Implementation of M-Chat for Screening of Early Signs of Autism in the Brazilian Health Care System: A Feasibility Study

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Article

Implementation of M-Chat for Screening of Early Signs of Autism in the Brazilian Health Care System: A Feasibility Study

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Abstract: Background: Although screening for early signs of autism spectrum disorder (ASD) using the Modified Checklist for Autism in Toddlers (M-CHAT) has been recommended by the Brazilian Ministry of Health since 2017, the feasibility of this intervention and its effects in primary care have not been sufficiently investigated. **Objectives**: (1) to assess the level of knowledge and practices of nursing professionals' caregivers in Brazilian primary health care regarding ASD, (2) to evaluate the feasibility of incorporating the M-CHAT into the vaccination childcare routine, and (3) evaluate the frequency of children with possible early signs of ASD using the M-CHAT. **Methods**: This is an observational, cross-sectional study conducted in a medium-sized city in southeastern Brazil. A total of 97 nurses from 21 health facilities participated. The professionals answered a questionnaire on knowledge and practices regarding ASD, attended a training on early signs of ASD and for the use of M-CHAT. Finally, they administered the M-CHAT to 267 parents of children aged 16 to 57 months in primary care settings. **Results:** Insufficient knowledge of ASD was identified among the nursing professionals evaluated. Approximately 80% agreed that the training was satisfactory, and 88% agreed that they felt competent to use the M-CHAT, 74% agreed with the benefits of using the M-CHAT to detect early signs of ASD in public health settings. However, 91% of the professionals reported that incorporating the M-CHAT into the day care routine overloaded their work, and less than 50% agreed that the instrument should continue to be used in the day care routine. Sixty-seven (25.09%) children screened positive for possible early signs of ASD by M-CHAT. **Conclusion:** The insufficient level of knowledge on ASD found among nursing professionals suggests gaps in Brazilian academic and professional training in this area. Although most participants recognized the importance of early detection of signs of ASD in primary care settings, the implementation of the M-CHAT in the routine primary care settings was not well accepted for most participants due to work overload, which indicates the need for public health policies to offer working conditions that minimize the overload of professionals, maintaining early screening interventions for ASD in Brazilian primary care institutions.

Keywords: Autism; M-CHAT; primary health care; early detection; public health; nursing

1. Introduction

Autism Spectrum Disorder (ASD) is classified under the category of Neurodevelopmental Disorders in the 5th revised edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [1]. The clinical features that support the diagnosis are persistent impairments in reciprocal social communication and social interaction, restricted and repetitive patterns of behaviors, interests

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or activities [1]. Signs and symptoms must be present from early childhood and limit or impair daily functioning [1]. The symptoms associated with ASD are usually recognized during the second year of life, between 12 and 24 months, however, in severe cases, these signs can be observed before 12 months of age [1]. Developmental indicators and the course of the clinical features of the disorder are associated with early developmental delays, social skills deficits, language delays and indicators of intellectual impairment [1].

It is well established in the literature that identifying and treating ASD at an early age is associated with better prognosis [2–5] enabling more complete neuropsychomotor development and better adaptive functioning, which has a positive impact on the quality of life of the individual with ASD themselves, as well as their caregivers and family members [6]. Previous scientific evidence indicates that children with ASD already present signs of ASD between 12 and 24 months. Study of Backes et al. [7] revealed, from the analysis of 171 episodes of home videos made available by parents and filmed before the diagnosis of ASD, that the loss of words, deficits in social skills, impairments in playing and socialization behaviors are indicators and warning signs for the ASD. Alhozyel et al. [8] examined the association of commonly measured early developmental milestones with later diagnosis of ASD comparing 280 children with ASD and 560 typically developed children matched to cases by date of birth, sex, and ethnicity. The findings highlight the potential role of early developmental milestones as early signs of ASD that could facilitate earlier referral and diagnosis of ASD. It is essential that children between 12 and 24 months of age be monitored to identify developmental delays and signs of risk for ASD [9]. In developing countries, these actions in childcare routines are very important, considering that in these countries exposure to perinatal risk factors use to be higher compared to developed countries, for example, preterm birth, low birth weight, hyperbilirubinemia clustering of pregnancy complications, maternal immigrant status [10].

Different technologies have been tested for the earlier diagnosis of ASD, including the use of innovative machine learning and deep learning technologies [11–13] especially in developed countries. However, in underdeveloped or developing countries, even screening for ASD with low-cost instruments that assess child development based on the reports of parents and caregivers of children at an early age remains a health challenge. In developing countries, one of the main barriers to early diagnosis of ASD is the implementation of screening and monitoring actions in public health services for the mental health of children in early childhood, even when public policies that advocate such early screening already exist.

Study of Araripe et al. [14] identified the profile of service use, barriers to access care, and sociodemographic factors related to these barriers in Brazilian families with children with ASD (sample of 927 families with children with ASD between 3 and 17 years from five Brazilian regions). The study verified a high variability of use of mental health services according to age, the region of residence, type of health care system used, and the parents/caregivers' education, but the access to behavioral interventions was more frequent among users of the private system/health insurance and families whose caregivers had higher education [14]. Montiel-Nava et al. [15] verified the age of parents' first concerns about their child's autism and compared them with the age of ASD diagnosis (sample of 2520 caregivers of autistic children in six different Latin America and Caribbean Countries). Results indicated that, on average, caregivers were concerned about their child's development by 22 months of age, however, the diagnosis was received when the child was 46 months of age.

Among the main reasons for this difficulty are the heterogeneity of the clinical characteristics of signs and symptoms [16–19], the lack of a consensus on what constitutes a diagnosis of ASD [16–19], difficulties in the population's access to health services [20–22], lack of health professionals properly trained in recognizing indicators of child development and early signs of ASD [23], and the irregular and non-standardized implementation of routine measures to assess early signs of ASD [14,23]. Considering this scenario, it is important that, on a micro-regional scale, policy makers and practitioners test strategies that can provide early screening for ASD and verify whether these

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strategies can in fact be successfully implemented facilitating effective planning and future investments.

Regarding the screening for early signs of ASD in Brazil, the role of primary care health teams is essential. In the country, the document "Guidelines for Rehabilitation Care for People with ASD" presents a set of expected child development indicators for early age groups (from 0 to 48 months), as well as indicators of delays in neuropsychomotor development and early signs of ASD [24]. The document is a valuable tool to be used by primary care teams, bearing in mind that to identify a sign of the disorder, it is essential that the professional also recognizes the expected developmental milestone for the age in each area. The guideline aims to provide guidelines for multi-professional teams in "Sistema Único de Saúde", the Brazilian public health system, for the health care of people with ASD and their families at the different points of care in the Care Network for People with Disabilities [24]. The Brazilian Ministry of Health has presented a set of guidelines for primary care health service professionals to monitor the development of children in the first three years of life, with the aim of detecting early signs of ASD, identifying suspected cases and referring them for diagnostic assessments by a specialized multidisciplinary team [24].

However, previous studies have already shown that primary health care professionals, including nursing technicians, nurses, psychologists, pediatricians and social workers, need continuing training to be able to identify early signs of ASD in toddlers [20,25]. Discussions and actions regarding the need to train health professionals arise in the context of various problems, such as gaps in academic training, lack of government investment and lack of preparation due to the scarcity of training and resources for the neuropsychomotor process of child development or the inappropriate use of neuropsychomotor development assessment tools [26]. Curricular structures of undergraduate courses in health areas have already revealed a lack of content on child development and signs of neurodevelopmental disorders and psychiatric disorders [27–29]. Even courses whose basic object of study is mental health are deficient in terms of training in this area, such as the Brazilian undergraduate in Psychology [29,30]. These gaps increase the risk of late diagnoses and interventions or even misdiagnoses [31].

In Brazil, previous studies show that both in primary care and in specialized outpatient services, pediatricians and other health professionals lack preparation to perform clinical assessments in suspected cases of various neurodevelopmental disorders, including ASD [15,23]. Although primary care is a privileged level of the SUS health care networks in Brazil, it is necessary to equip professionals to play this role and offer assessment models that can be included in routine actions to monitor the health of children at an early age.

One of the theoretical approaches with relevant contributions to reducing the translational gap between research and practice [32] is Dissemination and Implementation science (D&I), whose main purpose is to identify, understand, and optimize the process of applying scientific evidence in practical contexts and according to the reality of the population studied. This field encompasses stages such as planning, dissemination, adoption, adaptation to local specificities, and even evaluation of interventions. Thus, D&I, in the context of Implementation Science, investigates how the stages of a given implementation interact with the needs and specificities presented by the target audience, considering the particularities of the context in which the implementation takes place [33]. Previous Brazilian studies have already shown favorable results regarding the implementation of mental health monitoring actions in primary care [34]. However, there are still few studies that test screening actions for early signs of ASD in the health monitoring routines of toddlers in primary care [35]. Based on these premises, there is still a need in Brazil to test specific models of early screening for ASD that can be used by health professionals in charge of childcare in the first five years of life.

The screening for early signs of autism spectrum disorders (ASD) using the M-CHAT has been recommended by the Brazilian Ministry of Health since 2017, however, the feasibility of this measure has been little investigated in Brazilian public health services. Given the epidemiological relevance of autism and the importance of early diagnosis and treatment for a better prognosis, the objectives of this study were: (1) to assess the level of knowledge and practices of primary health care

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professionals in relation to autism; (2) to assess the feasibility of incorporating the M-CHAT into the routine of primary health care, specifically in the vaccination childcare routine, and (3) to assess the frequency of children with possible early signs of ASD detected by the M-CHAT

2. Methods

2.1. Study Design and Setting

The study design was observational and cross-sectional. The study was carried out in the municipality of Cotia, São Paulo state and located in the southeastern region of Brazil, which is the most developed in the country in terms of income and human development. According to Brazilian Institute of Geography and Statistics [36], the population of Cotia in 2021 was 257,882 inhabitants. In the last assessment, conducted in 2010, Cotia had a Human Development Index of 0.780, considered high compared to other Brazilian municipalities, however, with high levels of social inequality [37]. Although the GDP of the city of Cotia was R$ 62,486.58 (EUR: 10,243.60) in 2021 [36], much higher than Brazil's GDP per capita in the same year, which was R$ 42,247.52 (EUR: 6,925.82), income indicators alone do not guarantee human development, since Brazil is one of the countries with the greatest social inequality assessed by the GINI Index [38] in the world, and even in the most developed states, such as São Paulo, there are families in situations of socioeconomic vulnerability and food insecurity, especially on the outskirts of medium and large urban centers.

2.2. Participants

This was a non-probabilistic sample of nursing professionals and parents or caregivers of toddlers, selected according to convenience criteria. Our study was conducted with nursing professionals and parents or caregivers of toddlers from 21 of the 26 Basic Health units of Brazilian public health system in Cotia in 2021. Two groups took part in the study: (1) 97 (91.5%) nursing professionals working in public primary health care equipment's, out of a total of 106 eligible professionals. Most of nursing participants were female (87.23%), and mean age was 44.54 years old (SD = 9.32). Most professionals had the highest level of technical education (n = 47; 48.45%), followed by higher education (n = 27; 27.84%) and higher education and lato sensu postgraduate studies (n = 23; 23.71%). More than half of the professionals (n = 56; 59.57%) had worked in the health sector for more than five years, followed by those who had worked for between one and three years (n = 20; 28%), less than one year (n = 12; 12.77%) and three to five years (n = 6; 6.38%). The participating primary health care professionals were nominated by the local coordinators, considering their availability to take part in the study, so that there was no impact on the work routine in the institutions. At least two professionals from each of the 26 health units in Cotia took part in the study. Parents of children aged between 16 and 57 months also took part in this study. We assessed 267 mothers or main caregivers from an eligible sample of 3,601 children, attended at the childcare and vaccination sessions at the health units between November 2019 and January 2021. The inclusion criterion for mothers or caregivers was that they cared for their child for at least 6 hours a day. The age distribution of the children assessed ranged from 16 to 30 months (M = 22.39; SD = 4.23), and 50.94% were male.

2.3. Instruments

a) Questionnaire to assess knowledge of typical developmental milestones and early warning signs for ASD: developed by the researchers for this study, the instrument as-sesses expected developmental milestones and early warning signs for ASD in early childhood, predominantly between 12 and 30 months. It was based on the Ministry of Health's document "Guidelines for the Rehabilitation of People with Autism Spectrum Disorders" [24]. The questionnaire is structured in two parts: the first, made up of 14 multiple-choice questions, assesses professionals' knowledge of child development; the second, made up of 8 questions, assesses the conduct expected in primary care health services in cases where possible developmental alterations are identified. The validity of

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the instrument was checked by three independent judges, all of whom had a doctorate in human development, as well as clinical and teaching experience in developmental disorders. The criteria analyzed were clarity, precision and objectivity [39]. The judges' analysis to verify the objectivity, precision and clarity criteria of the instrument items showed agreement between the judges of more than 0.80 in the objectivity and precision criteria, with values of 0.86 and 0.87, respectively, which indicates a good degree of agreement, according to Pasquali [40]. In the clarity criterion, the score was 0.66, considered relatively low. Proposed changes were made to the items to create an instrument whose items had adequate criteria for precision, clarity and objectivity, considering the type of construct validity adopted.

b) The "Modified Checklist for Autism in Toddlers" (M-CHAT): developed by Robins et al. [41], the instrument comprises 23 items designed to screen for early signs of autism in children aged between 16 and 24 months, based on reports from parents or caregivers. Any previously trained health professional can use it. The items are scored with "yes" or "no" answers to indicate the presence of signs of ASD. The items assess the child's interest in social interaction, their ability to maintain eye contact, their aptitude for imitation, their tendency to play make-believe and to use eye contact and gestures to direct their partner's social attention or to ask for help. The M-CHAT scoring algorithm states that, except for items 2, 5 and 12, a "no" answer indicates a risk of ASD, while a "yes" answer indicates a risk of ASD for items 2, 5 and 12. According to the instrument's correction indication, a total score of 4 or more, or 2 or more positive critical items, indicates a risk of ASD, which suggests the need for more in-depth assessments by specialized professionals. In the original study evaluating the psychometric properties of the M-CHAT, internal reliability was found to be adequate for both the entire checklist and for the critical items (α = 0.85 and α = 0.83, respectively). Sensitivity was 0.97 and specificity was 0.95, both considered high [41]. The cross-cultural adaptation study of the M-CHAT for the Brazilian population was carried out by Losapio & Pondé [42], and the study evaluating the psychometric properties of the instrument for the Brazilian population was carried out by Castro-Souza [43], who found an alpha of 0.95, a sensitivity of 0.94 and a specificity of 0.91. These results indicate that M-CHAT is suitable for assessing early signs of ASD in children in Brazil.

c) Questionnaire to assess the training of professionals in the use of the M-CHAT in-strument and evaluation of its implementation in vaccination childcare routines, con-sisting of seven questions that assessed, according to the nursing professionals' reports, their perceptions of the quality of training and support actions for the use of the M-CHAT in childcare and immunization routines, the perception of overload and the evaluation of the maintenance of the M-CHAT as part of the routines.

3. Results

In the sample of nursing professionals assessed on their knowledge of ASD, which could range from 0 to 14 points, we found an average of 5.24 (SD=2.46). No professional answered all the questions correctly, and the maxi-mum score was 11 points. We found that no question was answered correctly by more than 70% of the nursing professionals assessed. Table 1 shows the frequency and percentage of nursing professionals who answered each question of the ASD knowledge questionnaire correctly.

Table 1. Frequency and proportion of nursing professionals who correctly answered the questions on the ASD knowledge questionnaire (n=97).

Question	Correct Answers	(%)
1) What are the established etiological factors of ASD?	57	58.16%
2) What are the signs and symptoms of ASD?	62	63.27%
3) Which syndromes are usually associated with ASD?	14	14.29%
4) Which symptoms of ASD are sensitive to drug interventions?	58	59.18%
5) What therapies are recommended for interventions for children with ASD?	57	58.16%

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6) Identify which characteristics of a clinical case presented may be indicators of ASD	17	17.35%
7) What is a savant skill?	21	21.43%
8) Which areas are predominantly affected in people with ASD?	32	32.65%
9) What is the approximate distribution of ASD cases by gender?	10	10.20%
10) What is the best estimate of the prevalence of ASD in the general population?	12	12.24%
11) Which of the ASD screening scales are you familiar with?	26	26.53%
12) What is the main care unit in the public health network responsible for monitoring children with ASD?	51	52.04%
13) What is the best composition of a multidisciplinary team for the clinical diagnostic evaluation of ASD?	58	59.18%
14) What assessment procedures should be carried out when receiving a child with suspected ASD?	38	38.78%

The questions with the highest frequency of correct answers referred to signs and symptoms of ASD, symptoms of ASD that are sensitive to medication and the types of therapies recommended for the treatment of children diagnosed with ASD, and the composition of the multidisciplinary team for the clinical assessment of the diagnosis. Less than 20% of the professionals assessed correctly answered the questions related to the epidemiology of ASD, ASD comorbidities with genetic syndromes and ASD symptoms. Approximately one in four professionals knew about tools for screening for early signs of ASD. Table 2 shows the frequency and proportion of nursing professionals who answered each question of the ASD practice questionnaire correctly.

Table 2. Frequency and proportion of professionals who correctly answered the questions on the ASD practices questionnaire (n=97).

Question	Correct Answers	(%)
1) Feel safe in explaining the stages of neuropsychomotor development to a baby's parents?	37	37.7 6%
2) Feel confident in assessing and communicating with the family about the stages of a baby's development?	55	56.1 2%
3) Feel confident in alerting the family when the child doesn't speak at 28 months?	61	62.2 4%
4) Feel confident in telling parents that their baby may have an indicator of altered development?	50	51.0 2%
5) Do you guide a child's parents to a referral when you notice a language delay or change?	83	84.6 9%
6) Do you ask for help from other professionals when the child doesn't know how to play as expected for their age with other children?	89	90.8 2%
7) Do you recommend that parents see a specialist when they report that their child is acting differently?	89	90.8 2%
8) Do you advise parents to seek specialized care when they notice that their child has difficulties and isn't saying anything?	89	90.8 2%

Regarding the scores for practices related to ASD, which could vary between 0 and 8 points, we found an average of 5.64 (SD=1.95). The questions with the highest frequency of correct answers (90%) referred to guidance for parents when the nursing professional notices any language alterations or changes in play behavior, and guidance for parents to seek specialized care when they notice behaviors that may indicate some neurodevelopmental alteration. The lowest scores were found for question 1, which assessed the professional's self-perception of their skills and competencies in advising a parent or caregiver on the stages of neuropsychomotor development. Table 3 shows the results of the differences in the means of the knowledge and practice scores in relation to the type of training of the professionals (assistant, technician or nurse).

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Table 3. Comparison of mean knowledge and practice scores in relation to type of training (n=97).

Groups	*M*	*DP*	*H(gl)*	*P*	Comparison	p_{Tukey}	*D*
			Knowledge				
Auxiliary (n=12)	3.42	2.19			Technical	0.09	0.72
Technician (n=46)	5.02	2.25	9.20(2)	0.01	Nurse	0.17	0.39
Nurse (n=39)	5.95	2.47			Auxiliary	0.02	1.05
			Practices				
Auxiliary (n=12)	5.17	2.25			Technical	0.92	0.12
Technician (n=46)	5.41	2.02	25.90(2)	0.31	Nurse	0.35	0.31
Nurse (n=39)	6.00	1.75			Auxiliary	0.40	0.45

The knowledge score was higher for professional technicians and nurses, which differed significantly from those trained as assistants, with medium and large effect sizes, respectively. The practice score showed no significant difference when comparing the types of training. However, even without significant differences, the pattern remained, with nurses scoring higher, with small effect sizes in comparison with assistants and technicians.

According to the M-CHAT, of the 267 children evaluated, 67 (25.09%) tested positive for possible early signs of ASD. The total M-CHAT scores of the 267 children ranged from 0 to 15 points, with a mean of 1.93 points (SD = 2.08). Regarding critical items, 209 children (78.28%) scored none, 44 children (16.48%) scored one critical item, eight children (3%) scored two critical items, three children (1.12%) scored three critical items, two children (0.75%) scored four critical items and only one child (0.37%) scored five critical items. Although the proportion of boys with possible early signs of ASD was higher, there were no significant differences in relation to the proportion of girls. No significant differences were found between the M-CHAT score and the sex and age group of the children assessed. Table 4 shows the associations between the M-CHAT score and the sex and age group of the participants.

Table 4. Association between M-CHAT score and gender and age group (n=267).

M-CHAT classification	Sex of the child		X^2	*p*
		Male		
No risk (n=200)	101 (50.50%)	99 (49.50%)	0.45	0.50
At risk (n=67)	30 (44.77%)	37 (55.23%)		
M-CHAT classification	Child's age group		X^2	*p*
	16 a 22	23 a 30		
No risk (n=200)	105 (52.50%)	95 (47.50%)	0.45	0.50
At risk (n=67)	39 (58.20%)	28 (31.80%)		

Regarding the feasibility of including the M-CHAT in the childcare routines of health units, approximately 80% reported that the course fulfilled its objective of training them in knowledge about early signs of ASD and 88% reported feeling able to use the M-CHAT. In addition, 74% agreed with the benefits of using the M-CHAT to detect early signs of ASD in public health. However, 91% of the professionals reported that incorporating the M-CHAT into the childcare routine overloaded

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their work and less than 50% agreed that the instrument should continue to be used in childcare routines.

4. Discussion

Our aim in this study was to assess the level of knowledge and practices regarding ASD among nursing professionals working in primary health care in the Brazilian public health system, in a medium-sized city located in the state of São Paulo, in the southeastern region of Brazil. In addition, we evaluated the feasibility of incorporating the M-CHAT into the vaccination childcare routines, after training nursing professionals. Additionally, we evaluated the frequency of children with possible early signs of ASD using the M-CHAT. It is well established in the literature that screening for signs of ASD among children in the first years of life, associated with proper diagnosis and treatment based on the best available scientific evidence, when carried out early, is associated with better prognoses [4,6].

The M-CHAT is a simple, quick-to-apply and low-cost instrument. It is currently considered one of the ASD screening instruments with good sensitivity and specificity rates, according to a systematic review with meta-analysis that evaluated 50 studies in which the M-CHAT was used [44]. Furthermore, the Brazilian study that assessed the psychometric properties of this instrument for the Brazilian population also found excellent internal consistency and high sensitivity and specificity [43]. For this reason, M-CHAT is recommended by different guidelines, including the Brazilian ones, to assess early signs of ASD at early developmental ages [45–47]. The M-CHAT has been used in several Latin American countries, such as Uruguay, Argentina, Chile and Brazil, over the last 10 years [22,48,49], and since 2017 its use has been recommended by the Brazilian Ministry of Health [50].

4.1. Feasibility and Evaluation of Training on ASD and M-CHAT

The training on neurodevelopmental disorders, identification of early signs of ASD and on the application of the M-CHAT was well accepted and well evaluated by the nursing professionals. Although most professionals recognized the importance of detecting early signs of ASD in primary care settings, the introduction of the M-CHAT into the routine of the community basic health units was not well accepted. The burden associated with the inclusion of this intervention was the main reason cited by professionals for low acceptance. We found that approximately 40% of the nursing professionals who took part in the study had less than three years in the health sector. Historically in Brazil, nursing professionals have received low salaries in the public health system, especially in primary health care setting and in early stages of career [51–53]. According to law 2564/2020 [54], the national salary floor for nursing professionals, for a 40-hour working week, should be R$2,375.00 (EUR 389.00) for nursing assistants, R$3,325.00 (EUR 545.00) for technicians and R$4,750.00 (EUR 778.00) for graduate nurses. Although the state of São Paulo, where the research was carried out, complies with the salary floor law for these professionals, the cost of living in this state is known to be higher, which can be a complicating factor in the household budget for these professionals. To get around these difficulties, a considerable number of these professionals must work double shifts, with excessive workloads that can exceed 60 hours a week [52,55]. In addition, an accumulation of administrative and care duties [56], an excessive number of appointments and procedures, inadequate infrastructure in health units and a shortage of working materials are other drawbacks. These results indicate the need for public health policy leaders to provide continuity to this assessment model and to identify strategies and interventions that minimize the burden on professionals, with the aim of making it feasible to maintain early screening interventions for ASD in Brazilian primary care institutions.

4.2. Knowledge About ASD

Our main results indicated a low level of knowledge and little expertise in handling situations in which neurodevelopmental alterations are identified in children aged between 12 and 30 months

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by nursing professionals, especially among nursing technicians and assistants. Important knowledge for primary care professionals, such as the etiology of ASD, risk factors, prevalence, clinical indicators for differential diagnosis and knowledge of ASD screening tools, showed low percentages of correct answers (up to 58% of correct answers). This result corroborates previous studies conducted in Brazil [57,58].

The practical questions that indirectly assessed knowledge of ASD (questions 1 to 4), showed that professionals perceived gaps in their academic training in relation to expected developmental milestones and recognizing early signs of ASD, as well as uncertainty in advising mothers and caregivers on what to do. This is consistent with the results of the first part of the questionnaire on general knowledge of ASD. The questions with the highest frequency of correct answers asked these professionals about their decision making in identifying language delays, impairments in play behavior and eye contact deficits. The answers to the questions about practices related to ASD were dichotomized as 'yes' and 'no', and the questions on the knowledge questionnaire were multiple choice, some with more than 6 possible answers. Our hypothesis is that the slightly higher scores for practice compared to knowledge of ASD may be related to the greater complexity of the multiple-choice questions in the ASD knowledge questionnaire compared to the dichotomized questions in the practice questionnaire. It may also be related to responses based on caution, i.e. when faced with signs or symptoms of neurodevelopmental abnormality, even with a high likelihood of a false positive, professionals tended to feel that the most appropriate course of action would be to refer the child for specialist assessment. This type of routine can contribute to early identification; however, false positive cases can overload the Brazilian public health system and increase the difficulty in absorbing the high flow of care.

4.3. Early Signs of ASD According to M-CHAT

We identified 25% of children with possible early signs of ASD. This result is similar to that found in underdeveloped or developing nations such as Indonesia, where Windiani et al. [59] found 24.54% of children with possible early signs of ASD, and much higher than what has been reported in studies carried out in developed countries. For example, in the American study by Kleinman et al. [60], the proportion of children identified with possible early signs of ASD using the M-CHAT was 11.63%, and in Spain, 17.29% [61]. We highlight that our result regarding a high proportion of cases with possible early signs of ASD should be analyzed with caution, since studies indicate that the high rates of false-positive cases may be associated with socioeconomic vulnerability, food insecurity or chronic nutritional deficiencies, as well to the lack of stimulation of children at early ages, adverse conditions that have gradually improved over the last few decades in Brazil, but which are still very prevalent in the country [62,63]. These adverse environmental variables limit adequate development even among children without ASD [64] and may also increase the number of false positives assessed by the M-CHAT in our study. In addition, false positives may be related to the lower educational level of parents or carers, or parents' inaccurate report or they're not being willing or psychologically ready to endorse an increased likelihood of ASD behaviors during screening [44,65].

Moreover, researchers recommend that health professionals adopt a cautious approach to monitoring for early signs of ASD in very young toddlers, since some children with ASD, symptoms are subtle early in development or show a prolonged course of symptom development, consistent with the theory that although brain development may be different before birth, measurable symptoms of ASD may emerge gradually because children are expected, and fail, in demonstrating more sophisticated behavior as they grow older [18,19,44]. To minimize the possibility of identifying false-positives cases, multiple assessments of children's neurodevelopment over time are recommended, using more than one screening tool and instruments that assess not only parents and caregivers reports on their children's development, but also direct observation of behavior in structured situations by trained professionals [44].

In our study, the follow-up of cases identified with possible early signs of ASD by the M-CHAT was planned to be carried out by a multi-professional team specializing in neurodevelopmental

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disorders to refute or confirm the diagnosis of ASD. However, this planning was made impossible by the resurgence of the COVID-19 pandemic and social isolation measures.

4.4. Limitations and Future Directions

Although we achieved our objectives, our study has limitations that need to be presented. Our results represent an overview of Cotia, regarding knowledge and practices about ASD by nursing professionals, and the use of the M-CHAT to screen for early signs of ASD in primary health care in the Brazilian public health system. However, they may not reliably represent the condition of professionals in other regions of the state of São Paulo or other Brazilian states, given the cultural and economic heterogeneity of the country, which has continental dimensions. For this reason, we recommend carrying out multicentric studies in different Brazilian states to produce more robust evidence with greater external validity in terms of generalization.

In addition, the cross-sectional design of our study allowed us to present a momentary overview of the variables analyzed. As the research was carried out during the first months of the COVID-19 pandemic in Brazil, a period of great stress and uncertainty, our results on the acceptance of the implementation of M-CHAT in childcare routines may have been influenced by this variable. Due to the worsening of the COVID-19 pandemic in Brazil and social distancing measures, it was not possible to objectively reassess the level of knowledge and practices about ASD among health professionals after the training. Therefore, our assessment of the effects of the training was based solely on the professionals' perception of the quality of the training, a result that may suffer from social desirability bias.

Furthermore, the follow-up and reassessment of the cases identified by the M-CHAT by a specialized multidisciplinary team was also made impossible by the worsening of the COVID-19 pandemic and, therefore, it was not possible to confirm the diagnosis of ASD among the children assessed. For future studies, we suggest evaluating children at an earlier age and following up cases for diagnostic confirmation, to produce more evidence on the sensitivity and specificity of the M-CHAT for identifying ASD in Brazilian children. Strategies for monitoring ASD signs can be carried out by nursing technicians and assistants who have been previously trained and supervised by nurses. Additionally, false positives and negatives resulting from these monitoring procedures can be monitored.

5. Conclusions

Nursing professionals of our sample showed insufficient knowledge regarding ASD, in terms of etiology, most prevalent signs and symptoms, epidemiology, treatment and screening tools, as well as little proficiency in guiding parents and caregivers of children with possible early signs of ASD. This result suggests the need to assess gaps in academic nursing training related to ASD, and the importance of continuing education on neurodevelopmental disorders. The training on neurodevelopmental disorders, identification of early signs of ASD and on the application of the M-CHAT was well accepted and well evaluated by the nursing professionals. We identified a high frequency of children with possible early signs of ASD as assessed by the M-CHAT.

Although most professionals recognized the importance of detecting early signs of ASD in primary care settings, the introduction of the M-CHAT into the routine of the community basic health units was not completely accepted for all. The burden associated with the inclusion of this intervention was the main reason cited by professionals for low acceptance. These results indicate the need for public health policy leaders to provide continuity to this assessment model and to identify strategies and interventions that minimize the burden on professionals, with the aim of making it feasible to maintain early screening interventions for ASD in Brazilian primary care institutions. Childcare in primary care is a privileged place for detecting early signs of ASD. This study presents preliminary data on how to implement these actions through nursing professionals. A low-cost action that can be expanded and tested in Brazilian public health.

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