. Instead, they outlined current training practices through survey information, provided a training and practice framework for staff working with individuals with ASD, and provided an overview of a nationwide training initiative (Bradbury et al., 2022; NHS Education for Scotland, 2014a; NHS Education for Scotland, 2014b; Health Resources and Services Administration, 2018; respectively). Sample sizes varied considerably from five (Warren et al., 2009) to 128 (Becevic et al., 2021) professionals in trial studies, and 27 (Gharder & Watson, 2019) to 798 (Dillenburger et al., 2016) professionals in mixed-methods studies (see Table 3 for further details).

Findings Relating to Training Pathways Available for Clinicians in ASD Diagnosis: Training Pathways Without 'Training to Train' Components

All seven of the studies that outlined diagnostic training used didactic education as part of the training program (Becevic et al., 2021; Hine et al., 2021; Mazurek et al., 2019; Samadi et al., 2016; Swanson et al., 2014; Warren et al., 2009). Five of the studies (71.4%) incorporated training in ASD screening tools, including two (Hine et al., 2021; Mazurek et al., 2019) that used the Screening Tool for Autism in Toddlers and Young Children (STAT; Stone

Table 3 Summary of study key characteristics for literature describing implemented training programs

Author/year	Implemented training	Training setting/ country	Identification of participants	Sample size (*n*)	Design	Training testing/elicit feedback	Key findings
Without training to train component							
Becevic et al. (2021)	Didactic presentations of EB screening, diagnostic and management case-based learning, presentations of complex ASD cases, expert and peer panels	Video-conferences held in 10 countries, including 37 US states	Retrospective review of ECHO Autism attendees (professional and non-professional) from September 2, 2015 to June 5, 2019	128 (26% response rate)	Nonrandomised retrospective cross-sectional survey design; quality improvement	Elicit feedback - Online post-virtual clinic surveys	Expert tele-mentoring of primary care providers through ECHO Autism project resulted in high satisfaction and increased self-efficacy in identifying and managing individuals with ASD. The use of real-life case discussions with peers and ASD specialists was viewed as beneficial for learners.
Hine et al. (2021)	Active, supervised learning experiences. Online learning modules, focus on the STAT, observations and in-vivo ASD evaluations	Developmental-behavioral pediatric rotations in Tennessee, USA	Medicine and pediatrics residents	63 (68% response rate)	Trial	Training testing - objective data regarding practice behavior. Elicit feedback - survey pre- and post- training	Increased administration of STAT (87%), diagnosis of ASD when doctor had not previously done so (42%), and in comfort level with every area of ASD-related competency. Increased perception of the appropriateness of this group assuming ASD-care roles.

Table 3 (continued)

Author/year	Implemented training	Training setting/country	Identification of participants	Sample size (n)	Design	Training testing/elicit feedback	Key findings
Mazurek et al. (2019)	In-person training (1.5 days), administration and interpretation of the STAT, bimonthly clinics (12 months) with didactic learning and case discussions with peers and ASD experts (via videoconferencing technology)	Primary care settings in underserved regions of Missouri, USA	Primary care practitioners working with children	18	Trial	Training testing - objective measures of practice behavior. Elicit feedback - pre- and post-training survey	The administration of screening measures significantly increased at child primary care well-visits; 89% of participants achieved reliability in administering the STAT. Significant improvement in self-efficacy scores post-training. All participants reported improved relationships with patients. Large majority of participants were accepting new referrals for ASD diagnostic evaluations by the end of program. Families avoided 173 miles of travel by receiving diagnostic services in their own communities. Prompt diagnostic evaluation in primary care was estimated to fast-track access to services by 2–6 months, based on current wait times.

Table 3 (continued)

Author/year	Implemented training	Training setting/country	Identification of participants	Sample size (n)	Design	Training testing/elicit feedback	Key findings
Samadi et al. (2016)	1 + 5 + 3-day didactic workshops, 2-day workshop using the Persian translation of the GARS2 with accreditation required and support from tutor	Four provinces in Iran	Professionals (therapists, education specialists and leadership roles) working with children	n trained = 67 n parents = 78 (60% response rate)	Trial	Elicit feedback–Survey with parent feedback	The recruitment of many post-graduate students and professionals assisted with screening and assessing a large number of children. Of those children who screened positive (n = 1579), only 131 (8.3%) parents responded to a follow-up invitation to complete a diagnostic assessment. All parents agreed their child had been well treated and 99% rated the appointment and assessment as acceptable.
Sengupta et al. (2022)	Biweekly clinics (12) using video-conferencing technology. Didactics and case-based discussions on EB screening, diagnosing, and managing ASD and its comorbidities with cultural adaptations outlined	India and other low- and middle-income countries from Asia and Africa	Recruitment through email and social media; primary care pediatricians, pediatricians with special interest in DBP, and others	62	Trial (mixed-methods: objective measures and survey)	Training testing–participation was measured and pre- and post-knowledge tests administered. Elicit feedback–survey pre- and post-training	Training was rated as highly satisfactory with moderate rates of attendance. Online learning enabled participants to attend across countries with minimal disruption to work schedules. Learners unanimously approved of interactive case-based discussions. Knowledge and self-efficacy improved following training.

Table 3 (continued)

Author/year	Implemented training	Training setting/country	Identification of participants	Sample size (n)	Design	Training testing/elicit feedback	Key findings
Swanson et al. (2014)	2-day workshop focusing on (a) administration and scoring of the M-CHAT and the STAT, (b) parent interview, (c) integration of information using DSM-framework, (d) explaining results to families, and (e) coding and billing	Pediatric providers, Nashville, USA	Community pediatric providers participating in program for 3.5 years	26 (95% response rate)	Trial (expansion on Pilot study; Warren et al., 2009)	Training testing–blinded, independent evaluation. Elicit feedback–retrospective survey of practice behavior	Number of children diagnosed within practice increased by 85%. Participants reported a significant increase in their level of comfort discussing ASD diagnoses. Of the 14 assessments independently reviewed, there was diagnostic agreement in 86% of cases (when forced choice was imposed). When providers were able to note uncertainty and uncertain cases were counted as agreements, agreement rose to 93% across the sample.
Warren et al. (2009)	2-day workshop with formal training using the M-CHAT and assessment interview, administration and interpretation of the STAT, parent interview, and billing/coding. Didactive and interactive training experiences	Community based physician practices in America	Pediatricians were targeted as they had established practices in underserved geographic locations	5	Pilot study	Training testing–independent evaluation process by blinded diagnostician	There was good agreement (71%) in diagnostic evaluations between pediatricians and independent diagnostic evaluations. Tendency to over diagnose when forced choices are used.

Table 3 (continued)

Author/year	Implemented training	Training setting/country	Identification of participants	Sample size (n)	Design	Training testing/elicit feedback	Key findings
With training-to-train component							
McNally Keehn et al. (2020)	Hub leadership received didactic education on ASD evaluation, administration and scoring of the STAT. Leadership then adapted local Hub training and clinical pathway. Clinical pathway (outlined) included a didactic curriculum, in vivo practice and supervision	Pediatric primary care practices, Indiana, USA	Pediatric primary care practices were in targeted regions known to have pediatricians who were actively engaged in early childhood initiatives. EAE Hub training included clinicians and support staff.	n primary care practices = 193 n community organisations = 136 n Hub training individuals = 90 n EAE Hub sites = 12	Trial; statewide tiered system approach	Training testing–system outcome measures (age at evaluation, wait time). Elicit feedback–trainee satisfaction measured overtime	Median latency from referral to EAE Hub evaluation was 62 days (compared with estimated 9- to 12-months in region). Targeted delivery of education, outreach, and intensive practice-based training appeared to assist in large numbers of children being assessed for ASD in primary care setting.
Pasco et al. (2014)	Three stage training: (1) 3-day training for experienced psychologists to provide support. Content included ASD theory, research and EB practice, and the provision of support and supervision (2) 6-day course on research, theory, problem-solving and intervention. (3) skills practice with 30 h of supervision or presentation of two detailed case studies. Internet-based courses for medical professionals ran concurrently with content relating to identification, diagnosis and treatment of ASDs	Nationwide health care initiative, Romania	Professionals (psychology, speech therapy, educational practitioners) working with children and young people with ASD; and medical professionals (general practitioners, pediatricians and psychiatrists)	62 (65% response rate)	Trial; nationwide initiative	Training testing - pre-and post-training knowledge questionnaires. Elicit feedback - Anonymous online follow-up survey	94% of survey respondents reported they were using the skills and concepts acquired during training; 76% considered that attending the training improved their overall professional performance. Potential transferable model for upskilling and increasing availability of diagnostic services in low- and middle-income countries.

Table 3 (continued)

Author/year	Implemented training	Training setting/country	Identification of participants	Sample size (n)	Design	Training testing/elicit feedback	Key findings
Health Resources and Services Administration (2018)	Fellowships provided for DBP: completed certifications to administer tools such as the ADOS. DBP also developed teaching skills, for example, through "teaching to teach" seminars, mentoring residents, and presenting to pediatric residents, peers and other learners and receiving feedback to improve their teaching skills	Clinical training in outpatient clinics, university-based centers, community clinics, schools, shelters, homes and virtual clinics using telehealth technology, USA	Developmental-Behavioral Pediatricians in the USA	n long-term trainees = 49 n medium-term trainees = 436	Evaluation - key findings outlined	–	Diagnostic services provided to nearly 35,000 children.
Current training practice review							
Dillenburger et al. (2016)	–	Statutory autism services sector, Northern Ireland	Recruitment by email and social media to health, social care and education staff from public and professional organisations and ASD charities and voluntary groups	n survey participants = 798; n interview participants = 31	Mixed-methods; survey and qualitative interview	–	Most professionals attended none or limited training (i.e. 1-2 h). Professionals wanted training to be more accessible, with multi-modal delivery, tailored to their role, relay 'real life' examples, and be informed by service users. Service users reported limited staff knowledge regarding diagnosis, especially for women with ASD. They reported delays in diagnosis as a result of a shortage of staff trained in ASD diagnostic procedures.

Table 3 (continued)

Author/year	Implemented training	Training setting/ country	Identification of participants	Sample size (*n*)	Design	Training testing/elicit feedback	Key findings
Bradbury et al. (2022)	–	No geographic limitations but most respondents from USA	Recruitment through several neuropsychology list serves	365	Survey	–	A large number of respondents (92%) received training through formal course work or supervised training - intensity and/ or duration of training not specified. Supervised clinical training experience (e.g., practicum, internship, post-doctoral fellowship; 78.5%), workshops/ CEs (77.4%), and self-study (70.6%) were identified as the most common means of obtaining ASD training. 42% wanted more training to enhance comfort in accurately identifying ASD.

Table 3 (continued)

Author/year	Implemented training	Training setting/country	Identification of participants	Sample size (n)	Design	Training testing/elicit feedback	Key findings
Ghaderi and Watson (2019)	–	Ontario, Canada	Physicians who would encounter individuals with ASD	n questionnaire = 27; n semi-structured interview = 5	Mixed-methods; survey and qualitative interview	–	Most participants did not feel that they received sufficient knowledge and training with regards to diagnosis and treatment of DD during their undergraduate medical education. Less than half found their professional training "very helpful". High rates (85.2%) of CE attendance but these were not considered helpful in improving knowledge of diagnosis. Work experience enhanced perceived knowledge about the diagnosis and treatment of ASD. Collaboration among healthcare professionals enhances the ASD diagnostic process.
Training framework and plan							
NHS Education for Scotland (2014a) & NHS Education for Scotland (2014b)	Recommended - Framework and plan of recommended training in a tiered approach, where the training provided is matched to the knowledge and skills required	A framework and plan for staff working with people with ASDs, their families and carers, Scotland	–	–	–	–	–

n number of participants; *h* hours; *ASD* autism spectrum disorder; *DD* developmental disorder; *EB* evidence-based; *DSM* Diagnostic and Statistical Manual; *DBP* Developmental-behavioral pediatrics; *ECHO* Extension for Community Healthcare Outcomes; *EAE* Early Autism Evaluation; *STAT* Screening Tool for Autism in Toddlers; *GARS2* Gilliam Autism Rating Scale-2; *M-CHAT* Modified Checklist for Autism in Toddlers; *ADOS* Autism Diagnostic Observation Schedule; *CE* continuing education

Table 4 *Summary of key study population and design characteristics*

Year of publication	N	%
Prior to 2009	0	0
2009–2017	6	42.9
2018–2019	3	21.4
2020–2022	5	35.7
Country		
USA	8	57.1
Other Western countries (e.g.,UK, Canada)	3	21.4
Low-middle income countries (e.g., Iran, India, Romania)	3	21.4
Participant discipline		
Primary Care Practitioners & Medical Specialists	8	57.1
Allied health	5	35.7
Methodology		
Research design	11	78.6
Trial or pilot study	8	72.7
Mixed methods approach (survey & qualitative data)	2	18.2
Cross sectional survey	1	9.1

et al., 2000), two (Swanson et al., 2014; Warren et al., 2009) that used the STAT and the Modified Checklist for Autism in Toddlers (M-CHAT; Robins et al., 2001), and one (Samadi et al., 2016) included a Persian translation of the Gilliam Autism Rating Scale (GARS2; Gilliam, 2001).

Mode of training varied with four studies delivering in-person training (57.1%; Swanson et al., 2014; Warren et al., 2009; Samadi et al., 2016, Mazurek et al., 2019), three studies utilised video-conferencing technology (42.9%; Becevic et al., 2021; Sengupta et al., 2022; Mazurek et al., 2019), while Hine et al. (2021) employed online and in-vivo training methods (14.3%). Of the seven studies, five (71.4%) reported the use of assisted learning through supervision (Hine et al., 2021; Samadi et al., 2016) or peer consultation with experts in ASD (Becevic et al., 2021; Mazurek et al., 2019; Sengupta et al., 2022). Workshops were described in four studies with durations ranging from 1.5 (Mazurek et al., 2019) to 2 days (Samadi et al., 2016; Swanson et al., 2014; Warren et al., 2009).

Two studies employed the use of blinded, independent evaluations to test a diagnostic training trial (Swanson et al., 2014; Warren et al., 2009). Good agreement was observed between the trainee and independent reviewer, when a diagnostic decision was forced (71–86%; Warren et al., 2009 and Swanson et al., 2014, respectively). This result was obtained following a 2-day workshop with formal training that included: using the M-CHAT and assessment interview, administration and interpretation of the STAT, developmentally appropriate parent interviews, and billing/coding. Key outcomes indicated significant over-identification of ASD when a diagnostic choice was forced (Warren et al., 2009) as well as an 85% increase in

the number of children diagnosed within the participating practice (Swanson et al., 2014).

Four studies implemented objective measures to test training programs including the review of practice behavior (Hine et al., 2021; Mazurek et al., 2019; Sengupta et al., 2022; Swanson et al., 2014), pre- and post-training assessment of knowledge, and clinic participation (Sengupta et al., 2022). Main findings from these quantitative data showed a significant increase in knowledge and self-efficacy following training, satisfactory attendance with the majority ($n = 48$, 77.5%) attending more than 75% of the training sessions (10 or more sessions), increased administration of the STAT (Hine et al., 2021), and increased number of ASD diagnoses performed (Swanson et al., 2014; Hine et al., 2021).

Qualitative data were obtained using a survey in most studies ($n = 6$, 85.7%). Of the studies including a survey, 83.3% ($n = 5$) reviewed learners' confidence, self-efficacy or comfort working with individuals with ASD following training, with improvement noted in all studies (Becevic et al., 2021; Hine et al., 2021; Mazurek et al., 2019; Sengupta et al., 2022; Swanson et al., 2014). Additional findings included that training improved relationships with patients (Mazurek et al., 2019) and increased perception of appropriateness of providing care to ASD groups (Hine et al., 2021), professional learners endorsed the use of real-life case discussions (Becevic et al., 2021; Sengupta et al., 2022), and tele-mentoring was rated as highly satisfactory by participants (Becevic et al., 2021; Sengupta et al., 2022).

Findings Relating to Training Pathways Available for Clinicians in ASD Diagnosis: Training Pathways with 'Training to Train' Components

Three records noted a training component with a goal to teach others (McNally Keehn et al., 2020; Pasco et al., 2014; Health Resources and Services Administration, 2018). Each record detailed a large-scale training approach, with one American study focusing on a statewide tiered system to enhance and streamline ASD evaluation (McNally Keehn et al., 2020). Moreover, a Romanian study employed a 3-year training and development project to improve diagnostic and intervention services at a national level (Pasco et al., 2014). The final record evaluated a pediatric training program across seven states in the USA (Health Resources and Services Administration, 2018).

All three records targeted more experienced or senior professionals to complete their training to train components, to support less qualified or experienced learners. In their tiered approach, McNally Keehn and colleagues (2020) provided training to leadership teams, which included "didactic education on ASD evaluation and certification in administration and scoring of the STAT" (p.3). The training was described as individualised and intensive and was delivered by the

developers of the STAT. The leadership team was then tasked with adapting a model of training in their evaluation hubs (McNally Keehn et al., 2020). In a separate approach, a three-stage training program focused on first recruiting and training experienced psychologists to provide support to other clinicians, who would be involved in the next two-stages of training (Pasco et al., 2014). Program content included ASD theory, research and evidence-based practice as well as training on the provision of support and supervision (Pasco et al., 2014). Lastly, a pediatric fellowship training program included curriculum to support the development of teaching skills to assist in teaching future learners (Health Resources and Services Administration, 2018). For example, fellows mentored residents and medical students, attended teaching to teach seminars, presented to residents, peers, and other learners, and developed seminars.

Training pathways without training-to-train components were also described in two of these studies (66.7%; McNally Keehn et al., 2020; Pasco et al., 2014). In line with the training detailed above, a didactic curriculum was included in both training programs described (McNally Keehn et al., 2020; Pasco et al., 2014). In addition, McNally Keen and colleagues (2020) incorporated the use of ASD and developmental screening tools in their clinical training, including the Ages and Stages Questionnaires- Third Edition (ASQ-3; Squires et al., 2009), M-CHAT,and the STAT. However, Pasco and colleagues (2014) employed online training courses with content relating to the identification, diagnosis and treatment of ASDs. Their courses addressed the needs of GPs, pediatricians and psychiatrists and were certified by the Romanian College of Physicians. Supervision was provided in both training models (McNally Keehn et al., 2020; Pasco et al., 2014). Contrary to the abovementioned records, these studies outlined a clinical pathway or published their training material (McNally Keehn et al., 2020; Pasco et al., 2014, respectively).

Key findings from records that included a training-to-train component were that large numbers of children were assessed for ASD in primary care settings (McNally Keehn, 2020) and diagnostic services were also provided to nearly 35,000 children (Health Resources and Services Administration, 2018). Median latency from referral to evaluation was reduced to 62 days, from an estimated 9- to 12- months (McNally Keehn, 2020). Using a nationwide, online training approach, 613 doctors received certification following completion of two online courses (Pasco et al., 2014). According to an online survey among course graduates ($n=118$), 51% of respondents had incorporated their learnings into practice, with an increase noted in the identification of signs of ASD in children (Pasco et al., 2014). The nationwide services were accessed by 1005 individuals with ASDs and service components included assessment, intervention or counselling (Pasco et al., 2014).

Current Training Practice Review

Three studies obtained survey data to review current professional training practices in the assessment and diagnosis of ASD (Dillenburger et al., 2016; Bradbury et al., 2022; Ghaderi & Watson, 2019). Only one study captured the duration of training received, with fewer than one-third ($n=165$; 29%) of health and social care staff having completed basic (i.e. 1–2 h) post-qualifying, in-service ASD awareness training (Dillenburger et al., 2016). One study reviewed common means of obtaining ASD training amongst 367 surveyed clinical neuropsychologists (Bradbury et al., 2022), with respondents indicating they undertook supervised clinical training experience (e.g., practicum, internship, post-doctoral fellowship; $n=288$; 78.5%), workshops/ continuing education ($n=284$; 77.4%), and self-study ($n=259$; 70.6%). Lastly, an additional study reviewed the usefulness of education about ASD in the medical education of 27 physicians (Ghaderi & Watson, 2019). Results indicated that less than half ($n=11$; 42%) found their professional training "very helpful" and despite high rates ($n=23$; 85.2%) of continuing education attendance, this mode of training was not considered helpful in improving knowledge of ASD diagnosis.

All three studies noted respondents rated their training in ASD diagnosis as insufficient (Ghaderi & Watson, 2019) or reported a desire for additional training (Dillenburger et al., 2016; Bradbury et al., 2022). In particular, Dillenburger and colleagues (2016) noted that trained professionals expressed a desire for training to be more accessible, with multi-modal delivery, real examples of individuals with ASD, and to be informed by service users. Similarly, physicians working with individuals with ASD noted that their experience enhanced knowledge about the diagnosis and treatment of ASD and collaboration among healthcare professionals enhanced the ASD diagnostic process (Ghaderi & Watson, 2019). One study reviewed qualitative survey data from service users who reported limited staff knowledge regarding diagnosis, especially for women with ASD. In addition, service users reported delays in diagnosis because of a shortage of staff trained in ASD diagnostic procedures (Dillenburger et al., 2016).

Training Framework and Plan

The NES Autism Training Framework (NHS Education for Scotland, 2014a) describes three areas of training relevant to health and social care settings, with one area including identification, screening, assessment and diagnosis. Within this area of training, four levels of skills and knowledge are recommended dependent on the degree and frequency of contact staff have with individuals with ASD and their families. According to the framework, all clinicians should be "autism informed" (first level) while the two most advanced

levels, that is, levels three and four, encapsulate enhanced and highly specialist knowledge and skills, respectively. These levels include additional knowledge and skills relating to the assessment and diagnosis of ASD as well as training and supervising others in these skills. Table 5 details the core elements of training that are recommended at enhanced and specialist levels of practice (p. 39 & 49; NHS Education for Scotland, 2014a).

The training framework is accompanied by the NES Training Plan for ASD (NHS Education for Scotland, 2014b), which summarises available training and the extent to which it meets recommendations of the NES Autism Training Framework (NHS Education for Scotland, 2014a), and notes relevant training gaps and challenges (NHS Education for Scotland, 2014b). Similar to results from training practice reviews (Dillenburger et al., 2016; Bradbury et al., 2022; Ghaderi & Watson, 2019), it was preferred that training at the enhanced and expertise levels included videos or input from those with lived experience of ASD. Mode of delivery was recommended to be face-to-face and an opportunity for evaluation was endorsed. At the expertise level, input from other experts was also recommended.

Discussion

The aim of the present study was to map the literature relevant to post-graduation clinician training and/ or education in the assessment and diagnosis of ASD. Specifically, we aimed to understand what is known about the training and educational pathways available for clinicians working in health and related settings seeking to build competency in the assessment and diagnosis of ASD and in training others to build aptitude in the area. We reviewed a total of 14 records, including published studies and grey literature. As a primary objective of a scoping review is to provide an overview of the existing evidence irrespective of methodological quality (Peters et al., 2015), all findings were considered and are detailed below.

Our findings indicate a paucity of research focusing specifically on ASD-specific training pathways available to obtain competency in the diagnostic evaluation of ASD. The predominant theme amongst the records included the use of a combination of training approaches, often didactic learning, and accreditation in the administration of an ASD specific assessment tool. Didactic training resources were only published in one record (Pasco et al., 2014; link not active), and therefore it was not possible to compare the content of current training practices. However, where didactic training was discussed, there was a focus on ASD theory and research, the assessment interview, case discussions, and evidence-based practice. Of the ASD diagnostic tools used in training, only one record (Health Resources and Services Administration, 2018) incorporated an assessment tool with a strong evidence base (i.e., the ADOS; Falkmer et al., 2013; Randall et al., 2018). This suggests that a review of current ASD training curriculum is required to ensure inclusion of ASD diagnostic tools with a strong evidence base. In addition, global accessibility of training programs would assist future research aimed at determining their quality and effectiveness, as well as enhancing learning opportunities for health professionals and organisations tasked with assessing and diagnosing ASD. One example of a clearly outlined training framework and plan can be seen in the NHS Education for Scotland recommended staff training (NHS Education for Scotland, 2014a; NHS Education for Scotland, 2014b). This example shows a promising format and guide to further develop globally accessible training programs.

Table 5 *NHS Education for Scotland recommended staff training for required knowledge and skill*

Training	Core elements of training
ASD skilled	
Screening, Assessment and Diagnosis of ASD[a]	How ASD is defined and diagnosed
	Screening for ASD
	Co-occurring conditions and differential diagnosis
	Sensory sensitivities
	Referral or signposting to more specialist services – pathway/ seeking consultation/referral route
ASD enhanced	
Screening, Assessment and Diagnosis of ASD[a]	How ASD is defined and diagnosed
Co-occurring conditions and Differential diagnosis	Diagnostic systems and criteria
	Screening and diagnostic tools for ASD
	Integrated assessments
	Outcome and signposting to more specialist services
	Co-occuring conditions and differential diagnoses
	Neurodevelopmental conditions
	Mental health problems

[a]*Assumes that ASD Awareness and Diversity is covered elsewhere*

However, it is important to note important differences and potential barriers to internationally relevant programs being applicable at the local level, such as access and proximity to providers, policies related to assessment and diagnosis and the professionals likely to be involved. Further, professionals working across different countries operate under different standards such as whether DSM-V and ICD-11 criteria are used. These factors likely explain the lack of global training programs to date.

Findings also showed that training was provided across a variety of modes including in-vivo learning with individuals with ASD symptomology, face-to-face with trainers, teleconferencing and through online modules. The use of supervision and/ or expert and peer support was apparent in the included records. Where training-to-train programs were reviewed, these were implemented as part of longer-term projects and targeted at experienced and senior staff. These results suggest a system-wide application of training, such as that implemented by McNally Keehn and colleagues (2020), enables experienced staff to supervise those in more junior positions and shows promise in building diagnostic capacity. Overall, professionals were dissatisfied with the amount of post-graduate training they received. Nevertheless, following training, clinicians unanimously reported increases in confidence and service provision. The self-reported positive impact of training for health professionals reiterates the importance of providing post-graduate, ASD-specific training to those working with individuals with ASD. However, high quality clinical research trials will be fundamental in determining the best approaches to training to build capacity in ASD diagnosis. In addition, clear guidelines of the clinical competencies/ expertise required to assess for and diagnose ASD are required to standardise training and clinical and research outcomes.

Regarding population features and characteristics, parallel to the increasing rates of ASD diagnoses (Hyman et al., 2020), research in the field appears to be gaining momentum with 35.7% of included records being published since 2020. Most of the research was completed with Western populations (78.5%), with over half (57.1%) based in the USA. Lower-to-middle income countries represented only 21.4% of the reports. The included literature showed over half of those engaged in training were medical professionals, with most other studies including allied health professionals. Our search terms focused on clinicians working in health and related settings. It is likely that there are a range of professionals who were not included as a result, in particular, those working in educational settings where ASD diagnoses are also undertaken. Collaboration in training across sectors is likely to be beneficial.

While only literature published in English was included, available data failed to equally represent a diverse demographic, which may exacerbate the diagnostic discrepancy that already exists for children from lower income, minority, and rural backgrounds (Mandell et al., 2002, 2005). Further, most training focused on young children, whereas clinicians are increasingly requiring expertise to diagnose those presenting later, including in adulthood. To develop standards for ASD training and diagnosis, the collection of data that captures broad demographic and socioeconomic regions is warranted.

One study that surveyed service users on their diagnostic experiences noted limited staff knowledge, especially for women with ASD (Dillenburger et al., 2016). This finding was consistent with growing research that supports gender specificity in ASD symptom presentation (Green et al., 2019). Further, differing phenotypes, psychiatric comorbidities, and level of "camouflaging" (behavioral coping strategies to conceal symptoms for use in social situations) contribute to an under-diagnosis in adolescent girls and women (Green et al., 2019). This gender disparity in clinical presentation impacts on the timeliness of diagnosis, and subsequent treatment of ASD and quality of life (Green et al., 2019). Implementing gender specificity in ASD diagnostic criteria could result in earlier diagnosis and treatment for girls and considerably reduce the psychological burden for these individuals.

Methodological characteristics varied across the included records and 11 studies with research designs were available in the included literature. Of those, 72.7% were pilot studies or trials, suggesting that ASD training is an emerging research area, and associated outcomes from these studies may require replication to establish a strong evidence base. Only two studies employed an independent evaluation process to test training (Warren et al., 2009; Swanson et al., 2014). While good agreement was observed between the trainee and independent reviewer (71–86%; Warren et al., 2009 and Swanson et al., 2014, respectively), there was a tendency to over diagnose when forced diagnostic choices were imposed (Warren et al., 2009). Moreover, one study did not include a measure to review the additive value of the training model over the screening tools employed (Warren et al., 2009). Additionally, the number of participants who achieved reliability in tool administration was not reported, nor was the process of determining the presence or absence of ASD (Swanson et al., 2014). This highlights the potential concerns regarding misclassification of ASD within the professional community (Warren et al., 2009; Swanson et al., 2014). The use of a training approach that includes ongoing training and a risk-stratified process for diagnostic purpose is warranted (Mazurek et al., 2019). Further, randomised controlled trials that allow training outcomes to be reviewed independent of ASD diagnostic measures, would enhance our understanding of training effectiveness and further assist in developing a stronger evidence-base regarding appropriate training in ASD diagnosis. Ultimately, the development

of standards for ASD training and diagnosis is paramount to reduce over- and under-diagnosis, and minimise the associated psychological burden.

Another key objective of the current study included identifying themes in the literature related to ASD diagnostic training. Three records assessed diagnostic training in low-to-middle income countries and focused on upskilling and increasing services to areas of economic and social disadvantage. This objective was approached using both nationwide, resource intensive training, as well as by telementoring of small groups of professionals. While each approach indicated positive results, such as increased scope of practice for professionals and boosted service availability (Samadi et al., 2016; Sengupta et al., 2022; Pasco et al., 2014), research in the area was in the trial phase. As such, it was not possible to compare each approach. Nevertheless, given the reported shortages of skilled professionals in ASD assessment (Gordon-Lipkin et al., 2016), and limited resources across many health settings, it may be beneficial to evaluate the cost-benefit of these low cost, high availability training pathways such as that offered through telementoring compared with resource-intensive, nationwide initiatives.

The current scoping review has several limitations. We chose to focus on training and education that focused specifically on assessment and diagnosis of ASD, which meant that we did not include more encompassing training that may have a component focusing on ASD diagnosis. For example, in North America the Leadership Education in Neurodevelopmental and Related Disabilities (LEND) program provides interdisciplinary training in developmental-behavioral practice including ASD diagnosis and is another model of training that also has a key role in clinician training (Leff et al., 2015). Further, we did not include work which only focused on specific tools or instruments, rather than making an ASD diagnosis and acknowledge that these assessments can contribute to diagnoses. In addition, some approaches focused more on training to screen with less attention to diagnosis, and so may have resulted in limited diagnostic assessment competency for participants. The study was limited to the advanced Google search for the first 100 sites identified possibly leading to missing some data; however, given the degree of overlap in information between sites, most relevant work was likely included. In addition, the search was limited to English, which may have contributed to the over-representation of western and English-speaking record samples retrieved. However, we know that many individual organisations and institutions have developed their own training and education programs (including our own) and future work should consider ways to include these programs which are not currently publicly available. Cultural beliefs surrounding the etiology of ASD vary widely (e.g., Welterlin & LaRue, 2007) and are likely to impact on the training and diagnostic experiences of health professionals. Reviewing literature from a greater diversity of countries would provide insights into such cultural differences.

Implications for Future Research and Practice

There is a need for further research to evaluate the effectiveness—to undertake accurate ASD diagnostic assessments—of clinician training and education in health and related settings. This scoping review did not identify an accessible training program that recognised factors such as gender nuances, the genetic aetiology of ASD nor diagnostic discrepancies in children from lower income, minority, and rural background: there is a need for more research in these areas. Furthermore, the scope and content of ASD diagnostic training for clinicians from non-English speaking countries needs to be investigated. This would facilitate the efficacy of training advice relevant to a diversity of culture and understanding in mental health. This may also promote increased understanding by clinicians of the need for cultural awareness when assessing individuals with ASD in all settings. The need for input into training from those with lived experience of ASD is also clear, and not yet being routinely included. Further, this review highlighted the need for more robust pre-service and in-service training on autism more generally, as well as training on how issues of diversity (e.g., gender, sexuality, linguistic) contribute to such assessments.

There is scope to integrate training from medical professionals outside of the typical fields currently involved. For example, specific information regarding the contribution of genetic variants to major psychiatric disorders and treatment responses is now available (GWAS Catalog, n.d.). There is substantial evidence for heritability in ASD (Vorstman et al., 2017), suggesting a strong genetic component. Moreover, genetic testing is recommended in ASD assessments in the USA but is rarely used in a clinical setting (Certification Examination in Psychiatry, 2017). As such, integrating clinical geneticists into ASD diagnostic training may enhance understanding and diagnostic capabilities, in some cases, as well as increase the number of diagnosticians in the field. The incorporation of genetic training is also important as the intersection of genetics with clinical practice increases (Nurnberger et al., 2018).

Conclusions

The lack of evidence to support ASD diagnostic training pathways for clinicians in health and related settings post-graduation poses a significant challenge for clinicians and service users. The aim of this scoping review was to highlight current knowledge in the literature relating to ASD-specific diagnostic training practices to identify current

standards of training and limitations or knowledge gaps. These findings are crucial to guide the development of a systematic review of ASD diagnostic training and the future implementation of diagnostic standards into routine clinical practice.

The current scoping review demonstrates post-graduate training has the potential to enhance clinician confidence and increase service provision in ASD assessment and diagnosis. There should be an emphasis on incorporating the use of efficacious ASD assessment tools in training programs. Moreover, system-wide training approaches show promise in building large-scale, diagnostic capacity and the use of tele-mentoring offers a cost-effective, convenient mode of training delivery. However, the limited evidence found suggests that high quality research will be fundamental in determining how to build clinician capacity in ASD assessment and diagnosis and to ascertain whether training pathways are a necessary component. Initial studies may benefit from establishing the clinician and trainer competencies required to undertake ASD assessment and diagnosis.

Declarations

Conflict of interest The authors declare that they have no relevant financial or non-financial interests to disclose.

Ethical Approval As this study is a scoping review, ethics approvals and consents were not required.

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