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Childhood apraxia of speech: A survey of knowledge of Jordanian speech-language pathologists

تعدُّر الأداء النطقي في الطفولة: مسح لمستوى معرفة اختصاصيي علاج النطق واللغة في الأردن

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Abstract:

Objectives: The study compared typical speech features and comorbid conditions of Childhood Apraxia of Speech (CAS) identified by speech language pathologists in Jordan with those identified in previous surveys and consensus studies on speakers of English. It also investigated current diagnostic practice of CAS in Jordan.

Methods: 143 Jordanian speech-language pathologists answered questions of an online questionnaire about their perception of typical speech characteristics of CAS and the comorbid conditions. They also reported own assessment procedures and estimated proportion of CAS cases on their caseload.

Results: The top speech features identified typical for children with CAS were: sequencing difficulties (99.3%), polysyllabic difficulty (97.2%), groping (91.6%), inconsistent speech errors (90.9%), unintelligibility (90.2%), vowel errors (88.8%), inappropriate prosody (85.3%), and disrupted coarticulation (80.4%). The top reported general CAS features and comorbid conditions were: higher occurrence in males compared to females (81.1%), use of nonverbal communication (80.4%), language impairment (72%), behavioural disturbances (75.5%), and neurodevelopmental disorders (74.1%). All features perceived as typical characteristics of CAS were consistent with those reported in previous literature on English speaking children with CAS. Responses were relatively uniform across educational and experience level of SLPs.

Conclusions: The results provide data on speech features regarded typical of CAS from Jordanian Arabic speakers that are similar to those identified for speakers of English and other languages. Results may contribute to cross linguistic consensus of typical CAS characteristics.

Keywords: Speech-Language Pathologists; Childhood Apraxia Of Speech; Speech Characteristics; Jordanian Arabic.

المخلص:

الأهداف: قارنت الدراسة السمات النطقية النموذجية والحالات المصاحبة لاضطراب تعذر الأداء النطقي في الطفولة (CAS) كما حددها اختصاصيو علاج النطق واللغة في الأردن، مع تلك التي تم تحديدها في دراسات مسحية سابقة ودراسات توافقية على متحدثي اللغة الإنجليزية. كما بحثت في ممارسات التشخيص الحالية لهذا الاضطراب في الأردن.

المنهجية: أجاب 143 اختصاصياً أردنياً في علاج النطق واللغة على استبيان إلكتروني تناول تصوراتهم حول الخصائص النطقية النموذجية لاضطراب CAS والحالات المصاحبة له. كما قدموا معلومات عن إجراءات التقييم التي يستخدمونها وقدرت نسبة حالات CAS ضمن عبء العمل لديهم.

النتائج: كانت أبرز السمات النطقية التي تم تحديدها كخصائص نموذجية للأطفال المصابين بـ CAS هي: صعوبات التسلسل (99.3%)، صعوبة نطق الكلمات متعددة المقاطع (97.2%)، البحث الحركي (91.6%)، أخطاء النطق غير المتسقة (90.9%)، ضعف الوضوح الكلامي (90.2%)، أخطاء في الحركات الصوتية (88.8%)، خلل في النبر والتنغيم (85.3%)، واضطراب التوافق النطقي (80.4%). أما أبرز السمات العامة والحالات المصاحبة فكانت: ارتفاع نسبة الإصابة لدى الذكور مقارنة بالإناث (81.1%)، استخدام التواصل غير اللفظي (80.4%)، اضطرابات لغوية (72%)، اضطرابات سلوكية (75.5%)، واضطرابات النمو العصبي (74.1%). وقد اتفقت جميع السمات المدركة كخصائص نموذجية مع ما ورد في الأدبيات السابقة حول الأطفال الناطقين بالإنجليزية المصابين بـ CAS. كما كانت الاستجابات متقاربة نسبياً عبر مستويات التعليم والخبرة لدى الاختصاصيين.

الاستنتاجات: تقدم النتائج بيانات حول السمات النطقية التي تُعد نموذجية لاضطراب CAS لدى الناطقين بالعربية الأردنية، وهي مشابهة لتلك المحددة لدى الناطقين بالإنجليزية ولغات أخرى، مما قد يسهم في تحقيق توافق عبر اللغات حول خصائص هذا الاضطراب.

الكلمات المفتاحية: اختصاصيو علاج النطق واللغة؛ تعذر الأداء النطقي في الطفولة؛ الخصائص النطقية؛ العربية الأردنية.

Introduction

Childhood apraxia of speech (CAS) is recognized as one of the speech sounds disorders (SSDs) with a primary problem in motor planning and programming of sequences of speech movements resulting from identified neurological impairments, associated with complex neurobehavioral disorders (e.g., genetic, metabolic), or as an idiopathic neurogenic speech sound disorder. (ASHA, 2007b). The deficit in children with CAS is described as difficulty with converting abstract phonological codes into motor speech commands during early stages of planning the movements of the intended speech sound or sequences and timing of articulatory gestures (Murray et al, 2021). The result is an unintelligible, inconsistent and robotic speech which adversely affects the child's communication skills (Murray et al., 2021).

The review of literature concerning CAS exposed two frameworks of studies. The first framework consisted of observations of cases of children with suspected CAS to arrive at a set of behavioural features necessary to differential diagnosis of CAS, while the second framework consisted of studies surveying practicing speech language pathologists to utilize their knowledge and experience with children with SSD to establish diagnostic criteria of CAS.

Several recent studies reported several typical behavioural characteristics of English-speaking children with CAS including inappropriate prosody with lexical stress errors (Ingram et al., 2019; Iuzzini-Seigel et al., 2017; Kopera & Grigos, 2020; Murray et al., 2015; Overby et al., 2020; Zuk et al., 2018), groping (Ingram et al., 2019; Iuzzini-Seigel et al., 2017; Kopera & Grigos, 2020), increased difficulty with longer or more complex words (Iuzzini-Seigel et al., 2017; Murray et al., 2015; Overby et al., 2020; Zuk et al., 2018), inconsistent consonant and vowel errors (Ingram et al., 2019; Kopera & Grigos, 2020; Murray et al., 2015), vowel errors (Ingram et al., 2019; Iuzzini-Seigel et al., 2017), voicing errors (Iuzzini-Seigel et al., 2015, 2017; Murray et al., 2015; Overby et al., 2020), disrupted coarticulatory transitions and difficulty achieving initial articulatory configuration and transitions into vowels (Iuzzini-Seigel et al., 2017; Overby et al., 2020; Shriberg et al., 2012, 2017; Zuk et al., 2018), slow DDK rate (Ingram et al., 2019; Murray et al., 2015; Overby et al., 2020), syllable segregation (Iuzzini-Seigel et al., 2017; Murray et al., 2015; Zuk et al., 2018), impaired volitional oral movement (Ingram et al., 2019; Kopera & Grigos, 2020), intrusive schwa (Iuzzini-Seigel et al., 2015, 2017; Murray et al., 2015; Overby et al., 2020; Zuk et al., 2018), poorer expressive than receptive language (Grigos et al., 2015; Kopera & Grigos, 2020), metathesis (Kopera & Grigos, 2020), frequent consonants and syllable omissions (Ingram et al., 2019), and increased unintelligibility (Froud & Khamis-Dakwar, 2012).

Typical CAS behaviours were also reported for children speaking languages other than English. For example, inappropriate prosody, groping, increased difficulty with multisyllabic word, disrupted coarticulatory transition, voicing errors, inconsistent speech errors, slow DDK rate, and increased articulatory variability were reported for Italian speaking children with CAS, (Fiori et al., 2016). Disrupted coarticulation, reduced vowel distinction and prosodic contrast were reported for Dutch speaking children (Maassen et al., 2001; Nijland et al., 2002, 2003). While these clinical feature appear to be shared with those for English speaking children with CAS, it seems that the manifestation of certain clinical features of CAS is dependent upon language-specific phonological properties. For

example, Wong et al. (2020) demonstrated that while poor speech intelligibility, poor DDK performance, inconsistent errors, and groping behaviors, are shared in both English and Cantonese speaking children with CAS, other features like lexical stress errors, intrusive schwa, and voicing errors may not be found in Cantonese speaking children with CAS due to differences in syllable structure, speech rhythm, and voicing contrast between both languages (Wong et al., 2023). Interestingly, as Cantonese is a tonal language, lexical tone production errors, tone perception difficulty, and tone sequencing difficulty were typical features of Cantonese-speaking children with CAS (Wong et al., 2022). Similarly, shared features were found between English and French speakers with CAS including: vowel errors, consonant and cluster errors, consonant epenthesis, devoicing errors, slow DDK rate, inconsistency and increased errors with longer words, yet schwa intrusion, and prevoicing errors were found to be irrelevant for French speaking children with CAS (Meloni et al., 2020). These variabilities among speakers of different languages highlight the necessity for more cross-linguistic research to improve the existing knowledge on core clinical features of CAS.

With an effort to arrive at a set of agreed upon distinctive characteristics for the diagnosis of CAS, an Ad Hoc Committee on Childhood Apraxia of Speech was formed by ASHA and released a position statement and a technical report (ASHA, 2007a, 2007b)(ASHA,2007a, 2007b). The statement and the report contained a review of research background of CAS, proposed a definition of CAS as primarily resulting from planning and programming deficits, and a provided three features with some consensus among researchers on CAS: “(a) inconsistent errors on consonants and vowels in repeated productions of syllables or words, (b) lengthened and disrupted coarticulatory transitions between sounds and syllables, and (c) inappropriate prosody, especially in the realization of lexical or phrasal stress” (ASHA, 2007b, pp. 4, 54, and 59). Since then, these features have been used by studies where a child should display all three of them to receive CAS diagnosis (Maas et al., 2012).

Another framework proposed by Ozanne (2005) provided a model of CAS diagnosis based on the occurrence of deficits on each of the following three levels: phonological planning (cluster I), motor planning (clusters II to IV) and oral motor control (cluster II to IV). However, observations of 100 children with SSD of unknown origin, showed that between 27% and 38% displayed inconsistent productions, difficulties with diadochokinetic tasks, and increased errors with increasing load, suggesting that these features, included in Cluster I and II, are not specific for CAS only (Ozanne, 2005).

Another checklist that is utilized for CAS diagnosis in research and clinical practice is Strand’s 10-point checklist (Shriberg et al., 2012). The checklist includes 10 segmental and suprasegmental features that can be present in children with CAS. To meet a diagnosis of CAS, a child should display the presence of at least four out of 10 following features across three tasks: (1) difficulty achieving initial articulatory configurations or transitional movement gestures; (2) syllable segregation; (3) equal stress or lexical stress errors; (4) vowel distortions and distorted substitutions; (5) groping; (6) intrusive schwa; (7) voicing errors; (8) slow rate; (9) slow diadochokinetic rates; and (10) increased difficulty with multisyllabic words. Murray et al. (2015) demonstrated a diagnostic accuracy of 91% for some of the same features, including syllable segregation, lexical stress matches, phoneme accuracy of polysyllabic words, and articulatory accuracy on repetition of [pətəkə] in the identification CAS from other SSDs. Iuzzini-Seigel et al. (2017) reported 70% sensitivity and 80% specificity for token-to-token inconsistency on monosyllabic words or at the phrase level for distinguishing children with CAS from those with other SSDs and those with language impairment. Despite the proliferation of research identifying potential markers of CAS over the past two decades, evidence-based diagnostic guidelines, criteria, or markers that reliably distinguish CAS from other SSDs are still lacking (Iuzzini-Seigel &

Murray, 2017). Possible challenges arise from the available perceptually based checklists of features that lack operational definitions of each feature or specifications in terms of critical thresholds for degree, frequency, and context of these features, in addition to the lack of psychometric properties of available assessment tools (Murray et al., 2021). The overlapping symptoms with other SSDs (Allison et al., 2020), high incidences of comorbidity (Iuzzini-Seigel, 2019), and variability across and within children over time (Lewis et al., 2004) are also among other challenges to establishing clear diagnostic criteria of CAS. Nonetheless, these checklists of features (e.g., ASHA, 2007) remain the most common approach for diagnosis of CAS for English speaking children (Iuzzini-Seigel & Murray, 2017).

Several studies attempted to investigate key characteristics of CAS based on reports by speech language pathologists on English speaking children. A survey of 75 SLPs in USA attending a continuing education workshop identified six characteristics of CAS with agreement of more than 51.5% of the surveyed respondents including: inconsistent productions, general oral-motor difficulties, groping, inability to imitate sounds, increasing difficulty with increased utterance length, and poor sequencing of sounds (Forrest, 2003). A US national survey of researchers and practicing SLPs on speech criteria of CAS concluded five top criteria that received agreement of at least 60% including: inconsistent productions, difficulty with sound sequencing, groping, articulation errors and reduced intelligibility (Millsbaugh & Weiss, 2006).

Joffe and Pring (2008) survey of SLPs' clinical practice in the UK with children with phonological problems found that 61% of the respondents were uncertain about differential diagnosis of CAS when asked to distinguish it from phonological delay. The most common features reported were: inconsistent production, oro-motor problems, groping, sequencing problems, difficulty in imitating sounds, distortion of vowels and a history of feeding and drinking problems. Another survey showed a lack of agreement among SLPs attending ASHA convention when asked to list the most essential features for CAS diagnosis (Meredith & Potter, 2011).

Recently, 165 SLPs in USA identified as having expertise with CAS were surveyed for their practice and beliefs about CAS. The majority of respondents reported using features aligning with ASHA (2007) technical report for differential diagnosis. To a great extent, level of experience did not affect their beliefs and practice concerning CAS diagnosis. Most of them indicated that continuing educational courses, clinical experience, participating in scientific research, and postgraduate degrees were the most frequent sources of knowledge (Randazzo, 2019).

Regarding surveys of SLPs reporting on children speaking other languages, Nijland (2009) identified six speech characteristics of CAS as reported by SLPs on Dutch speaking children as follows: difficulty sequencing articulatory movements, highly unintelligible speech, groping behaviour, suprasegmental disturbances, inconsistent speech errors, and complex articulation errors.

In Sweden, 178 SLPs were surveyed for their knowledge and experience in identifying CAS in Swedish-speaking children. The top CAS diagnostic features reported were: inconsistent speech production (85%), sequencing difficulties (71%), oro-motor deficits (63%), vowel errors (62%), voicing errors (61%), consonant cluster deletions (54%), and prosodic disturbance (53%). Features reported for Swedish speaking children with CAS were consistent with those of ASHA, Ozanne's diagnostic model, and Strand's 10-checklist. In addition, the majority of participants (89%) were uncertain of the diagnose of CAS due to a lack of competency (Malmenholt et al., 2017). Similarly, the 9 speech features of CAS reported by 260 Iranian SLPs on Persian speaking children include: inconsistency (86.9%), consonant sequencing problems (75%), low intelligibility (75%), groping (72.7%), slow diadochokinetic (DDK) (72.3%), articulatory configuration problems (66.2%), difficulty

with multisyllabic words (62.7%), suprasegmental disturbances (56.2%) and metathesis (53.5%) (Shakibayi et al., 2019). A Survey of 32 SLPs in Hong Kong identified 7 clinical features deemed important for the diagnosis of CAS in Cantonese speaking children including; within-speech groping behaviors, inconsistent errors, difficulty in movement transitions between syllables, poor DDK performance, poor performance on polysyllabic words, nonspeech groping behaviours, and lexical tone errors (Wong et al., 2023).

In addition to its effect on speech production, several comorbidities were found to be associated with CAS. For example, literature have shown that children with CAS may also exhibit receptive and expressive language problems (Ozanne, 2005; Lewis, et al., 2004), auditory speech perception deficits (Nigland, 2009), difficulty with lexical tone perception (Wong et al., 2022), difficulty focusing and maintaining attention (Teverovsky et al., 2009), fine motor movement deficits (Newmeyer et al., 2007; Teverovsky et al., 2009; Tükel et al., 2015), cognitive problems (Nijland et al., 2015; Teverovsky et al., 2009), phonological awareness deficits, learning disabilities (McNeill et al., 2009), poor social communication skills, behavioural dysregulation (Teverovsky et al., 2009), oral motor problems, and sensory processing differences (Newmeyer et al., 2007). Up to our knowledge, no study attempted to identify possible comorbid conditions in Jordanian Arabic speaking children with CAS. The majority of surveys have focused on clinicians' knowledge and perception of speech features they believe essential for CAS diagnosis. Studies surveying clinicians' knowledge of general features and concomitant conditions associated with children with CAS is still lacking. The present study is intended to expand the current research in this area.

Jordan is an Arabic speaking country in the Middle East with a population of more than 11.1 million inhabitants as of 2022 (Jordan Department of Statistics). Arabic speakers in Jordan are described as diagglossic in which two varieties of the language are spoken with Modern Standard Arabic (MSA), the official language in Jordan, is used in formal situations such as news, public speeches and religious services and is learned through formal education. On the other hand, the colloquial Jordanian Arabic (JA) is used in informal day-to-day settings and thus acquired by children as the native language (Walters, 1996). The consonant inventory of MSA consists of 28 consonants comprising 8 stops (3 voiced, 4 voiceless, 1 glottal), 13 fricatives (5 voiced, 7 voiceless, 1 glottal), 1 affricate (voiced), 2 nasals, 1 liquid, 1 trill, and 2 glides. Uvular and pharyngeal places of articulation are used to produce 5 dorsal consonants (Amayreh, 2003). A unique feature of Arabic phonology is the presence of "emphatic" consonant phonemes which are produced with a primary articulation along with a secondary articulation in which the root of the tongue is retracted into the pharynx. Five emphatics are used phonemically in Arabic /t̤/, /s̤/, /ð̤/, and /q/ of which only /q/ has no "nonemphatic" (plain) cognate (Ladefoged & Maddieson, 1998).

The vowel system consists of 6 vowels including the high front /i/, the high back /u/, the low /a/, and their long counterparts /i:/, /u:/, and /a:/. Two diphthongs are produced in MSA /aj/ and /aw/ and are produced in JA as prolonged monophthongs /e:/ and /o:/ (Ladefoged & Maddieson, 1998). JA shares the majority of consonants with MSA with some consonants having acceptable dialectal variants. For details on consonants in MSA and their acceptable variants in JA, see Amayreh (2003). Syllable structures in MSA includes six types of syllables: CV, CV:, CVC, CV:C, CVC, CV:CC, and CVCC (Holes, 2004). JA syllable structure retains that of MSA except for final clusters are usually simplified with epenthesis (e.g., /bint/ → /binit/ 'girl'), and word initial clusters are sometimes created (e.g., /kila:b/ → /kla:b/ 'dogs') (Dyson & Amayreh, 2007). Like English, JA is a stress-timed language and lexical stress rules in JA tends to be regular and predictable (Dyson & Amayreh, 2007). Usually one syllable has more stress than others in the same word. Stress usually falls on the *heavy* syllable

containing a long vowel (CVV). When a word does not contain a long vowel, stress usually occurs on penultimate syllables in words with two or three syllables and on the antepenultimate syllable in words containing four or more syllables (De Jong & Zawaydeh, 1999). Speakers of JA use intonation patterns similar to those used by English speakers to statements, wh-questions, commands, and exclamation, however, JA depends primarily on intonation rather than structural changes (i.e., auxiliary-verb inversion in English) to express yes/no questions (Al-Amayreh, 1991). Based on certain similarities between the phonological systems of JA and English, it is expected that voicing errors, multiple articulation errors, vowel errors, prosodic disturbances including disrupted lexical stress to be exhibited by JA speaking children with CAS.

Little is known about CAS in terms of diagnostic features, assessment method, and/or treatment in the middle east and there are currently no national guidelines or recommendations in Jordan concerning CAS. Two studies investigated CAS in Egyptian Arabic speaking children. The first demonstrated that prosodic difficulty, vowel errors, inconsistent consonants and vowel errors, frequent consonants and syllable omissions, impaired volitional and imitated oral movement, and increased difficulty for polysyllables were typical features CAS exhibited by speakers of Egyptian Arabic (Aziz et al., 2010). The other constructed a test battery for the diagnosis of CAS in Egyptian Arabic speaking children. The battery consisted of 4 test items: receptive-expressive discrepancy, consistency of speech productions, assessment of speech and nonspeech motor tasks of the articulators, an assessment of prosody. The tool was found valid and reliable in differentiating between children CAS, TD children or those with phonological disorders (Abdou et al., 2020). MSA is the formal language in both Jordan and Egypt, however, some variations exist between Jordanian Arabic and Egyptian Arabic dialects in terms of phonemes inventory, syllable structures, stress assignment (Mustafawi, 2017), speaking rate, vowel durations, and certain prosodic features (Biadisy & Hirschberg, 2009). Therefore, finding whether shared features of CAS do exist in both dialects can have implications on the efficacy of using the Egyptian test battery for the diagnosis of CAS for Jordanian Arabic speaking children.

Effort to establish a consensus on diagnostic features of CAS is still ongoing. It is important to identify typical features of CAS in speakers of other languages to determine possible universally shared features and those specific for certain languages with unique phonological properties. Based on the review of surveys of clinicians' knowledge of non-English speakers with CAS, it seems that some features are frequently identified as core features of CAS among Dutch, Swedish, and Persian speaking children (e.g., inconsistent speech production, sequencing difficulties, articulation errors, prosodic disturbance, difficulty with multisyllabic words, groping, etc). It is important to see whether SLPs in Jordan observe these clinical features in Jordanian Arabic-speaking children with CAS. Currently there is a lack of data on Jordanian SLPs' general knowledge of CAS and its possible comorbid conditions as well as current assessment practice. Therefore, the current study is intended to: (1) determine the typical speech features as well as general characteristics and comorbid conditions as reported by practicing SLPs in Jordan as on Jordanian Arabic speaking children with CAS. (2) Determine which features of CAS reported by SLPs on JA speakers with CAS are shared with those speaking English and other languages.. (3) Investigate Jordanian SLPs' reports on typical speech features, general characteristics of CAS and its comorbid conditions relative to their education and experience levels. (4) explore SLPs' self-perception of own clinical competence and the current diagnostic practice of CAS in addition to determining the estimated percentage of suspected CAS cases seen by SLPs in Jordan relative to the caseload of children with speech sound disorders.

METHOD

• Participants

Convenience sampling was employed in this study. Participants were required to be Jordanian SLPs working in Jordan with certified degrees (bachelor, master, doctoral) from universities inside or outside the country who have at least two years of work experience working with children with SSD.

• Materials and procedures

A web based open survey designed for this study was created using google forms and conveyed online to Jordanian SLPs working with children with SSD. Potential participating SLPs were approached through the managers of the organizations providing speech-language therapy, available online contact details, social media, and /or via e-mails with an attached link to the form. Potential respondents were required to read an invitation letter with information sheet containing details concerning the purpose of the study, its procedures, benefits, and contact details of the principal investigator. They were invited to participate in the survey if they have at least 2 years of experience working with children with SSD including children with CAS (page 1of the survey). Respondents were then asked to sign a consent form (page 2) provided on the survey link; once respondents submitted the consent form, they were directed through the survey questions. . Respondents were required to answer every question in order to move to the next and then press a submit button. Only completed surveys were analysed. IP address was used to avoid multiple entries by the same respondent. Only the principle investigator has access to password-protected data on Google Form. Responses were accepted between August 2020 and June 2022.

The survey consisted 30 main questions; 24 of them were yes/no questions inquiring SLPs knowledge of typical CAS characteristics (i.e. speech output, oral motor function, general features and comorbid conditions). These questions were chosen based on ASHA's description of Childhood Apraxia of Speech and review of scientific literature on typical CAS characteristics. Respondents were instructed to answer them based on their experience working with Arabic speaking children with CAS in Jordan. Respondents were asked to answer 4 multiple choice questions asking about their current assessment methods of CAS, perception of own clinical competence working with children with CAS (i.e., weak, good, expert), and 2 questions of background education and clinical experience information. Free-text response was added to let participants describe their method/s of assessment in writing if not mentioned in choices. An initial form of the questionnaire was piloted on five SLPs who have an average of 16 years of experience. They were asked to provide comments, suggestions, and recommendations regarding the content of the questionnaire. Minor revisions were made based on the collected feedback. No IRB approval was obtained for the study; however, this study was conducted in accordance with the guidelines of the World Medical Association Declaration of Helsinki.

• Data analysis

Statistical analysis was performed using the SPSS Version 26.0 (2019, IBM Corporation New York). Descriptive statistics including frequency and percentage were conducted for question. One-way Chi-Square test was conducted to check whether answers on questions about SLPs' knowledge of typical features as well as general features and comorbid conditions of CAS have the same distributions. Only questions with significant difference in the distribution of answers were considered an indication of agreement among SLPs on those features. In addition, Chi-Square test of independence was conducted to look for possible association between answers of each question and

education level and years of experience of participating SLPs. For each test, a p -value < 0.05 was considered statistically significant.

• RESULTS

Table 1 summarizes the educational and experience levels as well as clinical practice of the participants. A total of 143 Jordanian SLPs responded to all of the items on the questionnaire. As shown on Table 1, 106 (74.1%) participants hold an undergraduate degree in speech-language pathology was, while 37 (25.9%) participants hold a graduate degree in speech language pathology (34 with a master degree, and 3 with a doctoral degree). Table 1 also shows the distribution of participants according to years of clinical experience in speech language pathology. The majority of SLP had 2-5 years of clinical experience...

When the participants were asked about their current practice of assessing CAS, the majority (118, 82.5%) reported not using a specific protocol of assessment compared to 25 (17.5%) participant reporting that they use standardized tests. Of those reporting not using a specific assessment protocol, 68 (47.6%) reported using ASHA criteria of CAS, 17 (11.9%) reported using their own clinical assessment which included observation of child performance on diadochokinetic task (/pʌtʌkʌ/), looking for inconsistency in speech errors, observation of prosody, 29 (20%) reported using other evaluations including case history, oral-motor exam, and a general speech-language examination. Four participants (2.5%) indicated referring suspected cases to an expert clinician to confirm CAS diagnosis. Respondents were also asked to self-evaluate their clinical competence in managing children with CAS as poor, good, or expert. The distribution of their evaluation shows the majority of SLPs indicated that they have good competence when it comes to dealing with children with CAS. See Table 1.

In addition, respondents were asked to indicate the percentage of children with CAS out of the total number of children with speech sounds disorders on their caseload. The majority indicated the percentage of CAS cases on their caseload was 10-20%. See Table 1.

Table 1: Education, experience, and clinical practice of SLPs

Clinical skills	Frequency	Percentage (%)
Academic qualification obtained in SLP		
Undergraduate	106	74.1
Graduate	37	25.9
The number of years working with children with speech sound problems including CAS		
2-5	103	72.0
5-10	21	14.7
>10	19	13.3
Self-evaluation of clinical experience with CAS		
Poor	50	35
Good	87	60.8
Expert	6	4.2
Use of specific assessment protocol for CAS‡		
yes	25	17.5
No	118	82.5
Estimated CAS caseload compared to other speech sounds disorders		
5-10%	42	29.4
10-20%	53	37.1
20-40%	36	25.2
40-50%	12	8.4

General features and comorbid conditions

Table 2 summarizes the distribution of participants' answers on 10 questions pertaining to their knowledge of general features and comorbid conditions associated with children with CAS. Table 2 also illustrates results of one-way chi-square for equal distribution of answers. The majority of participants agreed that estimated occurrence of CAS in male children is higher than in female children, children with CAS rely on and prefer the use non-verbal communication. The majority of SLPs indicated that undesirable behaviours such as stubbornness and poor behaviour management, co-occurring neurodevelopmental disorders or conditions (e.g., autism), expressive language delay as the most common co-occurring problems of CAS.

When it comes to the association between SLP's education level and their years of experience and their knowledge of co-occurring features of CAS.

Comparisons of level of education with general characteristics and comorbid conditions showed that more SLPs with graduate degrees reported nonspeech orosensory problems as typical in children with CAS ($\chi^2 = 7.032$ and $p < 0.05$). More Graduate than undergraduate SLPs indicated that Children with CAS do not exhibit auditory speech perception deficits. ($\chi^2 = 4.231$ and $p < 0.05$), and that the estimated occurrence of CAS in males is higher than in females. ($\chi^2 = 5.918$ and $p < 0.05$). Contrary, more SLPs with and undergraduate degree than those with a graduate degree indicated that children with CAS rely and prefer nonverbal communication ($\chi^2 = 5.236$ and $p < 0.05$). Comparisons with experience level only revealed that more SLPs with clinical experience greater of > 10 years indicated that children with CAS exhibit nonspeech orosensory problems ($\chi^2 = 7.792$ and $p < 0.05$).

Table 2: SLPs' reports on general characteristics of children with CAS and comorbid conditions (n = 143)

#	Question	Frequency	Percentage (%)
1	Co-occurring of nonspeech oro-sensory and problems (e.g., feeding problems in infancy).		
	Yes	66	46.2
	No	77	53.8
2	The child with CAS shows attention deficit compared to their peers.		
	Yes	63	44.1
	No	80	55.9
3	A child with CAS shows undesirable behaviors such as stubbornness and poor behavioral		
	Yes	108	75.5
	No	35	24.5
4	A child with CAS shows significant impairment in auditory speech perception. ‡		
	Yes	33	23.1
	No	110	76.9
5	Estimated occurrence of CAS in male children is higher than in female children. ‡		
	Yes	116	81.1
	No	27	18.9
6	Co-occurring of neurodevelopmental disorders or conditions (e.g., autism). ‡		
	Yes	106	74.1
	No	37	25.9
7	CAS is not associated with clear cause.		
	Yes	81	56.6
	No	62	43.4
8	A child with CAS is delayed in babbling and cooing milestones. ‡		
	Yes	38	26.6
	No	105	73.4
9	A child with CAS shows expressive language impairment. ‡		
	Yes	103	72
	No	40	28
10	A child with CAS relies and prefers to use non-verbal communication. ‡		
	Yes	115	80.4
	No	28	19.6

‡ $P < 0.001$ on One-Way (χ^2)

- **Oral-motor and speech characteristics**

Table 3 summarizes the distribution of participants' answers on 14 questions related to their knowledge of oral-motor and speech characteristics of children with CAS as well as results of one-way chi-square for equal distribution of answers. The top characteristics regarded by the majority of the respondents as typical characteristics of children with CAS include: inconsistent errors on repeated productions, voicing errors, difficulty repeating a sequence of different syllables in diadochokinetic tasks (/pa ta ka/), articulatory groping and incoordination in tongue movement, unintelligible utterances, errors in sounds produced in word initial position, inaccurate production and substitution errors of vowels, errors in sounds produced in word initial position, produce articulation errors involving most speech sounds, greater difficulty and increasing unintelligibility with more complex word structures, disrupted coarticulation, and inappropriate prosody involving disturbed stress patterns. See Table 3.

Impaired volitional oral movements, weakness of the oral musculature, and difficulty repeating repeat individual syllables in diadochokinetic tasks (e.g., /pa pa pa/) were not regarded as typical characteristic of children with CAS by the majority of respondents. See Table 3.

Comparisons of level of education with oral motor and speech characteristics only revealed more SLPs with a graduate degree reporting that Children with CAS do not exhibit weak oral musculature ($\chi^2 = 5.981$ and $p < 0.05$). More SLPs with years of experience > 5 years indicating that children with CAS produce noticeable errors of sound in word initial positions than those with 2-5 years of clinical experience ($\chi^2 = 9.656$ and $p < 0.05$).

Table 3: SLPs' reports on oral-motor and Speech characteristics of children with CAS (n = 143)

#	Question	Frequency	Percentage (%)
11	The child with CAS shows weakness of the oral musculature that represented by drooling and the absence of the ability to blow. †	Yes	55 38.5
		No	88 61.5
12	The child with CAS produces voicing errors like substituting /t/ for /d/. ‡	Yes	106 74.1
		No	37 25.9
13	The child with CAS shows inconsistent errors on repeated productions. ‡	Yes	13 9.1
		No	130 90.9
14	The child with CAS is able to imitate single syllables in diadochokinetic tasks /pa pa/, /ta ta/, / ka ka/. ‡	Yes	93 65
		No	50 35
15	The child with CAS is able to imitate sequenced syllables in diadochokinetic tasks /pa ta ka/. ‡	Yes	1 0.7
		No	142 99.3
16	A child with CAS is able to imitate non-speech oral motor tasks (e.g., blowing, lip puckering, tongue protrusion,	Yes	67 46.9
		No	76 53.1
17	A child with CAS makes unintelligible utterances. ‡	Yes	129 90.2
		No	14 9.8
18	A child with CAS shows articulatory groping and incoordination in tongue movements. ‡	Yes	131 91.6
		No	12 8.4
19	A child with CAS shows noticeable errors in production of sounds in the initial position of the word. ‡	Yes	111 77.6
		No	32 22.4
20	A child with CAS produces articulation errors involving most of the speech sounds. ‡	Yes	99 69.2
		No	44 30.8
21	A child with CAS shows inaccurate production and substitution errors of vowels. ‡	Yes	127 88.8
		No	16 11.2
22	A child with CAS shows increasing difficulty and unintelligibility with more complex word structures. ‡	Yes	139 97.2
		No	4 2.8
23	A child with CAS shows disrupted coarticulation like pauses between vowels and consonants. ‡	Yes	115 80.4
		No	28 19.6
24	A child with CAS shows inappropriate prosody including disrupted stress patterns. ‡	Yes	122 85.3
		No	21 14.7

† $P < 0.01$ on One-Way (χ^2)

‡ $P < 0.001$ on One-Way (χ^2)

DISCUSSION

Childhood apraxia of speech (CAS) is a speech disorder which negatively impacts child's intelligibility resulting in a reduced ability to communicate. Speech-language pathologists are the key professionals who assess and diagnose speech, and language characteristics children with CAS may display.

The present cross-sectional study is the first of its kind to investigate current practice of CAS among Jordanian speech language pathologists as well as typical characteristics and comorbid conditions as reported by SLP's on Jordanian Arabic speaking children with CAS. The study also aimed to compare typical features of CAS for Jordanian Arabic speakers with CAS with those reported for English speakers with CAS.

• **SLPs experience and assessment approaches of CAS**

Results of the study indicated that the majority of SLPs in Jordan used their own assessment battery which include the use of either ASHA features, diadochokinetic task, inconsistency of speech errors, traditional evaluations (i.e., case history, oral-motor exam, and a general speech-language examination), clinical referral, or a combination of these procedures. Consistent with the current study, SLPs in the USA reported using ASHA standard, looked for inconsistency of speech errors and groping behaviours for differential diagnosis of CAS (Randazzo, 2019). Different assessment approaches for CAS diagnosis were also reported by Swedish SLPs (Malmenholt et al., 2017).

More than third of the participants (37.1%) indicated that CAS contributed to 10-20% of their caseload of children with SSD followed by about 29% of them indicated CAS contributed to 5-10%, and around 25% of them reporting CAS contributed to 20-40% (see Table 1). Even though there was no direct question for SLP to indicate their working setting, the survey was sent to clinicians working in various working settings, so we assume this could be the source of the different percentages of CAS cases on their caseload. It could also be a result of the differences in the diagnostic protocols used by SLPs in Jordan identify CAS cases. Overdiagnosis is perhaps the source of large percentages of CAS cases reported by some SLP on their caseload due to the inconsistent and conflicting behavioural features supposed to be diagnostic signs of CAS (Shriberg et al., 2003), or because extensive therapy with extended periods of time is typical for children with CAS compared to children with other speech sounds disorders (ASHA, 2007b).

• **General features and co-occurring conditions**

The present study displays that 5 out of 10 general and co-occurring conditions were identified by more than 70% of the speech language pathologist who responded to the questionnaire. Consistent with reports on English speakers with CAS, about 3 quarters of the participants indicated that Jordanian Arabic speaking children with CAS exhibit expressive language delay (Lewis et al., 2004; McNeill et al., 2009), undesirable behaviours such as stubbornness and poor behavioural management (Teverovsky et al., 2009) About 77% of respondents indicated that children with CAS do not show significant impairment in auditory speech perception. Studies yielded conflicting results on the role of speech perception in the general profile of CAS. For example, Nijland (2009) reported that children with CAS displayed problems on lower-order (rhyming task and categorical classification task) and higher-order (nonword and categorical discrimination tasks) perception tasks compared to those with phonological

disorders who displayed difficulties with higher-order tasks. Impaired auditory speech perception was even proposed as a potential mechanism underlying the disrupted motor planning and programming processes in children with CAS (Shriberg et al., 2012). However, a recent investigation found that children with CAS with comorbid language impairment showed significantly poorer syllable perception performance compared to children with CAS without language impairment suggesting that impaired auditory speech perception is not a core feature of CAS but is present in a subset of children with CAS with comorbid language impairment (Zuk et al., 2018). The finding of the current study may be due to the absence of speech perception evaluation as a part of the assessment protocols of CAS used by SLPs in Jordan. A large portion of the participants (80.1%) indicated that the occurrence of CAS in male is higher than that in female children (ASHA, 2007b), and as many as 80.4% of them reported that children with CAS prefer the use of non-verbal communication. This finding may be indicative of Jordanian SLP's use of gestural cuing to facilitate speech production (ASHA, 2007b) as a part of their current therapy practice for children with CAS.

Recent studies found that CAS may occur as a result of neurological events such as intrauterine stroke, infection or trauma (Brown et al., 2000) or may be present as comorbidity in some children with neurobehavioural and neurodevelopmental disorders such as galactosemia (Shriberg et al., 2011) intellectual disability, and autism spectrum disorders (Chenausky et al., 2019). Some forms of CAS occur as idiopathic neurogenic speech sound disorder (ASHA, 2007b). Concerning the current study, 56.6% of the participants agreed that CAS is not associated with a clear cause and 74.1% of them believed children with CAS may also have co-occurring neurodevelopmental disorders (e.g., autism). These findings may reflect the diversity of clinical experiences and viewpoints on CAS by the SLPs of the current study and to the multi-faceted nature CAS itself. Consistently, a survey showed 76% agreement among clinicians in the USA that CAS can co-occur in children with autism spectrum disorders and 79% agreement that it may co-occur with dysarthria (Randazzo, 2019).

Difficulty focusing and maintaining attention were among the functional problems identified to co-exist in children with CAS (Teverovsky et al., 2009). About 44.1% of participants reported that children with CAS show lack of attention compared to their typically developing peers. A total of 46.2% of participants reported that children with CAS have abnormal orosensory perception such as feeding problems during infancy (McCabe et al., 1998; Newmeyer et al., 2007). However, only a small proportion (26.6%) of the participants indicated that children with CAS were delayed with their cooing and babbling milestones (ASHA, 2007b). Delayed babbling was proposed as a key feature belonging to Cluster IV of Ozanne's diagnostic model of CAS (Ozanne, 2005). It is clear that the majority of SLPs in the current study failed to identify it as such. Therefore, it is recommended that oral-motor and sensory development and signs of CAS during the prelinguistic should be included in the evaluation protocol of children with CAS and should be addressed during college courses and continuing education workshops.

Findings of the current study revealed that more speech language pathologist in Jordan with a graduate degree identified the presence of feeding difficulty during infancy, difficulties in auditory speech perception, great reliance on nonverbal communication by children with CAS, and higher occurrence in male compared with female children than did those with an undergraduate degree. Duration of clinical experience of the speech language pathologists did not seem to greatly affect their reporting of general features of CAS except for one question where greater number of SLP's with an experience greater than 10 years reported oral sensory and feeding difficulty exist in children with CAS during infancy.

It is possible that the reduced number of SLPs in Jordan identifying certain co-occurring conditions of CAS can be attributed to the diagnostic procedures SLPs in Jordan currently use which focus on identifying core speech markers of CAS, while possible comorbid conditions are rarely included in the assessment protocol, thus the answers of a proportion of the respondents might not be based on their clinical observation of children with CAS but rather based on their previous knowledge obtained through education and their general assumptions about CAS. It is possible that the type of instruction and clinical training students of speech-language pathology receive during their college education in Jordan mainly emphasize the core speech features that children with CAS display, so they are less likely to get adequate exposure to the developmental, behavioural, neurological, sensory and perceptual domains of CAS. It is also possible that this limited knowledge is attributed to the heterogeneity of CAS signs displayed within and among children and to the lack of consensus in literature on a general framework of CAS that provide a detailed description of patients primary and co-occurring deficits (ASHA, 2007b).

- **Speech and oral motor characteristic of CAS**

Despite the limitation of the study in which SLPs were restricted to 14 predetermined features and were not given the option to indicate in words other observed features in Jordanian Arabic speakers with CAS, more than 50% of SLPs reported 11 typical speech characteristic which is similar to the number characteristics reported by previous surveys. Those 11 features corresponded largely with features exhibited by English speaking children with CAS. Over 99% of SLPs reported that children with CAS have difficulty producing diadochokinetic tasks with sequential motion rate, /pʌtʌkʌ/ (SMR) which is also observed for English speakers with CAS (Ingram et al., 2019; Murray et al., 2015; Overby et al., 2020), inconsistent errors on repeated productions was reported by around 91% of SLPs (Ingram et al., 2019; Kopera & Grigos, 2020; Murray et al., 2015). A large proportion of SLPs (85%) reported that Jordanian children with CAS exhibit inappropriate prosody and disrupted lexical stress (Ingram et al., 2019; Iuzzini-Seigel et al., 2017; Kopera & Grigos, 2020; Murray et al., 2015; Overby et al., 2020; Zuk et al., 2018), and 80% of them reported that children with CAS show pauses and disrupted coarticulatory transitions between sounds and syllables (Iuzzini-Seigel et al., 2017; Overby et al., 2020; Shriberg et al., 2012, 2017; Zuk et al., 2018). Increased difficulty with longer and more complex word structures is reported by around 97% of SLP (Iuzzini-Seigel et al., 2017; Murray et al., 2015; Overby et al., 2020; Zuk et al., 2018) and vowel errors were identified by 88.8% of SLPs (Iuzzini-Seigel et al., 2015, 2017; Murray et al., 2015; Overby et al., 2020).

In addition, SLPs reported unintelligible utterances (90.2%) (Froud & Khamis-Dakwar, 2012), voicing errors (74.1%) (Iuzzini-Seigel et al., 2015, 2017; Murray et al., 2015; Overby et al., 2020), multiple errors involving the majority of speech sounds (69.2%) (Ingram et al., 2019), and noticeable errors in sounds produced in word initial positions (77.6%) (Overby et al., 2020). Those features were found to be shared with children with other SSD (McCabe et al., 1998).

Motor programming deficits manifesting as groping and incoordination of tongue movement was reported by 91.6% of SLPs (Ingram et al., 2019; Iuzzini-Seigel et al., 2017; Kopera & Grigos, 2020). Oro-motor deficit including impaired volitional non-speech oral movements during elicitation marked by more than half (53%) of SLPs (Ingram et al., 2019; Kopera & Grigos, 2020).

Typical CAS behaviours reported by Jordanian SLPs are in line with certain typical features observed for children speaking other languages including Dutch (Maassen et al., 2001; Nijland et al., 2002, 2003), Italian (Fiori et al., 2016), French (Meloni et al., 2020), Egyptian Arabic (Aziz et al., 2010), and to a

certain extent Cantonese (Wong et al., 2020). It should be noted that differences in manifestation of certain CAS features depends on differences in the phonological systems across languages.

Findings of the current study showed that differences in the level of education and duration of clinical experience of the speech language pathologist did not have impact on their responses for the majority of oral-motor and speech characteristics of CAS except for the 2 features. More SLPs with a graduate degree than those with an undergraduate one reported that children with CAS do not exhibit weakness in oral musculature that causes drooling and impaired ability to blow. Also more SLPs with > 5 years of clinical experience indicated that children with CAS have difficulty producing initial articulatory gesture. The uniform responses across educational and experience level of the clinicians in this study may indicate the influence of ASHA consensus reports on the diagnostic markers of CAS on clinicians' knowledge including those in Jordan. Consistent findings were also reported for a survey of SLPs in USA where beliefs and practices were relatively similar regardless of clinicians' experience level (Randazzo, 2019).

Findings of the current study revealed that most SLPs in Jordan identified speech features for Arabic speaking children with CAS that are consistent with the majority of the consensus features of CAS proven to be differentially diagnostic reported by previous consensus studies (ASHA, 2007a; Iuzzini-Seigel et al., 2017; Murray et al., 2015; Shriberg et al., 2012), and by diagnostic checklists (Ozanne, 2005; ASHA, 2007b; Shriberg et al., 2012). These features include inconsistent speech errors, unintelligible speech, errors in the production of majority of phonemes, increasing difficulty with multisyllabic words, disrupted DDK sequencing, vowel production errors, groping, disturbed coarticulatory transitions, and inappropriate prosody.

The profile of CAS speech feature reported by SLPs on Jordanian Arabic speakers is also similar to that of SLPs reporting on children speaking English (Forrest, 2003; Randazzo, 2019), Swedish (Malmenholt et al., 2017), Persian (Shakibayi et al., 2019), and Cantonese (Wong et al., 2023) suggesting the presence of certain shared features of CAS across languages. Future studies should be directed toward identifying features of CAS that are language universal and those largely influenced by unique phonological characteristics of particular languages.

• Conclusion

Typical features of CAS identified by SLPs on Jordanian Arabic speaking children were consistent with those in previous consensus studies on English-speaking children and previous clinicians' surveys. Results may contribute in achieving crosslinguistic consensus on diagnostic features of CAS. Future studies should involve direct investigations of speech features displayed by Jordanian Arabic speaking children with suspected CAS as well as the occurrence and prevalence of possible comorbid conditions. Such studies will help, along with results from the current survey, in establishing a standard protocol for CAS diagnosis for Jordanian Arabic speaking children in Jordan. Surveys describing Jordanian SLPs' current practice regarding treatment approaches of CAS are also recommended.

Disclosure statement

The authors report no conflicts of interest.

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