

Factors Associated with Knowledge, Attitude, and Practices of Physicians related to Autism spectrum disorder in Romania

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Abstract

Background

An inadequate level of general knowledge of physicians regarding mental health, including Autism Spectrum Disorder (ASD) not only could have adverse effects on affected individuals' health and quality of life, but also could further delay its diagnosis and initiation of timely interventions. The purpose of this survey was to assess the level of knowledge, attitudes, and practices (KAP) of physicians regarding ASD in Romania and identify their associated factors.

Methods

For conducting this cross-sectional survey, investigators in the US collaborated with faculty at "Carol Davila" University of Medicine and Pharmacy (UMF) and developed a questionnaire by modifying similar questionnaires used in Pakistan and Turkey, to assess KAP of physicians and specialists regarding ASD in Romania. The Questionnaire was administered to a convenient sample of 383 practicing physicians or specialists. Exploratory Factor Analysis on 12 variables revealed five composite sub-scores: stigma, potential causes, children's behavior, misconceptions, and educational needs associated with ASD knowledge. We determined the variables associated additively or interactively with KAP regarding ASD by applying General Linear Models to the five sub-scores as dependent variables.

Results

Approximately 75% of the responding physicians were female and more than 80% were over the age of 30 years. The majority (73%-94%) of physicians in Romania have correctly responded to some basic questions regarding knowledge about ASD. We also found that younger physicians (age < 35 years) were more knowledgeable about potential causes of ASD than older physicians, age \geq 35 years, (adjusted mean sub-scores: 2.70 vs. 2.13, $P = 0.04$, adjusted for the "type of medical school attended" and "city where the clinic is located"), while older physicians knew more about the behavior of children with ASD ($P = 0.02$). We found a significant interaction between source of ASD knowledge and (city where the clinic is located) in relation to knowledge of the physicians' regarding stigma related to ASD. There were no significant interactions in relation to the physician's knowledge of behaviors of children with ASD.

Conclusion

Though Romanian physicians are knowledgeable about ASD, greater attention is needed on symptoms, causes, and awareness of stigma and misconceptions surrounding ASD.

Background

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder that is characterized by a deficit in social communications and interaction, and repetitive behaviors and interests that manifest in early childhood according to the Diagnostic and Statistical Manual, Fifth Edition (DSM-5) [1]. Some notable symptoms of ASD include but are not limited to: little or no eye contact; conversational difficulties; issues with disruptions in their routine; language disabilities; and intellectual impairment with significant variations in severity [1–7]. Although there is no cure for ASD currently, various treatments are available for improving symptoms to a certain degree in the forms of cognitive and behavioral therapy, and medications [6]. During the last three decades, different tools have been developed for assessment of ASD. These include Autism Diagnostic Observation Schedule (ADOS) [8], the Autism Diagnostic Observation Schedule-2 (ADOS-2) [9], Autism Diagnostic Instrument-Revised (ADI-R) [10] alongside the DSM-5 criteria [6, 11]. The prevalence of ASD in the US is estimated to be 1 out of every 54 children [12]. However, based on a study in 2012 [13], the World Health Organization estimates that globally 1 out of every 160 children is diagnosed with ASD [14]. Considering that many countries don't have an adequate infrastructure to identify all the ASD cases, the reliability of this global estimate is questionable [15]. As the first step in building an infrastructure to identify all ASD cases and make accurate referrals for appropriate interventions, it is important to assess the knowledge of general practitioners and family physicians who are usually the first to come across children with various developmental disabilities including ASD [16–20].

An inadequate level of general knowledge of physicians regarding mental health issues such as ASD could have adverse effects on patients' health and quality of life in various ways [20–22]. For example, the lack of general knowledge of physicians about ASD could further delay its diagnosis [23] and initiation of timely and appropriate cost-effective interventions, particularly in communities in which mental health is considered a stigma and a potential implicit bias in physicians' regarding their patient's mental health concerns [24, 25]. Since mental health illnesses, including ASD, are associated with stigma in many countries around the world, some medical students refrain from pursuing formal training in psychiatry as their field of choice [26–28]. The increased negative perceptions and attitude toward those with mental health problems, and increased stigma and misconceptions related to these conditions [18, 29], may result in a shortage of properly trained physicians specialized in mental health disorders such as ASD.

Moreover, greater focus is needed to educate a new generation of motivated medical school students about mental disorders including ASD [18, 30], who will be able to improve the perceptions of general populations about these disorders, and to develop their interests in pursuing related opportunities to seek formal residency and fellowship trainings in Psychiatry and other related fields. However, currently the medical education systems in many countries lack sufficient focus on ASD and other related disorders. There are some instances where physicians only have heard of mental health issues such as ASD through the media [18]. This limited knowledge can result in lack of sufficient confidence on the part of the physicians for diagnosing ASD and perhaps other mental health conditions [20], and discourage them from seeking further education and experience in the field.

Several studies from different countries have assessed the knowledge, attitude, and practices of physicians regarding ASD [31–35], and studies from many countries such as Turkey [31, 35], Pakistan [33, 34], Nepal [36], and Nigeria [32] all noted a deficiency in ASD knowledge among physicians. Studies from Pakistan [33, 34] also reported a significant degree of misconceptions regarding ASD among general practitioners and physicians. In addition, Minhas et al. highlighted a high degree of stigma, lack of available services, and the limited levels of ASD knowledge in general physicians in Pakistan and India, which takes a significant toll on parents and reduces their faith in the medical professional's ability to help children with ASD [37]. This study also noted that physicians specializing in ASD and other mental health conditions stay within urban areas, leaving rural populations with little to no support [37]. Some studies indicated a lack of formal training regarding ASD and the management of diagnosed children in terms of the available options [38, 39]. On the other hand, other studies have also shown that physicians that specialized in ASD, and/or had experience with ASD scored higher in knowledge assessments regarding ASD [40, 41], were able to understand the need for an early diagnosis [40, 42], had a more positive attitudes towards those with ASD [40, 43], and were able to better handle children with ASD in their practice [39].

Romania is an ethnically diverse, upper-middle-income country in Eastern Europe [44, 45]. The 2002 reformations to the 1997 Romanian Social Health Insurance Act provided a more comprehensive health insurance [46], and comprehensively covers roughly 85% of the population [47]. Statistics from 2016 show that Romania has approximately 2.26 physicians per 1,000 population [44]. It is also estimated that there are approximately 1,018 new cases of mental disorders per 100,000 annually, and roughly 1% of the population in Romania suffer from mental disorders [48]. Additionally, the National Program for Health Evaluation, Health Promotion, and Health Education that is supported by the Office of the United Nations High Commissioner for Human Rights (OHCHR) reported that the most frequent mental health disorders in children and adolescents in Romania are: anxiety disorders, depression, Attention Deficit Hyperactivity Disorder (ADHD), aggressive behavior (bullying), and ASD [49]. Based on a 2016 cohort of over 9000 children from 122 regular schools and 95 schools for children with special education needs (SEN), researchers in Romania reported a prevalence of 14.3% for ASD in children aged 7–9 years old [50]. However, since the study population for this study involved children with SEN, this estimated prevalence of 14.3% is clearly an overestimate and suffers from a serious selection bias, and may not accurately represent the ASD prevalence of Romania's population. Additionally, Romania's relatively limited service infrastructure for ASD diagnosis and lack of services for adults with ASD in most regions of the country [51] may be contributing factors of underreporting and stigma toward ASD in the country.

A significant proportion (90.4%) of Romanian children who require psychiatric care initially visit a general physician for advice and guidance [52]. Many of the instruments used internationally for ASD assessment include ADOS [8], ADOS-2 [9], and ADI-R [10] that are considered as the gold standard for assessment of ASD are translated [53–55] and are available in Romania [56] which are used in many public or private units in the country. Other instruments translated in Romanian and are available for use in Romania include Social Communication Questionnaire (SCQ) [57] and Autism Spectrum Rating Scale (ASRS) [58]. However, there are some instruments that are not adapted to Romanian cultures and

customs [59]. For example, the Checklist for Autism in Toddlers (CHAT) and its other versions are not available for assessment of ASD in Romania [59] but are used internationally to assess a broad range of developmental disorders including ASD in children under 3 years of age. In 2011, the Romanian Health Ministry developed the Screening Questionnaire for Autism Spectrum Disorders [Chestionarul de Screening pentru Tulburări de Spectru Autist (CS-TSA)] modeled after the CHAT to specifically aid Romanian physicians in the early detection of ASD between the ages of 0–3 years. [60]. Since 2016, CS-TSA has been included in the subsidized services of the National Health Insurance Company. Since then, it has become mandatory for family practitioners to administer the questionnaire. However, the Romanian medical school curriculum has not changed significantly since 1996. The current postgraduate curriculum requires one month of pediatric psychiatry training for family physicians in the residency program and three months of pediatric psychiatry training for pediatricians. Though the medical school curriculum regarding ASD hasn't changed in the past decade, access to more ASD cases, a greater awareness of the disorder in physicians other than specialists, and greater access to knowledge disseminated from other researchers and media (as a potential source for general knowledge about ASD in public) may have contributed to increase in ASD knowledge of Romanian physicians with pediatric psychiatry training.

In this cross-sectional study, we aim to assess the knowledge, attitude, and practices of physicians regarding ASD in Romania. In addition, we investigate factors associated with knowledge about ASD in Romanian physicians. Though a previous study has used factor analysis for a similar assessment [18], to the best of our knowledge, we are the first study that has assessed association of various factors with knowledge, attitude, and practices of physicians regarding ASD.

Methods

Study design

For this survey, investigators at the University of Texas Health Science Center at Houston (UTHealth) and “Carol Davila” University of Medicine and Pharmacy (UMF) collaborated to develop a questionnaire by modifying a previously established questionnaire used in Pakistan [34] and Turkey [35], to assess the knowledge, attitude, and practices of physicians and specialists regarding ASD in Romania. The questionnaire was translated to Romanian and back translated to English by the Romania team to ensure the accuracy of the translations. The study protocol was approved by the Institutional Review Boards (IRBs) of UTHealth (HSC-GEN-15-0844) and Ethical Review Committee (ERC) (PO-35-F-03) of Carol Davila-UMF.

Participants

Participants in this survey were selected from a listing of all the private practices and clinics of physicians in Romania. A volunteer team that included medical students from the “Professor Alexandru Obregia” Clinical Psychiatry Hospital were provided the aforementioned list such that they could assist with distribution and collection of completed questionnaire by physicians or specialists at each of their

practices from January to July in 2017. As a result of this effort, they collected a total of 383 completed questionnaires.

Data Management and Quality Assurance of Data

The UTHHealth team provided a Research Electronic Data Capture (REDCap) [61] bilingual (in Romanian and English) database for data entry from the questionnaires. We used double-data entry method to minimize discrepant data as part of quality assurance procedures. The Carol Davila team in Romania completed the first set of data entry in the REDCap database. Then the questionnaires were sent to the UTHHealth team in the US for a second round of data entry. Since physicians responded to the open-ended questions in Romanian, we identified a graduate student at UTHHealth, who is a native Romanian speaker, to translate the responses into English, which were then entered into the REDCap database.

Instruments

The questionnaire for assessing knowledge, attitude, and practices of physicians about ASD

The Questionnaire contained three sections. Section A had 19 questions focused on assessing socioeconomic and demographic information including age and sex. This section also inquired about the participant's background in the medical field and their current practice (e.g., location of clinic, number of patients seen in a day in their practice, etc.). This section ended by asking if the physician personally knew someone with ASD.

Section B had six questions to assess the participants' knowledge and attitude about ASD. This section first asked if the participant had ever heard of "*Autism or Autism Spectrum Disorder*." If the participant marked "Yes," then in the following question they were asked to provide the sources where they heard about ASD. All participants were then asked to provide an estimate for the prevalence of ASD in Romania, the US, and globally. The physicians were subsequently asked that out of every 100 children s/he sees in her/his practice how many children have ASD. At the end of this section there was a section comprised of 14 true or false statements that were prepared to assess various aspects of the knowledge, attitude, and practices of the physician about ASD in Romania, for which the response options were in a 5-point Likert-scale: "*Strongly agree*," "*Agree*," "*Undecided*," "*Disagree*," and "*Strongly disagree*."

Section C had six questions designed to assess the participants' practices about ASD. This section assessed the physician's knowledge of available tools to screen children for ASD. They were also asked to list the screening tools they had used in the past, if any. The physicians were then asked about early indicators of ASD in 2-year-old children and what they do when they suspect a child has ASD. Section C continued by asking the physicians about which ASD diagnostic tools they had used in the past ("*Have you ever used any of the following to diagnose a child with autism or Autism Spectrum Disorder*"). Next the physicians were presented with a 4-point Likert-scale question ("*In diagnosing children with autism, the following symptoms are*") comprised of 11 accurate or inaccurate symptoms used to diagnose ASD

with response options of “*Necessary*,” “*Not necessary, but helpful*,” “*Not helpful*,” and “*Don’t know*.” The last question in this section asked physicians to provide their opinion on ways to reduce the prevalence of ASD in Romania.

Sample Size Justification and Statistical Power

In order to estimate the proportion of physicians and specialists who are knowledgeable about ASD within a margin of error of 5% with 95% confidence, we needed to survey at least 384 physicians or specialists. Considering that around 5% of the surveys were expected to be incomplete, we planned to survey 400 physicians at the conference. In our survey a total of 383 physicians completed the survey. This sample size is also sufficient to detect an effect size of 0.3 or greater with at least 80% power at a 5% significance level, assuming the ratio of physicians in the two groups compared (e.g., male vs. female physicians) with respect to their knowledge sub-score ranged from 0.40 to 0.60.

Statistical Analysis

Descriptive Analysis

We used descriptive statistics to summarize various characteristics of the study population, including age and gender of the participants. Some of the open-ended questions were categorized before analysis. Physicians’ age was categorized as a dichotomous variable with categories of ≤ 35 & > 35 years. Since we received a variety of responses for names of the medical schools where the physicians earned their degrees, these responses were reduced to three categories: 1) Carol Davila University of Medicine and Pharmacy, 2) Grigore T. Popa University of Medicine and Pharmacy, and 3) Other Medical Schools. The physicians that responded to the survey had clinics in various cities of Romania, and the responses were categorized based on the number of survey responses received for each city, leaving us with four categories: Bucharest, Su eava, Br ila, and Other cities. We also asked physicians to write the year in which they completed their most recent continuing education course, for which the responses were divided into: before 2007, between 2007 and 2014, and after 2014. The physicians were also asked to write down how many years they had been practicing medicine, and the answers were reported as more than 30 years, between 16 and 30 years, and 15 years or less.

The responses for the average number of patients each physician saw in his/her practice daily and the average number of patients under the age of 12 seen by each physician in a day were categorized as: ≤ 20 patients, 21–40 patients, and > 40 patients per day. The self-reported responses for the average time a physician spent at his/her practice each day were categorized based on an 8-hour workday (≤ 8 hours and > 8 hours per day). Likewise, responses for the average time a physician spent with each patient was classified as ≤ 15 minutes and > 15 minutes. Only binary (yes or no) responses were allowed for other variables such as whether the physician completed specific ward rotations in or after medical school, and if the physicians had heard of ASD in the past and were reported as such.

All physicians were asked whether they had heard of ASD in the past. If a physician left this question blank, we interpreted that the physician did not know, hence included this in the group that have not heard

of ASD. Physicians were then asked to mark where they had heard of ASD as their source of ASD knowledge (SAK). The 10 SAK options provided for selection were: medical school, continuing education, conferences, primary literature, colleagues, television, newspaper, internet, radio, and other sources not included in the list. Physicians were allowed to choose more than one SAK. Responses to the SAK question from physicians that had indicated that they had not heard of ASD or did not respond to the question were included in the analysis as an additional category. This resulted in a three-level variable for each SAK: those who heard of ASD from the selected SAK (Yes); those who heard of ASD but did not hear of ASD from this SAK (No); and those who had not heard of ASD.

Developing sub-scores to quantify various aspects of physicians' knowledge about ASD

As part of the questionnaire, a 14-statement Likert-scale question was used to assess the physicians' knowledge about ASD. The responses were initially coded on a 5-point scale: 1-*"Strongly agree,"* 2-*"Agree,"* 3-*"Undecided,"* 4-*"Disagree,"* and 5-*"Strongly disagree."* Depending on whether the statement in the question was true or false, the *"Undecided"* groups were merged either with the *"Agree"* or *"Disagree"* groups. Since question 2, *"Autism is a possible result of neglect by the parents,"* is false, the physicians who marked *"Undecided"* for question 2 were merged with the *"Agree"* and *"Strongly agree"* groups. Conversely, because question 8, *"Children with autism require special education,"* is true, the physicians who marked *"Undecided"* for question 8 were merged with the *"Disagree"* and *"Strongly disagree"* groups. As a result of this reclassification, we derived binary variables based on whether the statements in the question were true or false. Since questions 1, 6, 8, 9, 10, 11, and 12 are true, we recoded *"Strongly agree"* and *"Agree"* as 1, and *"Undecided,"* *"Disagree"* and *"Strongly disagree"* as 0. For questions 2, 3, 4, 5, 7, and 14, which are false, *"Strongly agree,"* *"Agree,"* and *"Undecided"* were recoded as 0, and *"Disagree"* and *"Strongly disagree"* were recoded as 1. We determined that the responses to Question 13, *"Parents in Romania tend to think their children are at risk for autism,"* may not be reliable because the prevalence or risk of ASD in Romania is currently unknown. Additionally, we determined that the responses to Question 9, *"Children with autism deliberately misbehave,"* may not be reliable as they could fluctuate depending on how the physicians interpreted the statement. Due to their ambiguous nature, Questions 9 and 13 were excluded from further analyses.

Originally, the 14-statement Likert-scale question was designed to provide an overall score of the physicians' knowledge; however, the resulting scores suggested the possibility of involvement of independent sub-domains in the overall knowledge score. Since the underlying factors in the scale could negate each other's scores, we used Factor Analysis, as described in Samanic, et al. [62], to determine these latent factors. Factors with an Eigenvalue of 1.00 (i.e., % of variance explained by each factor is equivalent to the variance explained by only one variable) or more were retained for the analysis and questions with absolute value of factor loadings of ≥ 0.40 was used for inclusion of that variable in the composite score (weighted score or factor score) for further analysis. Questions 9 and 13 were excluded from this analysis since the responses were deemed unreliable as stated previously. The Factor Analysis resulted in five composite scores with factor-like sub-scores derived from the questions included in each

factor with equal weights of 1. The five sub-scores used for subsequent analyses are listed and described in Table 1.

Table 1

Distribution of physicians' responses to several statements used for assessing knowledge, attitude, and practices of physicians in Romania about Autism Spectrum Disorder (ASD) and information about the five sub-scores representing physicians' knowledge about ASD in Romania identified based on Factor Analysis applied to physicians' responses, n = 383.

Questions or statements *†	Statement is True (T) or False (F)	Frequency of physicians N (%**)		Latent characteristics of variables involved in the Factor and Factor-like sub-score
		Agree	Disagree	
1. Children with autism are often detached from their family and peers. ^a	T	280 (73.1)	96 (25.1)	Factor 1: Physicians' knowledge of stigma related to ASD Sub-score 1 = Q10 + Q11 + Q12
2. Autism is a possible result of neglect by the parents. ^b	F	160 (41.8)	217 (56.7)	
3. Autism is a precursor for schizophrenia. ^a	F	175 (45.7)	201 (52.5)	
4. It is often difficult to distinguish between autism and schizophrenia. ^c	F	215 (56.1)	160 (41.8)	Factor 2: Physicians' knowledge of potential cause (s) of ASD Sub-score 2 = Q2 + Q3 + Q4 + Q5
5. Autism is more prevalent in higher socioeconomic classes. ^c	F	191 (49.9)	184 (48)	
6. Children with autism are not affectionate. ^b	T	179 (46.7)	198 (51.7)	
7. Children can grow out of autism. ^b	F	353 (92.2)	24 (6.3)	Factor 3: Physicians' knowledge of the behavior of children with ASD Sub-score 3 = Q1 + Q6
8. Children with autism require special education. ^d	T	361 (94.3)	18 (4.7)	
10. There is a stigma against autism in my community. ^e	T	191 (49.9)	188 (49.1)	Factor 4: Physicians' knowledge of misconceptions about ASD Sub-score 4 = Q7 + Q14
11. Diagnosing a child with autism will lead to discrimination against this child and his/her family. ☒	T	239 (62.4)	137 (35.8)	
12. In general, there is a negative opinion toward children diagnosed with autism. ^a	T	189 (49.4)	189 (49.4)	
14. Autism is preventable ^e	F	160 (41.8)	217 (56.7)	Factor 5: Physicians' knowledge of educational needs related to ASD Sub-score 5 = Q8

Questions or statements *†	Statement is True (T) or False (F)	Frequency of physicians		Latent characteristics of variables involved in the Factor and Factor-like sub-score
		N (%**)		
		Agree	Disagree	

*Participants were asked, “indicate your response to each of the following statements”.

† Questions 9 and 13 were dropped from the analysis due to their ambiguity.

** Row percentages may not add up to 100% due to missing data; for ^a there are 7 missing data; for ^b there are 6; for ^c there are 8; for ^d there are 4; and for ^e there are 5.

Results

Descriptive analysis of demographic and socioeconomic characteristics from the 383 questionnaires revealed that about 75% of the participating physicians who responded were female and more than 80% were over the age of 30. Though all participants graduated from universities in Romania, more than half of the physicians graduated from UMFs (54.3%). Majority of the physicians completed the following rotations during their medical school years: Family medicine (65.8%); Pediatrics (89.3%); and Psychiatry (78.1%). Most participants practiced medicine within the capital city of Bucharest (57.2%) with patients mainly coming from urban areas (72.5%). More than 60% of physicians had practiced medicine for more than 15 years at the time of participating in the survey.

Discussion

To our knowledge, this is the first study that assessed the knowledge of physicians in Romania about ASD. Also, although there are very few other surveys that have used factor analysis to define latent structures (domains), this is the first survey that has used Factor Analysis to identify five independent domains for describing different aspects of the knowledge of physicians about ASD. In the following, we will discuss our findings in the context of each of these important issues.

Level of knowledge of practicing physicians in Romania about ASD

Although the finding from our descriptive analysis indicate that the Romanian physicians are knowledgeable about basic issues related to ASD, the overall responses from different parts of the survey suggest that majority of the Romanian physicians may benefit from additional training or continuing medical education in certain aspects of ASD including assessment and causes of ASD. In the following, we discuss these issues.

Findings from descriptive analysis related to knowledge of Romanian Physician about ASD

Findings from our survey indicate that the majority of physicians in Romania have some basic knowledge about ASD. For example, about 73% of physicians correctly responded to an important characteristic of children with ASD: being detached from family members. Additionally, about 94% of the physicians were aware of the educational special needs for children with ASD. Surprisingly, 92% of physicians thought that children with ASD could grow out of this complex disorder. Though cognitive behavioral therapy may help a large portion of children with ASD improve their symptoms and quality of life, most children do not grow out of the spectrum as there is no cure for ASD as yet [6]. Additionally, physicians' responses to some of the questions in the survey indicate deficiency in knowledge about some aspects of ASD which could be improved by relevant additional educational activities. For example, because only 16.3% of physicians correctly responded to all questions regarding the potential causes of ASD, we suggest provision of additional continuing education courses focused on improving physician's knowledge related to potential causes of ASD.

Similar to our survey, a study of 93 Youth and Family Center physicians from the Netherlands that assessed the physicians' knowledge about ASD and the stigmatizing attitude they held towards ASD and mental illness found that the physicians had sufficient general knowledge about ASD [64]. However, physicians in this study still had limited knowledge in specific areas such as language and communication related issues in ASD patients. Additionally, a study of 304 general practitioners from the United Kingdom found similar results in that general practitioners had adequate knowledge about ASD [16]. However, the authors of this paper noted a significant lack in confidence in the general practitioners' ability to manage children affected by ASD, regardless of their level of knowledge. Though we did not study the relationship between physicians' knowledge about ASD and their confidence in implementing that knowledge, it may be an important issue to be considered in future studies.

Developing latent domains for knowledge of Romanian physicians about ASD

It is customary to consider one single composite score to characterize the physicians' knowledge about a disease or a disorder. However, for complex disorders such as ASD, there may be interest in assessing knowledge of physicians regarding different aspects of ASD that cannot be characterized meaningfully into one single composite score. In this survey, since the 12 ASD knowledge questions sought information about different aspects of knowledge of physicians about ASD, we used Factor Analysis, [62], to determine the underlying latent factors. Based on the criteria of Eigenvalue ≥ 1.00 for selection of the composite sub-scores, we identified five independent domains or composite sub-scores: stigma, potential causes, children's behavior, misconceptions, and educational needs associated with ASD. These five composite sub-scores explained about 64% of the total variance in the 12 knowledge questions included in Factor Analysis. The five sub-scores used for subsequent analyses are listed and described in Table 1. We then used General Linear Models to determine characteristics of physicians associated with these five sub-scores. It is important to keep in mind that in this kind of situation a single overall knowledge score is not meaningful because the underlying factors in the scale could negate each other's scores, which makes it very difficult to interpret.

Factors associated with knowledge of physicians related to each of the five domains

Factors associated with physicians' knowledge of stigma related to ASD (Factor 1)

Our findings related to the effects of the location of the physicians' clinic, and whether or not they learned of ASD through TV on physicians' knowledge about stigma related to ASD in Romania, indicate that physicians from Brăila and other smaller cities were less aware of stigma associated with ASD than physicians from Bucharest (AMS difference = - 1.64 for Braila vs. Bucharest; AMS difference = -0.50 for Other cities vs. Bucharest). Physicians who did hear of ASD through TV were more knowledgeable about the stigma related to ASD than physicians who did not (AMS difference = 0.34 for TV-Yes vs. TV-No). Considering the role media and television play in our modern society, the varying portrayals of ASD in news and other media may contribute to the misconceptions and stigma related to ASD. Studies related to other disorders describe increased stigma and misconceptions of mental health due to their portrayals on TV [65–69]. However, few studies assessed this relationship in physicians, and no studies that assessed stigma and perceptions of ASD through television in physicians or other populations were found.

Furthermore, there are few studies that highlight the stigmatizing views of physicians related to ASD, and no studies that assess the potential sources and influences of these attitudes in physicians. However, a study of 93 Youth and Family Center physicians from the Netherlands reported that the Dutch physicians who participated in the study had higher stigmatizing attitude toward ASD compared to Western physicians, but lower than non-western physicians [64]. However, the authors found no association between stigma and ASD knowledge. Unfortunately, it is difficult to compare this study to ours as the measurement tools and analysis methods vary significantly.

Additionally, stigmatizing attitude regarding ASD and mental illness not only effect service delivery but also may potentially deter medical students from perusing psychiatry as a career choice. A study of 68 psychiatrists, 194 pre-clinical medical students, and 354 post-clinical medical students found that pre-clinical medical students were more likely to agree that psychiatrists are not real physicians, and that the level of stigmatizing attitudes decreased with increased exposure to the field of psychiatry [70].

Factors associated with physicians' knowledge of potential cause(s) of ASD (Factor 2)

Our findings from analysis of Factor 2 indicate that younger physicians (≤ 35 years old) were more aware about the potential causes of ASD (AMS difference = 0.72). Similarly, a survey of 348 general physicians in Pakistan reported that physicians less than 30 years of age were more knowledgeable about ASD than their older counterparts [34], and a study of 313 family medicine residents in Turkey also reported that physicians over the age of 35 were less knowledgeable about ASD than the younger residents [35]. This

finding may be a result of the continuously expanding pool of research surrounding ASD, and the inclusion of new findings in school curricula as new knowledge is uncovered. However, this finding also suggests that more efforts are needed to bring awareness about the potential causes of ASD to older physicians through formal continuing education programs. Additionally, physicians who saw 20 or less patients in a day were significantly less knowledgeable about potential causes of ASD than physicians who saw more than 40 patients in a day (AMS difference: -0.99), as were physicians that saw between 21 and 40 patients per day (AMS difference: -0.68). Physicians' general knowledge about various disorders including ASD may also increase as medical knowledge expands, and physicians' practices grow and they come across patients with a variety of ailments. [41]

Factors associated with physicians' knowledge of the behavior of children with ASD (Factor 3)

Older physicians (> 35 years) were more knowledgeable about the behavior of children with ASD than younger physicians (AMS difference = -0.26). Physicians who attended a public medical school were more knowledgeable about the behaviors of children with ASD private school counterparts (AMS difference = -0.57). Experience dealing with children with ASD gained over the years of their practice may provide physicians with a better understanding of the behaviors displayed by ASD children. Additionally, physicians with clinics in Suceava were significantly less knowledgeable than their colleagues that had clinics in Bucharest about the behavior of children with ASD (AMS difference = -0.68). Since larger cities, like the Romanian capital of Bucharest, usually house many of the larger educational institutes in the country compared to the smaller cities, physicians from larger cities may have access to more resources and the most up-to-date information about the behavior of children with ASD. Physicians from larger cities may also have more knowledge of this factor as they may be more likely to be exposed to children with ASD than physicians in smaller cities.

Factors associated with the physicians' knowledge of misconceptions about ASD (Factor 4)

Though we analyzed various variables using GLM models to determine factors association with physicians' knowledge of misconceptions regarding ASD, we found no significant additive or interactive effects for this factor. Even though there were no associations found using basic GLM analyses, future exploratory analyses may be needed to analyze the relationship between this factor and other variables.

Factors associated with physicians' knowledge of educational needs of children with ASD (Factor 5)

Our data also found that whether or not physicians learned of ASD through the newspaper had an additive effect with physicians' knowledge of educational needs of children with ASD. Physicians who did not learn of ASD through the newspaper (Newspaper-No) were less aware of the special educational needs of children with ASD compared to the reference group of physicians who had heard of ASD through the newspaper (AMS difference = 0.06; Newspaper-No vs. Newspaper-Yes). Newspapers,

including ones published online, are still important avenues of information for the general public. Pesonen et al. analyzed 210 full-length newspaper articles in Finland published between 1990 and 2016 to qualitatively assess how articles present ASD to the public. The authors found that 110 out of 210 articles reported information in simple and concise clinical language to educate the public about ASD. Though this study does not assess levels of knowledge for any population, we can see through this paper that newspapers can be a good source of ASD knowledge as long as readers keep in mind that the articles may present ASD knowledge with some bias. [71]

It is necessary to assess the knowledge, attitude, and practices of physicians about ASD as their views and background regarding ASD will potentially affect their practice and their diagnosis of children with ASD. Greater knowledge of physicians about ASD is essential for various reasons such as better service delivery [16, 72] for ASD children and earlier identification of cases for appropriate therapies [34] that rely heavily on physicians' knowledge of ASD. Additionally, greater knowledge of ASD among physicians can also increase the trust between parents, patients, and their physician [37]. Furthermore, as knowledge increases among physicians, they will be able to better educate future generations of physicians. As a result, this may help to decrease the stigma amongst medical students, and hopefully increases the number of students pursuing psychiatry or psychology, further benefitting the Romanian population as well.

While it may be easier to assume that the knowledge score about ASD are additive, further analysis of interactive relationships may help further clarify relationships between factors associated with the sub-scores. We recommend exploring interactions in other knowledge assessment studies as well to determine variables that may have synergistic effects in influencing the physicians' knowledge, attitude, and practices about ASD for a deeper and a more precise understanding of the related issues in the context of physicians' knowledge about a complex disorder such as ASD.

Limitations

We acknowledge that for this study we did not select a random sample of physicians who could represent all physicians in Romania. Instead, we used a convenient sampling of physicians who attended the Annual Conference of the Academic Society of Family Medicine in Romania, hence our study may have been influenced by selection bias and may not be representative of a random sample of physicians practicing in Romania. Since physicians that are interested in ASD are more likely to participate in the study, the responses may be skewed towards physicians that had existing knowledge of ASD. The results may also be influenced by the non-response bias for some questions. For examples, for some questions e.g., when the questions asked whether they have heard of ASD those who answered "Yes" were identified but the remaining answers were left blank. Therefore, for some limited variables it is not clear whether the response to the remaining questions is "No" or other than these two responses. Additionally, due to the nature of some questions such as the practitioner's year of graduation, the study may also have been affected by recall bias. Our study was also dependent on self-reported data regarding knowledge, practice, and attitude of physicians in Romania regarding ASD.

Conclusions

In this study we characterized five latent domains related to Romanian physicians' knowledge about ASD that include stigma, potential causes, behavior in ASD children, special education needs, and misconceptions related to ASD. Though practicing physicians in Romania have adequate general knowledge about ASD, greater focus is needed on increased awareness of stigma and misconception surrounding this disorder, as well as its symptoms and potential causes. Further studies are needed to analyze the effects of the specific factors identified in this study on ASD knowledge on physicians' perceptions and practices related to ASD.

Abbreviations

AMS

Adjusted mean sub-scores; ADHD:Attention Deficit Hyperactivity Disorder; ADI-R:Autism Diagnostic Instrument-Revised; ADOS:Autism Diagnostic Observation Schedule; ADOS-2:Autism Diagnostic Observation Schedule-2; ASD:Autism Spectrum Disorder; ASRS:Autism Spectrum Rating Scale; Carol Davila-UMF:“Carol Davila” University of Medicine and Pharmacy; CHAT:Checklist for Autism in Toddlers; CS-TSA:Chestionarul de Screening pentru Tulburări de Spectru Autist; DSM-5:Diagnostic and Statistical Manual, Fifth Edition; ERC:Ethical Review Committee; GLMs:General Linear Models; IRBs:Institutional Review Boards; KAP:Knowledge, Attitudes, and Practices; LSMeans:Least Square Means; REDCap:Research Electronic Data Capture; SCQ:Social Communication Questionnaire; SAK:Source of ASD knowledge; SEN; Special Education Needs; UMF:University of Medicine and Pharmacy; UTHealth:University of Texas Health Science Center at Houston.

Declarations

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Authors' contributions

Study concept and design (MHR, ID, FR), acquisition of the data (ID, FR, MHR, MH, MS, SG), analysis and interpretation of the data (MHR, SG, SK), drafting of the manuscript (MHR, SG, MH), critical revision of the

manuscript for important intellectual content (MHR, ID, FR, SG, MH). The author(s) have read and approved the submission of the final manuscript.

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Availability of data and material

The datasets used for the current survey will not be publicly available due to the identifiability of the individual sources or the location of physicians' practice. However, these data are fully secured and could become available under certain circumstances from the corresponding author based on a reasonable and a justified request.

Ethics approval and consent to participate

Informed consent was obtained from all participants in the following manner. On the cover page of the questionnaire it is stated that, "By completing this questionnaire, you agree to participate in this study. The decision to participate is voluntary and you can choose to stop at any time during the project. Any information collected by completing the questionnaire prior to your withdrawal from the study will be destroyed upon request." This project was reviewed and approved by the Commission for the Protection of Human Subjects (CPHS) of the University of Texas Health Science Center of Houston (UTHealth) as HSC-GEN-15-0844 and the Ethical Review Committee (ERC) (PO-35-F-03) of Carol Davila-UMF.

Consent for publication

Not applicable.

Competing interests

The authors report no competing interests. The manuscript has not been previously published and is not under consideration in the same or substantially similar form in any other journals.

Conflict of interest

The authors declare no conflict of interest.

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Tables

Table 1. Distribution of physicians' responses to several statements used for assessing knowledge, attitude, and practices of physicians in Romania about Autism Spectrum Disorder (ASD) and information about the five sub-scores representing physicians' knowledge about ASD in Romania identified based on Factor Analysis applied to physicians' responses, n=383. Questions or statements *† Statement is True (T) or False (F) Frequency of physicians N (%**) Latent characteristics of variables involved in the Factor and Factor-like sub-score Agree Disagree

- Children with autism are often detached from their family and peers. a T 280 (73.1) 96 (25.1) Factor 1: Physicians' knowledge of stigma related to ASD Sub-score 1 = Q10+Q11+Q12
- Autism is a possible result of neglect by the parents. b F 160 (41.8) 217 (56.7) 3. Autism is a precursor for schizophrenia. a F 175 (45.7) 201 (52.5)
- It is often difficult to distinguish between autism and schizophrenia. c F 215 (56.1) 160 (41.8) Factor 2: Physicians' knowledge of potential cause (s) of ASD Sub-score 2 = Q2+Q3+Q4+Q5
- Autism is more prevalent in higher socioeconomic classes. c F 191 (49.9) 184 (48)
- Children with autism are not affectionate. b T 179 (46.7) 198 (51.7)
- Children can grow out of autism. b F 353 (92.2) 24 (6.3) Factor 3: Physicians' knowledge of the behavior of children with ASD Sub-score 3 = Q1+Q6
- Children with autism require special education. d T 361 (94.3) 18 (4.7)
- There is a stigma against autism in my community. e T 191 (49.9) 188 (49.1) Factor 4: Physicians' knowledge of misconceptions about ASD Sub-score 4 = Q7+Q14
- Diagnosing a child with autism will lead to discrimination against this child and his/her family. ‡ T 239 (62.4) 137 (35.8)
- In general, there is a negative opinion toward children diagnosed with autism. a T 189 (49.4) 189 (49.4)
- Autism is preventable e F 160 (41.8) 217 (56.7) Factor 5: Physicians' knowledge of educational needs related to ASD Sub-score 5 = Q8

*Participants were asked, "indicate your response to each of the following statements". † Questions 9 and 13 were dropped from the analysis due to their ambiguity. ** Row percentages may not add up to 100% due to missing data; for a there are 7 missing data; for b there are 6; for c there are 8; for d there are 4; and for e there are 5.

Table 2. Descriptive characteristics of physicians that participated in the survey (N=383) Characteristics Categories N (%*)

Gender a Male 85 (22.2) Female 288 (75.2) Age b ≤35 years old (Y/O) 50 (13.1) >35 Y/O 320 (83.6)

Attended medical school in Romania c Yes 379 (99.0) Type of Medical school attended d Private 13 (3.4) Public 361 (94.3)

Medical school of degree conferral e Carol Davila University of Medicine & Pharmacy 208 (54.3) Grigore T. Popa University of Medicine & Pharmacy 64 (16.7) Other 94 (24.5)

Ward rotations completed in medical school Family Medicine Yes 252 (65.8) No 131 (34.2) Surgical Yes 308 (80.4) No 75 (19.6)

OB/GYN Yes 316 (82.5) No 67 (17.5) Psychiatry Yes 299 (78.1) No 84 (21.9) Pediatrics Yes 342 (89.3) No 41 (10.7)

Internal Medicine Yes 340 (88.8) No 43 (11.2) Geriatrics Yes 120 (31.3) No 263 (68.7) Emergency Yes 193 (50.4) No 190 (49.6)

Other Yes 121 (31.6) No 262 (68.4) Training after medical school ** Training at Certificate level 355 (92.7) Training at Masters level 39 (10.2) Training at Doctorate level 28 (7.3)

Other levels of training 107 (27.9) No training 34 (8.9) Most recent continuing education completed at the time of survey f > 2014 159 (41.5) 2007-2014 76 (19.8) < 2007 73 (19.1)

Years practicing medicine g ≤ 15 Years 97 (25.3) 16-30 Years 151 (39.4) > 30 Years 115 (30.0)

City in which the physician's clinic is located h Bucharest 211 (55.1) Sușeava 23 (6.0) Brăila 16 (4.2) Other 119 (31.1)

Average number of patients seen by the physician in a day i > 40 patients 16 (4.2) 21-40 patients 176 (46.0) 0-20 patients 166 (43.3)

Where the physician's patients come from? j Urban 270 (70.5) Rural 46 (12) Both urban and rural 56 (14.6)

Has the physician heard of autism? k Yes 305 (79.6) No 72 (18.8)

Physician's sources of knowledge about ASD (n = 305) Medical School Yes 137 (44.9) No 168 (55.1) Continuing Education Yes 166 (54.4) No 139 (45.6) Conferences Yes 225 (73.8) No 80 (26.2) Primary Literature Yes 205 (67.2) No 100 (32.8) Colleagues Yes 168 (55.1) No 137 (44.9) Television Yes 145 (47.5) No 160 (52.5) Newspaper Yes 75 (24.6) No 230 (75.4) Internet Yes 230 (75.4) No 75 (24.6) Radio Yes 27 (8.9) No 278 (91.1) Other sources I Yes 37 (12.1) No 253 (83.0) *Row percentages may not add up to 100% due to missing data; ** It is possible for physicians to have participated in multiple training programs after medical school, as a result, the percentages do not add up to 100%. The number of missing data for the variable with a are 10; for the variable with b are 13; for the variable with c are 4; for the variable with d are 9; for the variable with e are 17; for the variable with f are 75; for the variable with g are 20; for the variable with h are 14; for the variable with i are 25; for the variable with j are 11; for the variable with k are 6; and for the variable with l are 15. Table 3. Knowledge of the physicians about ASD symptoms, (n=383)* Symptoms Number and Percent of physicians Necessary n (%) Not Necessary but Helpful n (%) Not Helpful n (%) Don't Know n (%) Impaired social interaction a 332 (88.3) 27(7.2) 3 (0.8) 14 (3.7) Impaired communication b 320 (87.0) 45 (12.2) 3 (0.8) 0 (0.0) Visual hallucinations c 13 (3.5) 85 (22.7) 197 (52.5) 80 (21.3) Restricted and repetitive behavior c 247 (65.9) 80 (21.3) 12 (3.2) 36 (9.6) Lack of eye contact a 275 (73.1) 54 (14.4) 13 (3.5) 34 (9.0) Confirmed schizophrenia c 10 (2.7) 68 (18.1) 194 (51.7) 103 (27.5) Hearing voices d 15 (4.0) 84 (22.5) 188 (50.4) 86 (23.1) Language disturbances a 229 (60.9) 111 (29.5) 15 (4.0) 21 (5.6) Hypersensitivities to certain environments a 172 (45.7) 113 (30.1) 23 (6.1) 68 (18.1) Depression e 36 (9.6) 117 (31.3) 99 (26.5) 122 (32.6) Anxiety c 87 (23.2) 132 (35.2) 59 (15.7) 97 (25.9) *Participants were asked "in diagnosing children with autism spectrum disorder (ASD), the following symptoms are..."; a Data are missing for 7; b Data are missing for 15; c Data are missing for 8 physicians; d Data are missing for 10; e Data are missing for 9. Table 4: Latent sub-scores for physicians' knowledge, attitude, and practices as determined by factor analysis and their sub-scores, (n=383) Factors Latent characteristic of variables involved in the Factor Min Score Max Score Frequency of physicians at sub-scores for each Factor Row % (n) 0 1 2 3 4 Factor1 a Knowledge of stigma related to ASD (n=376) 0 3 26.1 (98) 17.6 (66) 13.3 (50) 43.1 (162) NP* Factor2 b Knowledge of potential cause(s) of ASD (n=374) 0 4 15.2 (57) 20.3 (76) 27.5 (103) 20.6 (77) 16.3 (61) Factor3 c Knowledge of the behavior of children with ASD (n=375) 0 2 20.3 (76) 37.6 (141) 42.1 (158) NP NP Factor4 d Misconceptions about ASD (n=377) 0 2 47.8 (180) 48.0 (181) 4.2 (16) NP NP Factor5 e Knowledge of educational needs and outcomes related to ASD (n=379) 0 1 4.7 (18) 94.3 (361) NP NP NP a Factor 1 sub scores were missing for 7 physicians; b Factor 2 sub scores were missing for 9 physicians; c Factor 3 sub scores were missing for 8 physicians; d Factor 4 sub scores were missing for 6 physicians; e Factor 5 sub scores were missing for 4 physicians; * NP = Not possible due to maximum score limitation Table 5: Factors associated with Physicians' ASD knowledge related to the five sub-scores based on final Multivariable General Linear Models (GLMs) along with the adjusted means of the five sub-scores for each level of the independent variables in GLMs Factor Variable Name Categories Adjusted Mean Sub-Score (AMS)† Adj. Mean difference* P value** 1 - Knowledge of stigma related to ASD (n=364) City where the clinic is located Bucharest (Reference) 1.93 - - Brăila 0.29 -1.64 <0.01 Suceava 1.98 0.04 0.86 Other 1.44 -0.50 <0.01 Television as a source of ASD knowledge Yes 1.70 0.34 0.02 No (Reference) 1.38 - - 2 - Knowledge of potential cause (s) for ASD (n=341) Age of physician at time of survey (years) ≤ 35 years

old (Y/O) 2.90 0.72 <0.01 > 35 Y/O (Reference) 2.18 -- Average number of patients seen in a day 0-20
 2.11 -0.98 0.04 21-40 2.42 -0.68 0.25 \geq 41 (Reference) 3.10 -- 3 - Knowledge of the behavior of children
 with ASD (n=350) Age of physician at time of survey (years) \leq 35 years old (Y/O) 0.37 -0.26 0.02 > 35
 Y/O (Reference) 0.64 -- Type of medical school attended Private 0.57 -0.57 0.03 Public (Reference) 1.02 -
 - City where the clinic is located Bucharest (Reference) 0.99 -- Braila 0.95 0.09 0.84 Suceava 0.30 -0.69
 <0.01 Other 0.94 -0.07 0.61 4 - Knowledge of misconceptions about ASD (n=377) Television or radio as a
 source of ASD knowledge Yes 0.51 -0.11 0.09 No (Reference) 0.62 -- 5 - Knowledge of educational needs
 regarding children with ASD (n=379) Newspaper as a source of ASD knowledge Yes 1.00 0.06 <0.05 No
 (Reference) 0.94 -- †Least Squared Means; *Adj. Mean difference from the reference; **H0: Least Square
 Mean (LSMean) (group 1) = LSMean (group 2).