Review

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The impact of autism-related training programs on physician knowledge, self-efficacy, and practice behavior: A systematic review

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Abstract

One in 44 children in the United States is diagnosed with autism spectrum disorder. Despite this, physicians receive little clinical training, inclusive of autistic patients. It is therefore not surprising that physicians report low levels of confidence in their ability to provide care to autistic individuals. This review examines the impact of specialized training programs on physicians' knowledge of autism and their self-efficacy and practice behavior related to caring for autistic patients. A search of MEDLINE, PsycINFO, PubMed, ERIC, Web of Science, and Scopus was performed to identify studies evaluating specialized autism training programs for physicians or physician trainees. Seventeen studies were found to meet the inclusion criteria. The Medical Education Research Study Quality Instrument was utilized to objectively measure the quality of the included studies. Based on the results reported in these studies, specialized autism training programs were associated with positive changes in physician knowledge and self-efficacy related to the care of autistic patients. Other than short-term increases in screening for autism, no other changes in physician behavior were studied. These results call for the development and evaluation of autism training programs that focus on improving physician behavior and patient outcomes.

Lay abstract

Autism spectrum disorder is estimated to impact 1.5 million children and almost 5.5 million adults. However, most physicians do not receive training on how to provide care to this increasingly large group of people. After performing a systematic review of the literature and screening over 4,500 unique articles focused on the effectiveness of autism-specific training programs designed for physicians and physician trainees, we determined that 17 studies met the pre-determined criteria for inclusion in this systematic review. The results reported by these studies suggest that by completing specialized training programs related to autism, physicians were more knowledgeable on topics related to the condition, more confident in their ability to provide care to autistic individuals, and more likely to screen their patients for autism spectrum disorder. However, further studies with higher quality data are needed to validate these findings and provide additional insight on the ability of these programs to improve physician behavior and patient outcomes. We are therefore advocating that medical educators develop and evaluate specialized autism training programs with an increased focus on improving physician behavior related to all aspects of providing care to autistic people.

Keywords

autism spectrum disorders, health services, professional development

Introduction

Autism Spectrum Disorder (ASD) is a phenotypically heterogeneous condition characterized by challenges with social interactions and the presence of stereotyped or repetitive behaviors, restricted interests or activities, and sensory aberrations (American Psychiatric Association, 2013). The condition is associated with a wide spectrum of

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developmental trajectories and co-occurring conditions such as anxiety, attention-deficit/hyperactive disorder, and epilepsy (Masi et al., 2017). The number of individuals diagnosed with ASD has increased rapidly in the past 30 years. Despite the fact that the current ASD prevalence is estimated to be one in every 44 children in the United States (Maenner et al., 2021), the healthcare system has not adapted to meet the needs of these individuals. This means that the estimated 1.5 million autistic children and almost 5.5 million autistic adults in the United States (Dietz et al., 2020; Kogan et al., 2018) are often left without access to high-quality medical care.

Autistic individuals face unique challenges with accessing the healthcare system. Physicians have cited many barriers to care for autistic children, including inadequate reimbursement, limited time for patient visits, lack of confidence in managing behaviors that may be associated with autism, lack of prior training on the condition, and lack of knowledge and resources related to diagnosing and treating autistic children (Mazurek, Harkins, et al., 2020). Compared to neurotypical children, autistic children experience a four-fold higher odds ratio of having unmet healthcare needs (Karpur et al., 2019), which may contribute to their lower health-related quality of life (Kuhlthau et al., 2010). Autistic adults are similarly at an increased risk of not only experiencing unmet physical and mental healthcare needs but also developing preventable conditions such as obesity, hyperlipidemia, and hypertension (Nicolaidis et al., 2013; Tyler et al., 2011). Racial disparities often exacerbate the above challenges. Previous studies have found that parents of Black and Latino autistic children not only report increased difficulty accessing healthcare but also experience challenges with finding providers who spend enough time with the patient during the visit, listen carefully, take family values and customs into consideration, and include family members as partners in the healthcare process (Bishop-Fitzpatrick & Kind, 2017). It is likely that the poor health outcomes of autistic individuals can be traced back to these aforementioned barriers of care, suggesting that if we are able to overcome some of these challenges, we could improve the quality of care autistic individuals receive.

In addition to the many barriers to care mentioned above, a lack of physician knowledge and self-efficacy, or confidence, often makes it challenging for autistic individuals to find physicians who are able to provide them with high-quality care. One study of healthcare providers at Kaiser Permanente Northern California found that 77% reported only fair or poor knowledge and/or skills in caring for autistic adults (Zerbo et al., 2015). This low level of physician self-efficacy has also been found in medical students and pediatric residents at The University of Alabama at Birmingham and at three universities in Palestine (Austriaco et al., 2019; Shawahna et al., 2021). One explanation for these findings may be the lack of autism-specific curricula in medical education. A survey of primary care providers in the United States caring for autistic children found that 57% of those surveyed cited a lack of prior training related to autism as a barrier to providing care to this population (Mazurek, Harkins, et al., 2020). It is possible that this at least partially results from the lack of condition-specific requirements mandated by accrediting agencies such as the Accreditation Council for Graduate Medical Education ("Common Program Requirements"). Without mandating that trainees receive clinical exposure to autistic patients, physicians can complete their training without the tools needed to provide autistic people with adequate healthcare. Improving access to autism-related medical education can therefore be proposed as a potential mechanism to improve the quality of healthcare received by autistic individuals.

The current review identifies existing autism-related educational programs for medical students, residents, fellows, and physicians. The goal of this review is twofold. By synthesizing the results of these studies, we aim to examine the impact that autism-specific training programs have on improving physician knowledge, self-efficacy, and practice behavior related to caring for autistic patients. Furthermore, we strive to identify gaps in the literature that should be addressed in future studies to provide a stronger foundation for the efficacy of these specialized training programs.

Methods

Search strategy

An initial search of MEDLINE, PsycINFO, PubMed, ERIC, Web of Science, and Scopus was performed on 24 January 2021. An additional search was performed on 7 May 2021, using the same search criteria. The search strategy was designed to capture all studies that focused on preparing physicians or physician trainees to care for autistic individuals. The search strategy utilized in this review was as follows: ("autism" or "ASD" or "Asperger") and ("doctor" or "physician" or "clinician" or "practitioner*" or "pediatrician*" or "psychiatrist*" or "medical student*" or "residen*") and ("workshop" or "training" or "educ*" or "curriculum" or "course" or "fellowship" or "rotation" or "knowledge" or "attitudes").

Eligibility criteria

To be included in this review, peer-reviewed original research articles needed to discuss the implement and evaluation of specialized autism training programs that are designed for physicians or physician trainees (medical students, residents, or fellows), have the majority of participants (greater than 50%) consist of physicians or physician trainees, focus specifically on ASD, and relate to improving physician knowledge, self-efficacy, or practice behavior regarding autism. Articles were excluded if they did not

focus on physician education and autism, were not experimental in nature or did not present original data, had fewer than 50% of study participants identified as physicians or physician trainees, only reported physician knowledge/attitudes toward caring for autistic individuals, focused on general intellectual/developmental disabilities rather than autism specifically, did not implement the described curriculum, or were conference abstracts or dissertation papers.

Study selection and quality assessment

L.C. performed the literature search and screened all articles for inclusion. Any initial questions about eligibility were referred to L.K.F. and both authors came to a consensus about inclusion. L.C. then conducted a full-text analysis of selected articles to determine final eligibility. After the full-text analysis was completed, additional articles that did not meet eligibility criteria were excluded. Both authors then reviewed the final collection of articles and came to a consensus on the studies that met the inclusion criteria of the present review.

The Medical Education Research Study Quality Instrument (MERSQI), a 10-item survey assessing study quality in the domains of design, sampling, data, validity, analysis, and outcomes (Reed et al., 2007), was utilized to objectively measure the quality of studies included in the review. Reed et al. did not provide MERSQI cutoff scores to facilitate categorizing studies as high- or low-quality. However, one systematic review utilized a MERSQI score of 14 to denote a high-quality study (Lin et al., 2016). Given that the maximum MERSQI score is 18, this high-quality range spans 4 points. To allow for balance in categorizing low-, medium-, and high-quality studies, it is intuitive to assign a range of 4 points to the low-quality range as well. The minimum score possible using the MERSQI tool is 5; therefore, studies earning 5 to 9 points will be considered low-quality, and studies earning 9 to 14 points will be considered medium-quality. These cutoffs can be further justified when evaluating the MERSQI scores received by articles included in the broader medical education literature. For example, the average MERSQI score reported in the study that created the tool was 9.95 (Reed et al., 2007). In addition, a synthesis of 28 medical education literature reviews reported an overall average MERSQI score of 11.3 (Cook & Reed, 2015). The mean MERSQI scores for both studies are within the medium-quality range, further justifying our cut-off ranges for categorizing studies based on MERSQI scores.

To provide further rigor to the quality assessment process, the authors came to a mutual conclusion on how to interpret all elements of the MERSQI scale and developed clarifying operational definitions when deemed necessary. These operational definitions used to grade the articles in this review are found in Supplementary Table 1. Both authors independently scored all articles utilizing the MERSQI scale. When there was a discrepancy in scoring, both authors re-scored the article, discussed the reasoning behind the initial score given, and came to a mutual conclusion on the final score.

Data abstraction

During data abstraction, in-depth information about the included educational programs, including the content, delivery method, duration, and frequency, was noted for all included studies. Special attention was also paid to the learning objectives, outcome measures, results, and trainee demographics of each specialized training program. After an initial review of the data, the authors identified trends in the literature and organized important findings into tables that highlighted common themes between articles. The dataset was organized into the domains of knowledge, self-efficacy, and practice behavior to mirror previous work that utilized these domains to outline the desired educational outcomes of disability-related medical training programs (Minihan et al., 2011). Relevant information such as the program's target patient age and study design were also noted.

Results

Study selection

After the removal of duplicates, our search yielded 4,507 unique articles. Following an initial screen, 4,414 were excluded—3,938 (89%) were not related to physician education and autism, 404 (9%) were not original research, 50 (1%) studied physician knowledge/attitudes toward autism but did not present a novel educational program, 19 ($<1\%$) were conference abstracts, and 3 ($<1\%$) presented educational programs related to general developmental disability. After a full-text review of 93 articles, 17 were determined to meet the inclusion criteria for the systematic review. A summary of the results of the 17 included studies is shown in Table 1. Figure 1 provides an overview of our review process.

As stated above, the MERSQI (Reed et al., 2007) was utilized to objectively measure the quality of the included studies. Studies could earn a total of 18 points, and the final scores received by each article can be seen in Table 1. Across the 17 studies included in this review, the mean MERSQI score was 9.9, and the range of scores received by studies was 5–12. No studies met the high-quality cutoff (MERSQI 14), but 71% (12 out of 17) were categorized as medium-quality (MERSQI score range 9 to 14). We will focus our descriptions below on the studies of medium-quality.

Study/participant characteristics

Of the 17 studies included in the review, 13 (76%) included physicians, two (12%) included residents, and another two

Table 1. Overview of included studies.

Study	Intervention structure and duration	Target patient population	Participants	Study type	Outcomes	Results	MERSQI score (out of 18)
Bellesheim et al. (2020)	Structure: Online interdisciplinary didactic and case-based sessions facilitated by pediatrician specialists, child/adolescent psychiatrists, clinical psychologists, social workers, dieticians, and parents of children on the autism spectrum. Training also included 6 quality improvement sessions on applying process improvement tools to ASD screening. Duration: twice monthly for 12 months, 1.5 h	Pediatric	28 general pediatricians, family medicine physicians, and nurse practitioners	Single group pre-test and post-test	Physician behavior	During the year-long training, there was an increase in developmental screening rates at 12 months** and at 18 and 24 months**. There was also an increase in ASD screening rates at 12 months** and at 18 and 24 months***. At 1 year following the conclusion of the training, there was a increase in general developmental screening rates* but no maintained significant increase in ASD screening rates (NS).	9.5††
Biel et al. (2017)	Structure: (1) In-person didactic lessons facilitated by child/adolescent psychiatrists (2) supplementary 30 min one-on-one coaching sessions focused on ASD screenings Duration: 6 × 45 min	Pediatric	14 pediatricians, family practitioners, and nurse practitioners	Single group pre-test and post-test	Knowledge, Physician behavior	Participants' scores on an exam testing ASD knowledge increased from 50.8% pre-training to 75.7% post-training. Appropriate screening improved from 10% to over 60% (NA).	8.5†
Bordini et al. (2014)	Structure: In-person lectures and case-based discussions facilitated by ASD experts Duration: weekly for five weeks, 3 h	Pediatric	22 pediatricians and general practitioners	Single group pre-test and post-test	Knowledge, Physician behavior	Participants showed an increase in ASD-related knowledge**. There was also a slight increase in the number of specialist referrals for ASD-related care (11 to 13) (NA).	11.5††
Carbone et al. (2016)	Structure: (1) Full-day in-person workshop OR half-day in-person workshop OR online workshop that included didactic material on ASD surveillance and ASD screening, training on the administration of the M-CHAT, and sessions on quality improvement (2) site visits (3) monthly conference calls Duration: 3–6 months	Pediatric	43 physicians and staff at 22 pediatric and 4 family medicine practices	Single group pre-test and post-test	Self-efficacy, Physician behavior	Participants' self-efficacy significantly improved in all domains***. 14 of 22 practices also reported subjective improvements in family-centered care***. ASD screening increased from 16% to 91%***. The number of clinics screening at least 80% of patients increased significantly from 3.8% (1/26) to 80.8% (21/26)***. Four years following training, 69.2% (18/26) maintained their screening program and 89% of these clinics (16/18) screened at least 80% of patients (NA).	11.5††
Eray & Murat (2017)	Structure: One in-person didactic session taught by two child and adolescent psychiatrists Duration: 2 h	Unspecified	75 family practice physicians	Single group pre-test and post-test	Knowledge	Participants showed positive improvement in 7 out of 9 questions related to prevalence and etiology, 4 out of 6 questions related to diagnosis, and 4 out of 7 questions related to treatment*. The number of physicians who felt they had received adequate training on ASD increased from 26 (34.7%) to 66 (88%) post-intervention (NA).	10††
Giachetto et al. (2019)	Structure: Online interdisciplinary didactic and case-based sessions facilitated by pediatricians, neuro-pediatricians, and a child psychiatrist Duration: monthly for 20 months, 1 h	Pediatric	38 pediatricians, child psychiatrists, and psychologists	Single group pre-test and post-test	Knowledge	Participants reported improvements in self-perceived knowledge related to eight domains**. Participants did not reach the defined level of competency in any outcome measure.	8.5†
Havercamp et al. (2016)	Structure: An online lecture followed by a panel discussion including adults on the autism spectrum and parents of children on the autism spectrum Duration: 1 h	Pediatric and Adult	99 third-year medical students	Single group post-test	Knowledge, self-efficacy	Participants reported very positive or positive changes in regard to: knowledge of appropriate action (85.8%), confidence and comfort (74.7%), communication (76.8%), understanding of barriers to care (89.9%), self-assessed skills in helping patients (82.8%), and ability to provide better care (85.9%) (NA).	8†
Hine et al. (2021)	Structure: (1) Online didactic modules on ASD screening, parent-completed ASD screening measures, and the STAT. (2) in-person observation of a physician performing ASD screenings Duration: three modules, duration not otherwise specified	Pediatric	63 residents in pediatrics, medicine-pediatrics, and neurology	Single group pre-test and post-test	Self-efficacy	Following the completion on the training, there was a significant increase in comfort level with symptom identification***, diagnosis***, making referrals for services***, and providing primary care to children with ASD***.	8†
Major et al. (2013)	Structure: In-person case-based modules facilitated by developmental-behavioral pediatric or neurodevelopmental disability faculty members Duration: 20–90 min	Pediatric	114 pediatric or medicine-pediatric residents	Single group pre-test and post-test	Knowledge, Self-efficacy	Participating physicians showed an average gain of 16.7%*** on an objective knowledge-based test and reported improvement in self-assessed knowledge, proficiency, and confidence***	12††

(Continued)

Table 1. (Continued)

Study	Intervention structure and duration	Target patient population	Participants	Study type	Outcomes	Results	MERSQI score (out of 18)
Mazurek et al. (2019)	Structure: (1) 1.5 day didactic and interactive in-person workshop on administering STAT (2) online interdisciplinary didactic and case-based sessions facilitated by pediatrician specialists, child psychologists, child/adolescent psychiatrists, social workers, dieticians, and parents of children on the autism spectrum. Duration: bimonthly for 12 months, 90 min	Pediatric	18 pediatricians, family medicine physicians, and nurse practitioners	Single group pre-test and post-test	Self-efficacy, Physician behavior	Participants showed an increase in overall self-efficacy***. Screening increased significantly from 65% to 91% of all 18-month visits* and from 59% to 92% of all 24-month visits*. 100% of participants reported change in practice behaviors.	9.5††
Mazurek, Parker, et al. (2020)	Structure: Online interdisciplinary didactic and case-based sessions facilitated by physicians, psychologists, family resource specialists, dieticians, and parent experts Duration: twice monthly for 6 months, 2 h	Unspecified	104 general pediatricians, internal medicine-pediatrics physician, family medicine physicians, nurse practitioners, and physician assistants	Single group pre-test and post-test	Knowledge, Self-efficacy, Physician behavior	Participating physician reported significant improvements in knowledge*** and overall self-efficacy***. Among the participating physicians there was a small 6-month increase in autism screening rates (NS) and a small, insignificant 6-month decrease in addressing comorbidities (NS).	11††
Mazurek, Stobbe, et al. (2020)	Structure: Online interdisciplinary didactic and case-based sessions facilitated by physician specialists, parents of children on the autism spectrum, and an individual on the autism spectrum Duration: weekly for 3 months, 1 h	Adolescents and young adults	11 general pediatricians, family medicine physicians, internal medicine-pediatrics physicians, and nurse practitioners	Single group pre-test and post-test	Knowledge, Self-efficacy, Physician behavior	Participants showed a small but insignificant improvement in overall provider knowledge (NS) but did show a significant improvement in overall self-efficacy**. 75% of participants reported changes in practice behaviors.	12††
Pasco et al. (2014)	Structure: Online asynchronous didactic courses Duration: 2 courses, unspecified time	Unspecified	118 general practitioners, pediatricians, and psychiatrists	Single group post-test	Knowledge	51% of individuals who completed the post-training survey implemented knowledge gained during the training, mostly in identifying signs of ASD in children (NA).	5†
Swanson et al. (2014)	Structure: In-person didactic and interactive training on how to use various ASD screening tools (M-CHAT & STAT), the use of parent-report interviews, integrating information into a diagnostic impression, how to communicate results to families, and how to bill for ASD assessments Duration: 2 days	Pediatric	27 general pediatricians, developmental and behavioral pediatricians, pediatric neurologists, and pediatric nurse practitioners	Single group pre-test and post-test	Physician behavior	Participants experienced a positive shift in identified practice behavior** and the percentage of participants likely to conduct within-practice assessments for ASD increased from 23% to 68% (NA). There was an increase in the number of primary ASD diagnoses given by participating physicians* as well as an 85% increase in the number of children diagnosed with ASD by the primary care provider (NA). Among the 14 cases that underwent independent evaluation, diagnostic agreement was found in 12 cases (86%) (NA).	10.5††
Taslibeyaz et al. (2016)	Structure: Pre-recorded interactive and non-interactive case-based videos Duration: 30 min	Unspecified	60 medical students	Randomized control trial	Physician behavior	Significant improvements in symptom identification and diagnostic accuracy were seen in both the non-interactive video group** and interactive video group***. The interactive video group performed significantly better on symptoms identification and diagnostic accuracy than the non-interactive video group*. The flexibility of the interactive videos improved decision-making.	11.5††
van 't Hof et al. (2021)	Structure: Didactic lessons facilitated by child/adolescent psychologists delivered in an interactive virtual classroom Duration: weekly for three weeks, 1.5 h	Pediatric	78 physicians	Single group pre-test and post-test	Knowledge Self-efficacy, Physician behavior	Participants showed an increase in general** and physician-specific** ASD knowledge. Physician-specific knowledge remained increased after 6 months**, but general knowledge did not. Self-efficacy increased** and remained increased after 6 months**. No significant change in ASD referral rates.	11.5††
Warren et al. (2019)	Structure: In-person workshop with interactive training experiences and real-time practice with performing clinical assessments on children on the autism spectrum (M-CHAT, Screening Tool for Autism in Two-Year-Old's, DSM-IV-based diagnostic interview as well as a medical history interview) Duration: 2 days	Pediatric	5 community pediatricians	Single group post-test	Physician behavior	Of the 21 cases of ASD identified among the study participants, the complete diagnostic evaluation was confirmed in 15 (71%). Of the 19 children given a diagnosis of ASD, the diagnosis was confirmed in 14 (74%). Diagnostic certainty was lower for children not receiving an ASD diagnosis*.	9.5††

NS: non-significance; NA: significance testing not performed; DSM-IV: *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.).
*$p < 0.05$, †low-quality; **$p < 0.01$, ††medium-quality; ***$p < 0.001$.
Quality evaluation

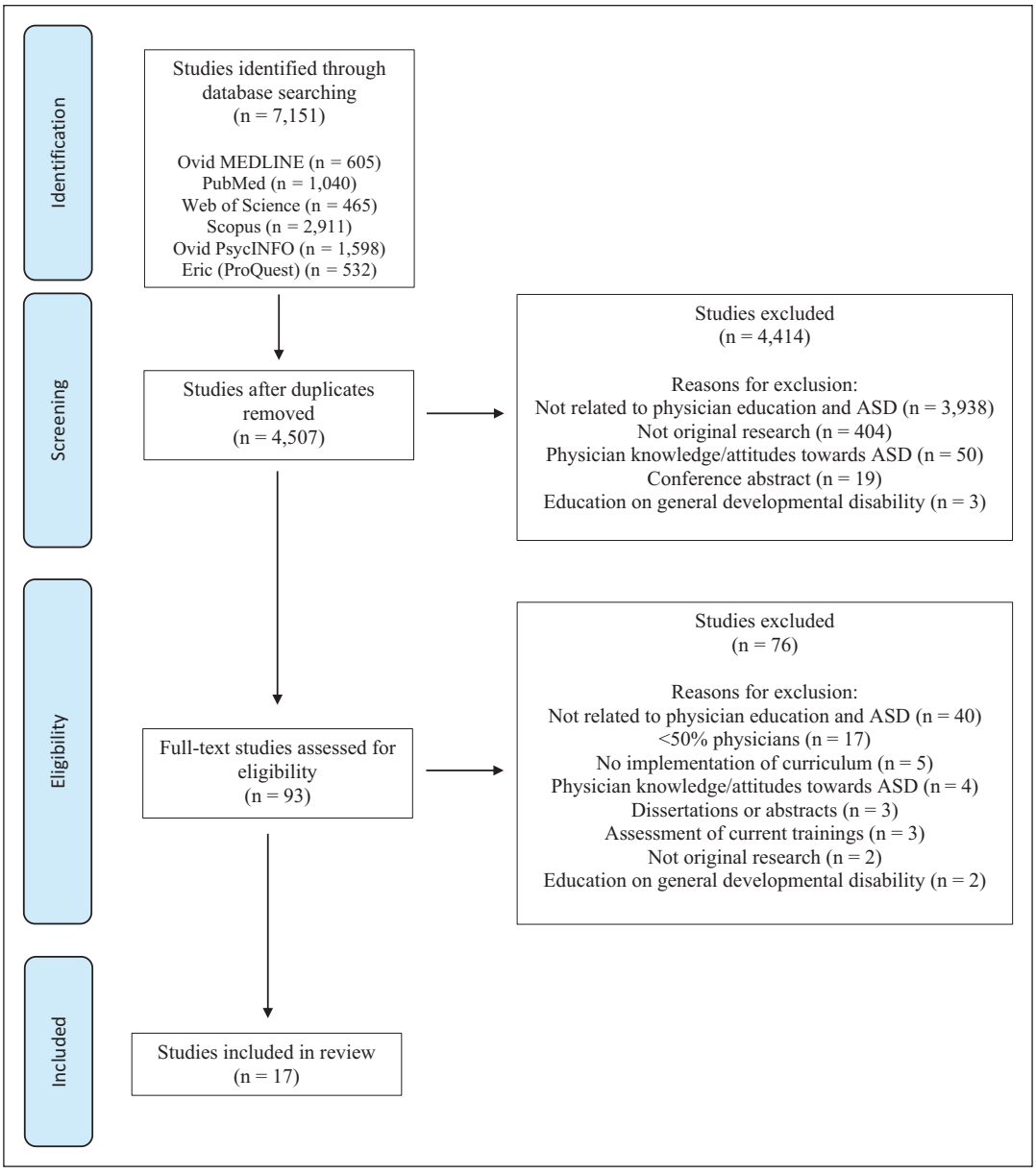

Figure 1. Overview of literature review process.

(12%) included medical students. Of the 13 focused on training physicians, three (23%) included at least one specialist physician, who was either a psychiatrist or a neurologist. Neurology residents were also included in one of the residency-level training programs. Other physicians trained in the programs included family medicine physicians, internal medicine physicians, internal medicine-pediatric physicians, general pediatricians, and developmental-behavioral pediatricians. Two of the 13 training programs for physicians (15%) only included pediatricians, and 11 of the 17 studies included in the review (65%) focused exclusively on pediatric patient populations. None of the studies identified focused on autistic adults. The educational programs described in the identified studies also utilized a wide variety of teaching mechanisms: seven (41%) were entirely online, six (35%) were entirely in-person, and four (24%) were a hybrid of the two. The duration of training programs also varied: some lasted for a few hours, but others had regular, recurring meetings for many months. While we were unable to calculate effect sizes for the studies included in this review due to the lack of control groups and inconsistent outcome measures, a descriptive analysis of the results from the various studies allowed us to draw comparisons between different programs and analyze the effectiveness of the different program structures and delivery mechanisms.

The most commonly utilized training model was the Extension for Community Healthcare Outcomes (ECHO)

model, which was employed in five of the 17 (29%) studies. The ECHO model consisted of online meetings with a didactic component followed by case-based presentations. These sessions were led by a group of autism specialists that often included pediatricians, psychiatrists, psychologists, social workers, family resource specialists, and/or dieticians. Some ECHO programs also included community members, such as parents of autistic children. These specialized training programs often required physicians to attend multiple ECHO sessions at a regular interval over the course of the program (Mazurek et al., 2019; Mazurek, Parker, et al., 2020). While the core components of the ECHO model were used in each of these studies, there was a high degree of variation in the duration of the training programs and in the frequency of ECHO meetings. While one study had participants attend bimonthly ECHO clinic meetings for a year (Mazurek et al., 2019), another had trainees attend weekly ECHO clinic meetings for three months (Mazurek, Stobbe, et al., 2020). Despite the variations in training duration and frequency, all of the studies that utilized the ECHO training model reported some level of positive outcomes (Bellesheim et al., 2020; Giachetto et al., 2019; Mazurek et al., 2019; Mazurek, Parker, et al., 2020; Mazurek, Stobbe, et al., 2020); however, not all of the studies showed the same level of success. For example, two of the three ECHO studies that measured knowledge and self-efficacy reported significant changes to both outcome measures (Giachetto et al., 2019; Mazurek, Parker, et al., 2020), but another was only able to significantly increase self-efficacy and had no impact on knowledge (Mazurek, Stobbe, et al., 2020). Of the ECHO studies that captured data related to ASD screening, one resulted in a significant increase in the ASD screening rate (Mazurek et al., 2019), one resulted in an insignificant increase in the ASD screening rate (Mazurek, Parker, et al., 2020), and another led to an initial significant increase in the ASD screening rate but failed to maintain this increase at one-year follow-up (Bellesheim et al., 2020).

The studies that did not implement the ECHO model were highly variable in structure and duration, but for the purpose of this analysis, they will be organized into three groups based on their delivery method: entirely in-person, entirely online, or a hybrid of the two. Six of the 12 non-ECHO programs (5 medium-quality and 1 low-quality) (Biel et al., 2017; Bordini et al., 2015; Eray & Murat, 2017; Major et al., 2013; Swanson et al., 2014; Warren et al., 2009) were entirely in-person but differed greatly in length. While one took the form of a two-day workshop (Warren et al., 2009), another was only two h long (Eray & Murat, 2017). Three of the 12 non-ECHO programs (2 medium-quality and 1 low-quality) occurred entirely online (Pasco et al., 2014; Taslibeyaz et al., 2017; van ‘t Hof et al., 2021). While some of the online-only courses occurred live over the span of a few weeks and required the physician to join at a particular time (van ‘t Hof et al., 2021), others were asynchronous and could be completed in any time frame (Pasco et al., 2014). It is also important to note that most of the training programs, even those that occurred exclusively online, had some live interactive component. The remaining three non-ECHO training programs (1 medium-quality and 2 low-quality) employed a hybrid model consisting of both online and in-person components and were highly variable in duration, ranging from one day to a few months (Carbone et al., 2016; Havercamp et al., 2016; Hine et al., 2021).

Content and outcomes

The training programs included in this review showed a high level of variability in course goals and associated learning outcomes. For example, some training programs focus only on the acquisition of knowledge and self-efficacy related to caring for autistic individuals. These programs tended to be didactic in nature and focused on concepts related to ASD epidemiology, clinical characteristics, and treatment methodologies (Bordini et al., 2015; Eray & Murat, 2017). Other training programs focus on changing physician behavior, but only as it relates to autism screening. These programs featured screening tools for ASD, such as the Modified Checklist for Autism in Toddlers (M-CHAT) and Screening Tool for Autism in Toddlers and Young Children (STAT), and provided opportunities for learners to practice the administration of these tools (Carbone et al., 2016; Mazurek et al., 2019; Swanson et al., 2014). Some educational programs also focus on content specific to a particular group of autistic individuals. For example, one program focused on training physicians how to work with transition-age patients. This training included instructional material pertinent to healthcare transition and the care of autistic adolescents, such as how to support families through the transition period, relationships and sexuality, housing and community support, the role of the primary care provider in healthcare transition planning, and life skills development (Mazurek, Stobbe, et al., 2020).

While the content may have differed between training programs, many programs captured data on similar outcome measures. Of the 17 included studies, 10 (59%) measured physician knowledge, eight (47%) measured physician self-efficacy, and 11 (65%) measured some aspect of physician behavior, mostly related to ASD screening. Most studies reported improvements in one or more of these outcome measures, and these improvements were seen across all participant groups regardless of their training level. For example, medical students saw improvements in symptom identification and diagnostic accuracy following an online-only training program (Taslibeyaz et al., 2017). Residents reported statistically significant increases in knowledge and self-efficacy after completing a specialized training program (Major et al., 2013).

Physicians reported similar significant increases in knowledge and self-efficacy (Mazurek, Parker, et al., 2020; van 't Hof et al., 2021) while also showing improvements in autism screening rates (Carbone et al., 2016; Mazurek et al., 2019). Additional details about the outcome measures used in these studies can be seen in Table 2.

Physician knowledge was one of the main outcome measures assessed in the included studies, and all of the specialized training programs that measured knowledge reported some level of positive results (Table 1). While some of the studies relied on participants' self-assessed levels of knowledge, others utilized objective tests designed to measure physicians' knowledge on various topics related to caring for autistic individuals (Table 2). For example, one study utilized the Autism Spectrum Disorder Knowledge Questionnaire–Physician Edition (AKQ-P) to show that an educational program led to an initial increase in both general autism knowledge and physician-specific autism knowledge. This study showed that while physician-specific autism knowledge remained increased at six months post-training, general autism knowledge did not (van 't Hof et al., 2021). Another study measured both the objective and self-assessed knowledge of residents and found that both had been significantly increased after they participated in a case-based training program (Major et al., 2013).

Physician self-efficacy was the second outcome measure assessed in this literature review, and all of the identified studies measuring self-efficacy found significant improvements in the outcome measure following the completion of a specialized autism training program (Table 1). For example, one study found that physicians became more comfortable with identifying the symptoms of ASD, making appropriate diagnoses and referrals, and providing care to autistic children (Hine et al., 2021). Another study found that levels of self-efficacy remained increased six months following the completion of a training program (van 't Hof et al., 2021), suggesting that these educational programs are able to have a lasting impact on physicians' confidence in their ability to provide care to autistic individuals.

While it is important to improve physician knowledge and self-efficacy related to caring for autistic individuals, it is perhaps more important to improve physician behavior. A subset of studies included in this review measured changes in autism screening rates following the completion of specialized autism training programs (Table 1). These data can be utilized to understand how specialized training programs impact one dimension of physician practice behavior. Of the six studies that measured whether or not statistically significant changes in screening rates occurred following training, four (67%) reported significant increases in autism screening rates (Bellesheim et al., 2020; Carbone et al., 2016; Mazurek et al., 2019; Swanson et al., 2014), while the remaining two (33%) reported no significant changes in screening rates (Mazurek, Parker, et al., 2020; van 't Hof et al., 2021); however, it is unclear how long these behavior changes persist following the completion of these training programs. While one study found that 16 of 18 (89%) clinics involved in a training program focused on increasing ASD screening rates continued to perform autism screenings on at least 80% of their patients four years following the completion of the training (Carbone et al., 2016), another reported that autism screening rates dropped back to baseline after only one year (Bellesheim et al., 2020).

Discussion

Many of the training programs identified in the review were associated with improvements in physician knowledge and self-efficacy. However, the majority of studies focused on practice behavior only investigated improvements in autism screening, which does not begin to capture all elements of physician behavior that are relevant to the care of autistic patients. Furthermore, none of the identified studies measured changes in patient health outcomes. Finally, an analysis of the quality of the studies included in this review suggests that there is a lot of room for improvement regarding study design and training evaluation. Taken together, the results put forward in this review show that autism-specific training programs can be effective at improving physician knowledge of ASD and physician self-efficacy regarding caring for autistic patients. However, there is more limited evidence showing that autism-specific training programs can increase rates of autism screening, and there is no evidence showing that these training programs can improve other aspects of physician behavior, such as providing appropriate accommodations in the clinical setting or improving engagement with autistic patients. Future studies thus need to develop and critically evaluate specialized autism training programs designed specifically to improve physician behavior so that we can better understand the impact these programs have on physicians' ability to provide competent care to their autistic patients.

The importance of these training programs is underscored by the low levels of knowledge and self-efficacy currently reported by medical students, residents, and physicians in regards to treating autistic individuals (Austriaco et al., 2019; Zerbo et al., 2015). Due to the current shortage of autism specialists in psychiatry, developmental & behavioral pediatrics, and neurology, the care of autistic patients usually falls to primary care providers (internists, pediatricians, and family medicine physicians)—the same providers who cite that they do not feel confident in their ability to care for autistic patients. This shortage of specialists and the lack of training for primary care providers have been linked to many health disparities for autistic people, including the delayed diagnosis of ASD (Kalkbrenner et al., 2011; Mazurek, Harkins, et al., 2020). The lack of specialized training programs has also previously been cited as a

Table 2. Outcome measures.

Study	Outcomes	Outcome Measures: Knowledge	Outcome Measures: Self-Efficacy	Outcome Measures: Screening
Bellesheim et al. (2020)	Physician behavior	N/A	Physician-reported count of ASD and general developmental screening tools used in a 30 day period	N/A
Biel et al. (2017)	Knowledge, Physician behavior	Unspecified test	N/A	Not specified
Bordini et al. (2014)	Knowledge, Physician behavior	Test with 13 multiple choice questions and clinical vignettes involving patients on the autism spectrum that addressed diagnostic criteria, diagnosis of atypical cases, comorbidities, differential diagnoses, and treatment	N/A	Number and profile of ASD cases referred to specialist
Carbone et al. (2016)	Self-efficacy, Physician behavior	N/A	Survey consisting of 16 questions with Likert-type scale responses addressing ASD-specific needs and ASD-associated conditions	Monthly chart audit on whether or not an ASD screening tool was administered during an 18- or 24-month visit
Eray & Murat (2017)	Knowledge	Test with 6 questions on ASD prevalence, etiology, symptoms, treatments, and myths	N/A	N/A
Giachetto et al. (2019)	Knowledge	Survey with Likert-type scale responses addressing self-perceived knowledge in eight domains: identify neurodevelopmental deviances, ASD diagnosis, comorbidity diagnoses, differential diagnosis, resources for a comprehensive approach, pharmacological treatments, transfer knowledge to local teams, identify family needs	N/A	N/A
Havercamp et al. (2016)	Knowledge, Self-efficacy	Test with 10 close-ended questions on the perceived effect of the training on disability knowledge, confidence and comfort, skills, and ability to provide care		N/A
Hine et al. (2021)	Self-efficacy	N/A	Survey with Likert-type scale responses addressing comfort level with identifying and distinguishing symptoms, diagnosing/referring, and providing primary and follow-up care to families of children on the autism spectrum	N/A
Major et al. (2013)	Knowledge, Self-efficacy	Unspecified general and module-specific test Survey addressing perceived general knowledge and module-based proficiency	Survey addressing perceived module-based proficiency and confidence in speaking with families about autism	N/A
Mazurek et al. (2019)	Self-efficacy, Physician behavior	N/A	Primary Care Autism Self-Efficacy (PCASE) Survey; addresses participant confidence in providing effective care across 57 items	Percentage of all 18- and 24-month visits that included administration of an autism screening tool in the past 6 months Survey addressing perceived of changes in practice behavior

(Continued)

Table 2. (Continued)

Study	Outcomes	Outcome Measures: Knowledge	Outcome Measures: Self-Efficacy	Outcome Measures: Screening
Mazurek, Parker, et al. (2020)	Knowledge, Self-efficacy, Physician behavior	33-item test addressing ASD screening/identification, psychiatric comorbidities, medical comorbidities, and management of additional autism-specific needs	Primary Care Autism Self-Efficacy (PCASE) Survey; addresses participant confidence in providing effective care across 57 items	Medical record review assessing appropriate screening behavior
Mazurek, Stobbe, et al. (2020)	Knowledge, Self-efficacy, Physician behavior	29-item test addressing ASD identification, psychiatric comorbidities, medical comorbidities, healthcare transition, and management of additional autism-specific needs	Primary Care Autism Self-Efficacy (PCASE) Survey; addresses participant confidence in providing effective care across 57 items	Open and close-ended questions assessing perceived changes in practice behavior
Pasco et al. (2014)	Knowledge	Unspecified online survey	N/A	N/A
Swanson et al. (2014)	Physician behavior	N/A	N/A	Checklist addressing diagnostic certainty Retrospective self-reported data on practice characteristics regarding autism screening, referrals, and diagnosis
Taslibeyaz, et al. (2016)	Physician behavior	N/A	N/A	Unspecified achievement score related to identifying symptoms of ASD and making a diagnosis of ASD The think-aloud protocol was used to collect information about the decision-making process of students
Van 't Hof et al. (2021)	Knowledge Self-efficacy, Physician behavior	Autism Spectrum Disorder Knowledge Questionnaire–Physician edition (AKQ-P); 20 multiple choice questions on general ASD knowledge (prevalence, sex differences, risk factors) and 12 multiple choice questions on physician-specific ASD knowledge (early ASD signs, detection, diagnostic criteria, comorbidity)	Five-question questionnaire on a 10-point Likert-type scale measuring self-efficacy of early ASD detection	Physician referral rate and reason for referral
Warren et al. (2019)	Physician behavior	N/A	N/A	Video recording of ASD assessments Referral of patients for subsequent evaluation Completion of a diagnostic certainty checklist

barrier to accessible healthcare for autistic individuals (Mazurek, Harkins, et al., 2020). To overcome these barriers, we must ensure that primary care providers receive adequate training related to providing care to autistic patients. This will ultimately increase autistic people's access to high-quality healthcare and will hopefully lead to improvements in their physical and mental health.

Quality of included studies

While the data presented in this review show that specialized training programs have a positive impact on physician knowledge, self-efficacy, and some elements of physician behavior, they must be contextualized with a discussion on the quality of the included studies. As mentioned above, the MERSQI was utilized to objectively measure the quality of included studies. Out of a maximum of 18 points, the articles included in this study received an average of 9.9 and all fell within a range of 5–12. Using the MERSQI cutoffs explained in the "Methods" section, 71% of the 17 studies were of medium-quality and 29% were of low-quality.

There were many reasons that the studies included in the review lost points on the MERSQI, the most common of which were relying on subjective (rather than objective) data, lacking a case-control study design, and not using validated survey measures. For example, only one study utilized a randomized controlled study design (Taslibeyaz et al., 2017): all others utilized either a pre-/post-assessment model or relied exclusively on a post-assessment examination. The lack of a randomized control group in most of these studies introduces selection bias into the results. Furthermore, only collecting post-assessment data makes it difficult to accurately assess the impact of the specialized training program. In addition, many of the included studies relied solely on participants' self-assessment of their knowledge, self-efficacy, or practice behavior (Giachetto et al., 2019; Havercamp et al., 2016; Hine et al., 2021; Mazurek et al., 2019; Pasco et al., 2014; Swanson et al., 2014). In these studies, the lack of an objective assessment to measure the outcomes of interest means that the data are subject to bias from participants' perceptions and may not be an accurate measure of the program's impact. Furthermore, while many studies in the review measured similar outcomes, they did so in inconsistent and unstandardized ways. To better quantify the effectiveness of these specialized training programs, standardized assessments need to be developed, validated, and widely implemented across various practice settings. One example of such a survey is the AASPIRE Adult Autism Healthcare Provider Self-Efficacy Scale, which measures physicians' self-efficacy regarding their ability to provide healthcare to autistic adults (Nicolaidis et al., 2021). These deficiencies in study development and design must be remedied moving forward to improve the quality of evidence on the effectiveness of ASD-related physician training programs.

Guidance for the development of specialized training programs

To increase the amount of autism-specific training received by physicians and physician trainees, educational programs must be developed that are not only applicable to a wide variety of trainee levels but also easily implemented on a large scale. This is especially challenging in medical education due to the busy and unpredictable schedules of physicians and the limited curriculum space in medical school and residency. Online programs may be a potential solution to this problem. Even though exclusively online modules were not always successful at improving physician behavior (van 't Hof et al., 2021), they greatly increase the accessibility of training programs and should thus be considered when an in-person option is not logistically possible.

The duration of a training program can also impact its accessibility. While the results of our review suggest that training programs spread out over a longer period of time may be more effective at improving physician knowledge of autism (Mazurek, Parker, et al., 2020; Mazurek, Stobbe, et al., 2020), it is important to note that an in-person training program showed improvements in physician knowledge after only 5 weeks (Bordini et al., 2015). It is also important to note that training programs of the same duration had different effects on ASD screening rates (Carbone et al., 2016; Mazurek, Parker, et al., 2020). This suggests that other factors, such as learner demographics, practice settings, and delivery mechanisms, also play a role in the efficacy of these specialized training programs. These data also highlight the potential application of the Universal Design for Learning (UDL) framework, which promotes the idea that educational materials should be maximally accessible and adapted to meet the needs of the learner. This framework has already been used in a variety of medical education settings (Balta et al., 2021; Dickinson & Gronseth, 2020) and can be used to make specialized autism training programs accessible to a diverse audience. This will help ensure that as many physicians as possible are able to benefit from the positive effects of these specialized training programs.

One way to ensure that physicians receive basic training related to autism is to integrate autism-related content into medical school and residency training programs. The positive results reported in studies involving medical students (Taslibeyaz et al., 2017) and residents (Major et al., 2013) suggest that specialized autism training programs are able to improve the knowledge, self-efficacy, and some level of practice behavior of trainees. While autism-related training should ideally be longitudinal in nature and target learners at all stages of training, including autism-related

content in medical school will ensure that all future physicians have received a small amount of training on caring for autistic individuals that can then be built on as they pursue additional specialized training in residency.

Another important aspect to consider when designing future specialized autism training programs is the geographic diversity of the target physicians. Delivering training programs at the institutional level will allow for the customization of the curriculum so that physicians can be made aware of local policies and regulations influencing the care of autistic people in their communities. This would also allow students, residents, and physicians to learn about organizations and resources within their communities that they could refer their autistic patients to. There are a few relevant examples of such institutional programs, such as the "Time for Autism" program at the Brighton and Sussex Medical School and the "Autism Program" at the Boston Medical Center (About Time for Autism, 2022; The Autism Program at Boston Medical Center, 2022).

Identified gaps and future directions

One important gap identified in this review is that while most of the studies identified (11 out of 17, or 65%) focused exclusively on training physicians to work with autistic children, no study focused exclusively on autistic adults. Multiple studies have proven the effectiveness of early diagnosis and intervention in autistic children (Estes et al., 2015; Wong & Kwan, 2010), which does underscore the importance of training pediatricians on how to work with this patient population; however, it is just as important to note that autistic adults often have unmet healthcare needs and experience poor health outcomes (Nicolaidis et al., 2013; Tyler et al., 2011). This may be due in part to the lack of training programs designed for physicians who work with autistic adults. The lack of autism-related training received by non-pediatric physicians becomes apparent when autistic children age out of pediatric care, as parents of autistic children commonly identify physicians' lack of knowledge of autism as a major barrier to effective healthcare transition (Cheak-Zamora & Teti, 2015). There was also a lack of physician specialists in the identified studies. While some of the studies included psychiatrists and neurologists, the studies identified in this review would have benefited from including a wider variety of physician specialists. Future studies evaluating the effectiveness of specialized training programs will therefore advance the field significantly if they include physicians who care for adult patients and physician specialists.

Another gap identified by this review is the lack of training focused on addressing the diversity of healthcare experiences among autistic people. Despite there being reported disparities among autistic individuals of different racial/ethnic backgrounds (Bishop-Fitzpatrick & Kind, 2017), no study in this review designed a curriculum with components focused on eliminating these disparities. Moving forward, specialized training programs should consider addressing the needs of underserved or underrepresented groups of autistic people so that physicians are able to provide culturally competent care to all of their autistic patients.

Another important point to make is that very few of these studies directly involved autistic individuals in their curriculum development or program dissemination. While four out of five studies utilizing the ECHO-based model included either an autistic individual or a parent of an autistic child as part of the panel discussions (Bellesheim et al., 2020; Mazurek et al., 2019; Mazurek, Parker, et al., 2020; Mazurek, Stobbe, et al., 2020), none of the other articles stated whether or not they included autistic individuals in the development or dissemination of their educational programs. Autistic individuals, their parents, and other community members can draw from their lived experiences and provide invaluable expertise on the barriers they face while accessing healthcare: expertise that will improve the quality of these specialized autism training programs. Moving forward, guidelines for appropriate community-based participatory research (Burke et al., 2013; Nicolaidis et al., 2011) should be taken into consideration to ensure that autistic individuals, their family members, and other key stakeholders are able to play an active role in the development of medical curriculum related to autism.

In addition to the gaps in content discussed above, future studies assessing the effectiveness of specialized autism training programs must make improvements in study methodology and design. As discussed above, many of the studies relied on subjective assessments of the outcome measures, and there was no consistency in the evaluation methods between studies. Standardized assessments of knowledge, self-efficacy, and practice behaviors related to autism should be developed, validated, and utilized. This will not only improve the quality of the data produced by the studies but also allow investigators to compare the effectiveness of different educational programs. Improving the quality of evidence will give medical educators more objective guidance in designing and implementing successful autism training programs.

One of the most important goals of these training programs is to promote changes in physician behavior that lead to improved clinical outcomes for autistic patients. As alluded to above, one gap in the literature highlighted by this review is that the primary behavior change evaluated by the included studies was ASD screening. None of the included studies evaluated other aspects of physician behavior relevant to caring for autistic patients. Because it is often difficult to change physician behavior (Wilensky, 2016), future specialized training programs need to be developed with this goal in mind to give them the best chance at being effective. Past research has suggested that

active and multifactorial educational programs are more effective in promoting physician behavior change than traditional passive programs (Mostofian et al., 2015). Educational programs that are patient-mediated, consist of educational outreach, and feature reminders or educational meetings have also been shown to be more effective at causing physician behavior change than those involving other tactics (Johnson & May, 2015). Knowing that these are the elements that promote physician behavior change, educators should work to incorporate them into future ASD-related training programs so that they have a better chance at improving physician behavior and ultimately clinical outcomes of autistic patients.

In addition, to meaningfully assess the goals of improving physician behavior and patient clinical outcomes, future studies must adopt more objective methods of data collection. Potential mechanisms of objectively measuring physician behavior change include performing a chart audit on ASD screening rates, videotaping encounters to assess clinical competency, and soliciting feedback from patients and/or their families (Gerbert & Hargreaves, 1986). Potential mechanisms of objectively measuring changes in clinical outcomes of autistic patients include the use of standard behavioral measures such as the Aberrant Behavioral Checklist (ABC; Aman et al., 1985). It will also be important to collect information regarding patient-reported quality of physical and mental health. The accurate measurement of physician behavior and patient clinical outcomes is critical in the iterative design of effective specialized educational programs.

Limitations

The current systematic review is subject to several limitations. First, the review process itself may be subject to publication bias, and it is also possible that the search strategy and manuscript selection process did not identify all relevant studies. Second, to focus the results and future directions of the review, the search strategy developed by the authors excluded training programs that did not have a majority-physician audience; however, some of the educational programs for allied health professionals may be useful in improving ASD-related physician knowledge, self-efficacy, and practice behavior. Third, because of the inconsistency regarding program structure and duration, in addition to inconsistencies in study design and the lack of standardized and validated assessments, it is difficult to make comparisons between studies and identify educational programs that are more successful than others. A fourth limitation to this review is the utilization of the MERSQI tool to evaluate the quality of included studies. While the MERSQI is a commonly-utilized tool within the field of medical education, it failed to capture all relevant aspects of study quality. For example, the MERSQI does not recognize diversity in single-site studies with large sample sizes. In addition, low-quality studies cannot hold their conclusions because of inappropriate methods of data analysis, but the MERSQI does not penalize inappropriate data analysis enough.

Conclusion

The results presented in this systematic review support the effectiveness of specialized training programs in improving physicians' knowledge regarding ASD and self-efficacy related to providing care to autistic people; however, more work is needed to develop effective educational programs that can help physicians translate these improvements into changes in practice behavior and ultimately in health outcomes of autistic individuals. As the number of ASD cases continues to increase and more autistic children age out of pediatric care, there will be an increasing demand for physicians who are able to provide longitudinal care to autistic patients in a variety of primary care and subspecialty settings. Specialized training programs that can effectively improve physicians' ability to provide high-quality care to autistic individuals of all ages are urgently needed.

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Supplemental material

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