Trends
in Psychiatry and Psychotherapy

JOURNAL ARTICLE PRE-PROOF
(as accepted)

Original Article

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http://doi.org/10.47626/2237-6089-2024-0891

Original submitted Date: 05-Sep-2024

Accepted Date: 09-Jun-2025

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ABSTRACT:

The WHO Caregiver Skills Training (WHO CST) program is designed to train caregivers of children with neurodevelopmental disorders, improving access to interventions in areas where professional resources are scarce. This study assesses the effectiveness of the WHO-CST online program in Brazil, focusing on symptom improvement in children with Autism Spectrum Disorder (ASD). Methodology: This open clinical trial included 37 caregivers who participated in nine on-line sessions. The primary outcome measured was the decrease in scores on the Autism Treatment Evaluation Checklist (ATEC), along with evaluations of target behaviors, like reduction of disruptive behaviors, improvement in communication, and enhancements in play, and the Clinical Global Impression (CGI) scale. Results: Of the enrolled participants, 28 caregivers completed the training. The results showed a substantial 14% reduction in baseline ATEC scores ($p < 0.01$), significant improvements in CGI scores ($p < 0.01$), and positive changes in 77% of the targeted behaviors after the training. Conclusion: The WHO CST online program.is associated with reduced symptoms of autism in children with neurodevelopmental disorders in Brazil, as shown by this open clinical trial. These findings highlight the value of online interventions in enhancing caregiver capabilities and improving child outcomes in resource-limited settings.

Keywords: Neurodevelopmental disorder, autism spectrum disorder, Caregiver skills training.

INTRODUCTION

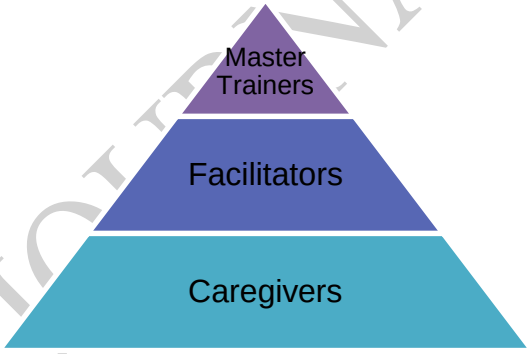
The incidence of neurodevelopmental disorders (NDDs), especially autism spectrum disorder (ASD), among children has been increasing in recent years(1), posing new challenges for healthcare systems, especially in low- and middle-income countries(2) . These challenges include limited access to diagnosis and treatment, as well as a shortage of qualified professionals to provide mental health care(3–5). To address these gaps, the World Health Organization (WHO) developed the Caregiver Skills Training (WHO-CST) program. This initiative leverages local infrastructure to train caregivers of children with ASD and other NDDs, enhancing their ability to recognize developmental delays, implement early interventions, and effectively stimulate development(5,6).

Although Brazil lacks official data on the prevalence of ASD, the country faces multiple challenges in diagnosing and managing this condition, including delayed diagnoses, a lack of specialist knowledge, and insufficient professional training in ASD care(7). Programs that empower caregivers to engage in early interventions have emerged as viable alternatives to address the growing demand for services. Initially designed for in-person implementation, the WHO-CST program had to be adapted in Brazil and other countries due to disruptions caused by the Coronavirus Disease 2019 (COVID-19) pandemic(8). In response to these disruptions, the Brazilian healthcare system prioritized COVID-19 cases, leading to the suspension of many non-urgent medical consultations. Consequently, telemedicine and online therapies, including the CST program, were adopted to ensure continued access to care(9).

The WHO CST program follows a cascade training model in which master trainers—specialists trained by WHO—train non-specialist facilitators who then train parents and other caregivers of children with neurodevelopmental disorders (NDD's)(5) (figure 1).

The WHO CST undergoes adaptation and validation processes tailored to the local context, structured into three phases: 1) **Cultural and linguistic adaptation**, to ensure the program's materials are suitable for the local setting; 2) P**re-pilot phase**, which evaluates the acceptability and feasibility of the adapted program under the supervision of master trainers; and 3) **Pilot phase,** which assesses the feasibility, acceptability, and effectiveness when implemented by non-specialist professionals, known as facilitators, who work directly with families of children with NDDs. Upon successful completion of the pilot phase, the WHO-CST program is considered ready for large-scale community implementation.

Figure 1. Cascade training model



The Master Trainers, specialized professionals trained by the WHO, train the Facilitators—non-specialist professionals working in the field—so that they can train caregivers and disseminate the program within their service settings.

Most CST studies have traditionally been conducted in-person, demonstrating positive outcomes io across high-income and low-and-middle-income countries (LMICs), thereby confirming the program's feasibility, acceptability, and effectiveness compared to enhanced treatment-as-usual and the intervention's theory of change (10–13). Studies have also reported favorable effects on parental skill acquisition, the caregiver-child relationship, and the child's nonverbal communication, social interaction, and adaptive behaviors. CST has been studied in several countries, including Serbia, India, Ethiopia, Italy(10,11,14,15). Similar results were observed in rural areas of USA(16) where the program was implemented *via* telehealth. A study of CST delivered virtually was conducted in Italy with good acceptability and feasibility of delivery and showing promising effects on caregiver competence, however no statistically significant group effects for parental stress nor for parental self-efficacy when compared to in-person CST or treatment as usual(17). Although CST was designed for a global audience only two studies(11,14) have evaluated the impact of pilot-phase training in these settings, and no studies have been conducted in Latin America.

In Brazil, the WHO CST program was initiated in 2019, involving the translation and adaptation of materials as well as an assessment of the program's acceptability and feasibility (phases 1 and 2)(18). The pilot phase was conducted during the second half of 2020 and was adapted for online delivery due to the COVID-19 pandemic(19). Currently, while 90% of the Brazilian population has internet access, the distribution of health professionals remains uneven, with a concentration in capitals cities and more developed, densely populated regions.

This disparity highlights the urgent need for studies evaluating the effectiveness and feasibility of telemedicine for ASD in Brazil(20,21).

Our study aimed to evaluate the effectiveness of the online WHO-CST program in Brazil, a middle-income country.

METHODOLOGY

This clinical trial was approved by the Human Research Ethics Committee of the Complexo Hospital de Clinicas of the Federal University of Paraná (CHC-UFPR) under protocol number 02994018.7.0000.0096 and was registered on Plataforma Brasil. The pilot program was conducted as an open clinical trial from October to December 2020. Additionally, our study was registered in the Brazilian Clinical Trials Platform (ReBec) under number RBR-8mxj56m. All meetings were conducted online via the Zoom® platform.

Phase 3 – Pilot – Implementation of CST in a public setting

Eleven facilitators (Table 1) participated in a one-week online training conducted by master trainers over five days. The mornings were dedicated to synchronous activities, including live lectures and simulations led by the master trainers. In the afternoons, facilitators engaged in asynchronous tasks, such as assessments, recorded videos featuring master trainers simulating interactions between children and caregivers, and the review of theoretical materials. On the final day of training, each pair of facilitators practiced conducting a session.

Master Trainers are specialized professionals with prior experience in treating children with ASD. Four professionals were selected based on their

expertise in this field and received specialized training from WHO. Their primary role is to disseminate WHO training to Facilitators.

Facilitators are healthcare professionals seeking training focused on children with ASD and their families. They were trained by Master Trainers and are responsible for delivering ongoing instruction to caregivers throughout the program.

Support materials, including handouts and training videos, were made available in a cloud-based platform with restricted access for program participants. All meetings were conducted via Zoom. Once the Facilitators completed their training, they began instructing caregivers under the supervision of Master Trainers.

Table 1. Demographic characteristics of the facilitators.

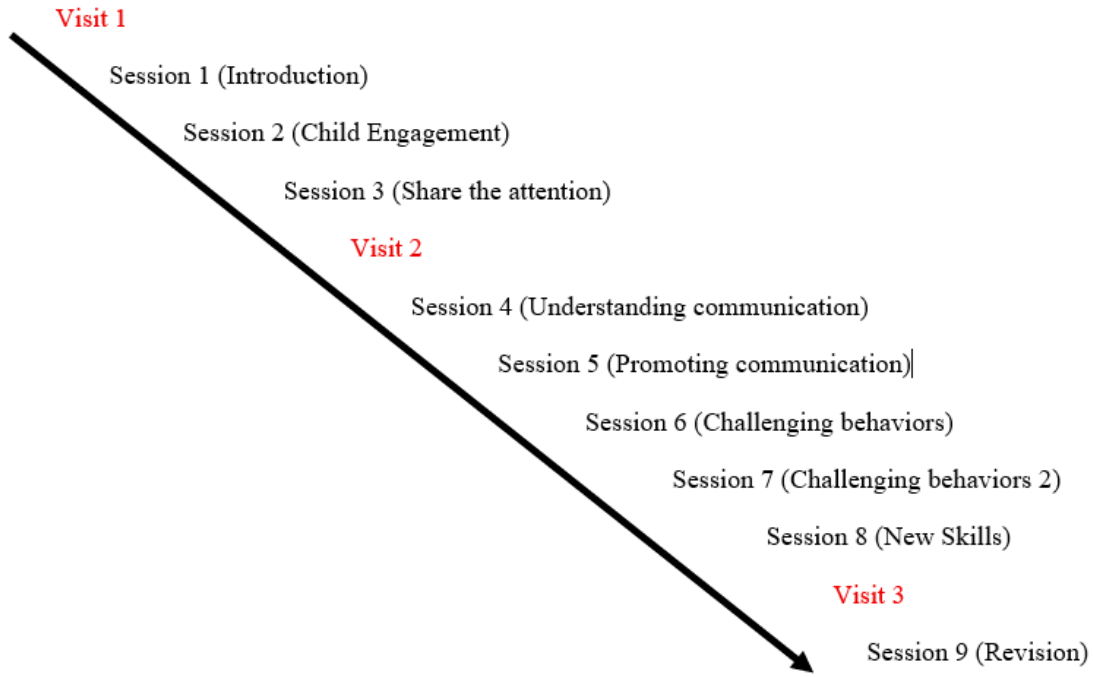
Characteristics	Frequency n (%) / mean + SD
Female/ male	9 (81,8%)/ 2 (18,2%)
Age	43,6 +-8,64
Public Health worker	8 (72,7%)
Years of professional atuation	18,7 +-8,92
Years of atuation with Child with ND	13,8 +-9,17

The program consists of nine group sessions and three home visits, during which Facilitators introduce a different theme in each session and assess the unique needs of each caregiver, as well as the target behaviors addressed by the program(5) (Figure 2).

In this phase of our study, the caregiver training was conducted by Facilitators under the supervision of Master Trainers across five different groups. The primary objective of the pilot phase was to assess whether caregiver training

provided by Facilitators resulted in improvements in caregiver-reported symptoms exhibited by children with NDD's.

Figure 2. Program Sections



During the pilot, 9 sessions and 3 home visits are conducted with families to address specific ASD symptoms. In each session, specific topics were addressed, while home visits focused on the Target Behaviors.

3.1 Selection and characteristics of the sample

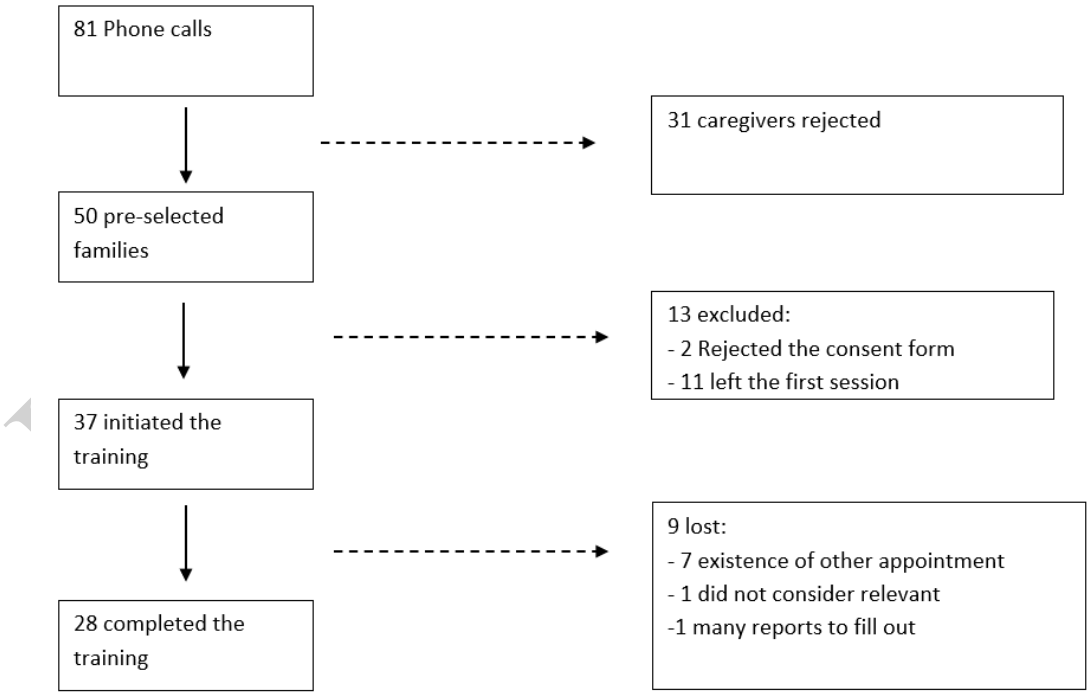
Caregivers and patients were recruited through telephone contact with families on the waiting list of an outpatient unit specializing in neurodevelopmental disorders (NDDs) who had not yet received specialized intervention. A total of 81 calls were made to caregivers of children awaiting care at a specialized center for neurodevelopmental delays within the public health system, following the order of referral to the service.

Of these, the first 50 caregivers who agreed to participate in the CST program were selected. However, two were subsequently excluded for not

signing the Informed Consent Form, and eleven withdrew after the first meeting when program details were explained (Figure 3). Ultimately, the study included caregivers of 37 children aged 2 to 9 years (Table 2), all diagnosed with neurodevelopmental delays or Autism Spectrum Disorder (ASD) and having internet access. Although the inclusion criterion encompassed children with neurodevelopmental disorders, without specific diagnoses, all participating children in the study had an ASD diagnosis by a healthcare professional.

Participants were classified as "dropouts" if they missed more than three sessions. In total, there were nine dropouts: seven due to other obligations, one who did not find the meetings relevant, and one who found completing the research questionnaires too burdensome. For these cases, the Last Observation Carried Forward (LOCF) method was applied.

Figure 3. Sample selection



Flowchart of participant selection and retention. Out of 81 families initially contacted by phone, 31 caregivers declined participation, resulting in 50 pre-selected families. Of these, 13 were excluded prior to initiating the training (2 declined the consent form and 11 discontinued after the first session). Thirty-seven

families began the training, and 9 were subsequently lost to follow-up due to scheduling conflicts (n = 7), lack of perceived relevance (n = 1), and excessive reporting demands (n = 1). A total of 28 families completed the training.

3.2 Primary outcomes measures

3.2.1 Autism Treatment Evaluation Checklist (ATEC)

The Autism Treatment Evaluation Checklist (ATEC) is designed to assess the effectiveness of treatments for ASD by categorizing symptoms into four distinct domains: (1) Speech/Language/Communication, (2) Sociability, (3) Sensory/Cognitive Awareness, and (4) Health/Physical Behavior. The ATEC score ranges from 0 to 180, with higher scores indicating greater symptom severity. Although the ATEC does not have a defined cutoff point, individuals can be classified into different percentiles based on their scores. This scale is administered both before and after interventions to evaluate changes in symptom severity(22).

ATEC is widely used in longitudinal studies due to its high internal consistency and ability to capture individual variations in children's progress, which is crucial for assessing intervention efficacy in specific patient subgroups(23). Furthermore, total and subscale scores have demonstrated strong correlations with cognitive, language, and adaptive behavior skills, as well as autism symptom severity across different assessment points. Additionally, ATEC is a practical and easily applicable tool, as it can be completed by parents, facilitating large-scale data collection across diverse cultural and geographical contexts(24).

3.2.2 Clinical Global Impression scale (CGI)

The Clinical Global Impression (CGI) scale is used to evaluate patients, with the CGI-I scale assessing the improvement achieved by the patient, and the CGI-S scale evaluating the severity of the condition. Both scales are applied before and after interventions, considering symptoms observed during the sessions, as well as data obtained from anamnesis and the patient's health history(25). The researchers are trained to standardize the administration of the questionnaire to ensure the reliability and and accuracy of the data collected.

3.2.3 Target Behaviors

The measures for target behaviors, developed by the WHO, were adapted from protocols established by the Research Units on Pediatric Psychopharmacology (RUPP) Autism Network. This approach involves identifying the two most concerning behaviors for each caregiver, referred to as 'target behaviors,' which require tailored interventions(26).

Target behaviors are areas of concern for caregivers and prioritized for intervention during home visits. Examples include improvements in verbal and non-verbal communication, enhanced play (functional or imaginative), reduced aggression, and improved social interaction. During the three home visits, Facilitators address these target behaviors, applying CST techniques to offer more effective strategies for caregivers to manage them. Following the intervention, caregivers assess changes in these behaviors using a Likert scale to measure symptom improvements or worsening.

3.3 Secondary Outcomes measures

3.3.1 ATEC subtests

The ATEC categorizes autism symptoms into subtests, as previously described. These include: (1) Communication, consisting of 14 items; (2) Sociability, covering 20 items; (3) Sensory/Cognitive Awareness, comprising 18 items; and (4) Health/Physical/Behavior, which includes 25 items. As a secondary outcome, our study assessed which subtests were most affected by the training and which specific symptoms showed the greatest improvement post-intervention.

3.3.2 Strengths and Difficulties Questionnaire (SDQ)

The SDQ is a screening tool designed to assess mental health problems in children. It is divided into five subscales: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior. The scoring for the first four subscales ranges from 0 to 40, with higher scores indicating greater severity of the issues. Prosocial behavior is scored separately, with a maximum score of 10, where higher scores indicate more proficient social skills.

3.4 Group Sessions

Participants were divided into five groups, with a maximum of 10 families per group. Each group was supported by a Master Trainer, two Facilitators, and one researcher.

To adapt the program to an online format, several modifications were made, which were previously discussed by the Master Trainers and the research

team. The training manuals were provided both digitally and in print, with all materials made available to families from the first session. All group sessions were conducted via video calls, maintaining the same structure as the in-person format, with Master Trainers present throughout. Home visits were replaced with individual online sessions, during which facilitators conducted video calls with the caregiver and child to discuss target behaviors, observe interactions, and provide real-time guidance, each lasting approximately 1.5 hours. All individual sessions were recorded and later reviewed with the Master Trainer.

The live role-playing by facilitators was replaced with a pre-recorded demonstration between the Master Trainers, which was shown during the group sessions.

The sessions were structured as follows (27):

1. Introduction to CST: Engaging caregivers and children.
2. Management of Child Engagement: Techniques for sustaining children's involvement.
3. Sharing Attention: Helping children share attention during play and daily routines.
4. Understanding Communication in Its Various Forms.
5. Promoting Communication.
6. Preventing Disruptive Behaviors: Strategies for maintaining engagement and regulating behavior.
7. Alternative Behaviors: Offering alternatives to disruptive behaviors.
8. Skill Development: Teaching new skills in small steps and providing varying levels of support.

9. Reflection and previously learned concepts for problem-solving and self-care.

The reliability of the CST program's implementation in Brazil was assessed using the 'Implementation Fidelity' scale, following WHO guidelines, which require that at least 25% of the sessions be evaluated with this tool. The home visits were adapted for online delivery and were scheduled before the first session, between the third and fourth sessions, and between the eighth and ninth sessions.

During these visits, Facilitators identified the two behaviors of greatest concern to each caregiver, referred to as 'target behaviors.' These behaviors were then individually addressed using specific techniques from the program during each visit(5).

3.5 Data analysis

Quantitative analyses were conducted to assess the effectiveness of the intervention and the comparability of the study groups. Pre- and post-intervention changes were analyzed using paired-samples Student’s t-tests. Baseline equivalence among the five groups was examined through a one-way ANOVA with Welch’s correction applied to the total ATEC scores. Statistical significance was set at $p < 0.05$. All analyses were performed using Jamovi ® (version 1.6.15).

Results

Demographic Data

Of the 37 children evaluated in the study, 83.8% were male, with a mean age of 5.22 years (±1.51). The mean age at which caregivers first noticed symptoms indicative of neurodevelopmental delays was 1.67 years (±1.04), while the mean age at diagnosis was 3.34 years (±1.53).

The majority of caregivers were mothers (83.3%), with a mean age of 35.2 years (±7.79). Regarding employment status, 56.6% of primary caregivers were homemakers or unemployed, while the remainder were engaged in various occupations. Most caregivers (55.6%) had completed high school, and all participants resided in urban areas.

Table 2. Demographic characteristics of the participants.

	n (%)/mean + SD
Child	
Male	31 (83.8%)
Age	5.22 ±1.51
Age at which parents first noticed the symptoms	1.67 ±1.04
Age of ASD diagnosis	3.34 ±1.53
Psychiatric comorbidity	3 (8.1%)
VABS 3	
Communication	71.8 ±11.1
Daily life activity	77.0 ±10.4
Socialization	77.0 ±13.0
ABC	73.7 ±9.53
Motor skills	80.6 ±15.1
Primary Caregiver	
Mother	30 (83.3%)
Age	35.2 ±7.79
Ethnicity	
White	27 (75%)
Black	8 (22.2%)
Asian	1 (2.8%)
Married/living with a partner	22 (61.1%)
Schooling	
Elementary school complete	6 (16.7%)
High school complete	20 (55.6%)
Higher education complete	10 (27.8%)
Does not work outside the home	32 (88.9%)

ASD: Autism Spectrum Disorder; VABS 3: Vineland Adaptive Scales 3rd edition; ABC: Adaptive Behavior Composite.

Primary Outcomes

4.1 Autism Treatment Evaluation Checklist (ATEC)

Analysis of the ATEC scale data revealed a significant overall reduction in caregiver-reported autism symptoms, with a mean decrease of 11.3, $p < 0.01$,

and an effect size of 0.575, corresponding to a 14.91% reduction in symptoms (Table 3). Furthermore, no statistically significant differences were observed among the groups for the pre-intervention ATEC total scores ($F(4, 12.76) = 0.770$, $p = 0.564$) or the post-intervention scores ($F(4, 9.61) = 0.431$, $p = 0.783$), indicating a consistent response to the intervention across all five participating groups.

Table 3. Pre-and post-intervention scores.

Item		Initial mean (SD)/median Score	Final mean (SD)/median Score	p-value	Effect Size
ATEC					
	Total	75.1 (27.40)/77 (34.0)**	63.9 (29.18)/65 (43.5)**	**0.006***	0.58
	Communication	14.0 (6.59)/14 (10.0)**	11.7 (6.39)/10 (9.5)**	**0.042***	0.41
	Sociability	14.6 (7.95)/12 (9.5)**	13.9 (8.23)/14 (10.0)**	0.376	0.17
	Sensory/Cognitive	14.9 (6.35)/15 (8.5)**	12.6 (5.52)/12 (7.0)**	**0.019***	0.48
	Health/Physical/Behavior	28.7(16.59)/25 (26.5)**	25.7 (15.52)/22 (20.0)**	0.164	0.28
CGI-S		4.42 (0.77)/4	3.89 (0.94)/4	0.001*	0.86
CGI-I		0.79 (0.85)/1	1.53(0.61)/2	0.002*	-0.84
SDQ					
	Total	18.46 (5.05)/17.5 (5.5)**	17.96 (6.61)/17.0 (8.75)**	0.551	0.12
	Pro-social	4.54 (2.32)/4.0 (3.0)**	4.85 (1.99)/5.0 (3.0)**	0.527	-0.13
	Hyperactivity	6.58 (1.77)/7.0 (3.0)**	6.73 (2.24)/7.0 (2.0)**	0.621	-0.10
	Emotional	3.46 (2.12)/3.0 (3.0)**	3.47 (2.58)/2.5 (4.0)**	0.743	0.06
	Peer	3.48 (1.69)/5.0 (2.0)**	3.49 (2.10)/5.0 (3.0)**	0.764	-0.06
	Conduct	3.50 (1.59)/3.5 (2.5)**	3.51 (1.56)/3.0 (2.0)**	0.032*	0.45

Comparison of questionnaire scores before and after the parent training program, analyzed using paired t-test. Values are presented as mean ± standard deviation. Statistical significance was set at *$p < 0.05$.
** Interquartile range (IQR)
ATEC: Autism Treatment Evaluation Checklist; CGI-S: Clinical Global Impression scale for severity; CGI-I: Clinical Global Impression scale for improvement; SDQ: Strengths and Difficulties Questionnaire.

4.2 Clinical Global Impression scale (CGI)

The results demonstrated a significant improvement in symptom severity, as measured by the caregiver-rated CGI-Severity (CGI-S) scale. The average score decreased from 4.42 to 3.89 ($p < 0.01$), indicating a reduction in symptom severity following caregiver training (Table 3). Additionally, the CGI-Improvement (CGI-I) scale showed progressive symptom improvement across successive individual sessions. During the second home visit, the median CGI-I score was 1, increasing to 2 by the third visit. The mean score rose from 0.79 to 1.53 between these visits ($p < 0.01$), further suggesting continued improvement over time (Table 3).

4.3 Target Behaviors

We also assessed target behaviors within families using a Likert scale to measure symptom improvement or worsening as rated by caregivers. Significant enhancements were reported by caregivers across multiple domains: verbal communication increased by 31.4%, play skills improved by 25.9%, disruptive behaviors decreased by 22.0%, and social interactions improved by 12.5%.

Overall, 77% of the target behaviors showed improvement, with 40.4% demonstrating significant gains, while only 2 families noticed the symptoms were worsening. However, due to the absence of a control group, comparisons with a non-intervention group were not possible.

Secondary Outcomes

Analysis of the ATEC scale sub-items revealed significant improvements in the communication domain as reported by caregivers, with scores decreasing from 14 to 11.7 points ($p < 0.05$). Sensory/cognitive awareness also showed notable improvement, with scores dropping from 14.9 to 12.6 points ($p < 0.05$). However, no significant changes were observed in the other symptom categories (Table 3).

The overall SDQ score did not show a significant difference pre- and post-intervention ($p = 0.55$ However, conduct-related symptoms significantly decreased ($p < 0.05$) (Table 3).

The Program Implementation Fidelity questionnaire was applied in 74% of the sessions, including individual sessions. The mean score was 2,64, indicating adherence to the training program by caregivers, as scores above 2.00 denote satisfactory implementation.

Discussion

Our pilot study suggests an association between the online delivery of the WHO CST program in Brazil and caregiver-reported improvements in overall autism symptoms. Caregivers reported reductions in autism-related symptoms and enhancements in behavioral, communicative, and socialization skills, as well as in caregiver-identified target behaviors(28). Analysis of the ATEC scale revealed a notable reduction in reported autism symptom severity, with consistent improvements reported across all participant groups. Additionally, CGI-Severity scores showed a significant decrease in symptom severity post-training, while the

CGI-Improvement scale indicated progressive symptom enhancement across successive individual sessions.

Caregivers also reported substantial improvements in target behaviors, particularly in verbal communication, play skills, and social interactions, along with a reduction in disruptive behaviors. Overall, the majority of target behaviors exhibited positive changes, supporting the intervention's effectiveness in addressing key developmental areas.

These findings suggest a potential impact of the CST program on communication and cognitive awareness, as indicated by the ATEC subscale analysis. While no significant changes were observed in other symptom domains, caregivers reported some improvements in conduct-related behaviors.

Most families who withdrew from the study did so due to work-related obligations. One family left because they did not find the program relevant to their needs, while another felt that the number of questionnaires was too high. An important consideration for future implementations is offering alternative scheduling options to facilitate greater caregiver participation. The dropout rate in this study was higher than that reported in Italy(10).

The fully online training for caregivers offers several advantages, including significant cost reductions, the elimination of travel requirements for facilitators, and the ability to train a larger number of caregivers simultaneously, including those from different regions of the country.. Previous research has demonstrated that online training effectively improves behavioral impairments in children with ASD(29–31). This approach represents a powerful strategy for expanding access to early interventions for children with neurodevelopmental

delays in low- and middle-income countries. However, despite these advantages, online training may exclude individuals who do not have access to the internet or familiarity with this technology.

Our study did not compare online and in-person CST, as the pilot had not yet been conducted in a face-to-face format due to the COVID-19 pandemic. A future comparison between these delivery methods would be valuable to assess whether in-person implementation would influence feasibility, acceptability, and clinical outcomes. In this regard, findings from the Italian study provide an interesting point of reference(17). Their results indicated that virtual CST was feasible and acceptable, but caregiver participation was lower, and technological barriers complicated implementation. While online delivery effectively improved caregiver knowledge and strategy use, it did not significantly impact parental stress or self-efficacy compared to in-person CST. Additionally, facilitators and caregivers in the Italian study highlighted the potential benefits of a blended approach, combining online and in-person components to enhance engagement and reduce the limitations of a fully virtual format. These insights could inform future adaptations of CST in our context.

Our study aligns with findings from CST implementations in rural USA, the only other region, alongside Brazil, to apply the CST program in an online format. The USA study reported a reduction in the overall ATEC score, particularly in the communication subscale. Similarly, our study found statistically significant improvements in communication, as well as in sensory/cognitive awareness and the overall ATEC score. One possible explanation for this difference is our larger sample size.

Furthermore, the U.S. study also documented positive changes in atypical behaviors and communication, assessed using the Autism Impact Measure scale(16). Comparable outcomes were observed in Taiwan, where the program effectively reduced autism symptoms measured by the ATEC scale, including decreases in the total score and improvements in communication, socialization, and health/behavior subscales. Notably, a three-month follow-up confirmed the persistence of these improvements, reinforcing the CST's potential for fostering long-term behavioral changes(12).

Our study yielded secondary outcomes comparable to those observed in the WHO-CST program in Serbia and India, two other middle-income countries similar to Brazil. The Serbian study reported enhancements in communication and behavioral subscales on the ATEC. In contrast, our study demonstrated significant improvements not only in communication but also in sensorimotor cognitive symptoms. Similarly, the Indian study found improvements in communication skills and symptom management after CST, aligning with our results.

The CST program, whether in-person or online, holds great potential for large-scale implementation. By training facilitators, it can be expanded nationwide without the need for specialized centers, as it can be delivered in primary healthcare units and psychosocial assistance centers across Brazil. The online format, in particular, offers a viable alternative for regions lacking trained facilitators, enhancing accessibility.

This pilot study, conducted entirely online, demonstrates that while the virtual format may reduce direct caregiver interaction and pose challenges for

individuals with limited technological proficiency, it significantly increases the program's reach. Notably, online training is especially beneficial for expanding services to remote areas, a crucial advantage in a country like Brazil, where specialized professionals are scarce.

Considerations and limitations

The small sample size and the absence of a control group represent significant limitations of our study, restricting our ability to rule out placebo effects and response biases, limiting direct comparisons with other interventions. Another limitation is that the caregivers were from urban areas and may have had easier access to the Internet and were likely more comfortable with technology. Additionally, the lack of a structured clinical interview to confirm ASD diagnoses is another limitation. However, the study was conducted as a real-world trial tailored to low- and middle-income countries (LMICs), following WHO recommendations. Despite this limitation, all participants had a clinical ASD diagnosis.

Implications

Despite these limitations, the WHO-CST program seems to be effective in reducing ASD symptoms in children in Brazil. Further randomized clinical trials are necessary to extend our findings. This could enhance the promotion and implementation of this program in Brazil and other low- and middle-income countries.

Acknowledgements

We are grateful to Autism Speaks for its funding support and extend our sincere appreciation to Pamela Dixon for her valuable contributions to this initiative. We also acknowledge the WHO CST Team—Felicity L. Brown, Laura Pacione, Erica Salomone, Chiara Servili, and Stephanie Shire—and the Department of Mental Health, Brain Health and Substance Use, World Health Organization, Geneva, Switzerland, for their expertise and commitment to the program. Our deepest gratitude goes to the families who participated in the study, as well as to the dedicated public health professionals involved in the implementation of the program. We also thank the experts, reviewers, and local CST teams for their essential role in the development and field testing of the program.

Last literature review: 24 of February 2024.

The authors have no conflicts of interest to declare.

Author contributions: CRediT TaxonomyLetícia Pascelli Sant Ana SantosCRediT contribution not specifiedCamila CardosoConceptualization-Equal, Funding acquisition-Equal, Investigation-Equal, Methodology-Equal, Project administration-Lead, Writing - original draft-EqualCristiane GeyerCRediT contribution not specifiedMaria Solineide AlencarCRediT contribution not specifiedKarime NogaraCRediT contribution not specifiedVinicius BragaData curation-SupportingElyse MatosCRediT contribution not specifiedAndré ChoinskiCRediT contribution not specifiedSergio AntoniukCRediT contribution not specifiedMaria de Fátima MinettoCRediT contribution not specifiedGustavo DoriaCRediT contribution not specifiedRaffael MassudaCRediT contribution not specified

Handling Editor: Dr. Carmem Gottfried

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