European Journal of Special Education Research
ISSN: 2501 - 2428
ISSN-L: 2501 - 2428
Available on-line at: www.oapub.org/edu

DOI: 10.46827/ejse.v12i3.6666 Volume 12 | Issue 3 | 2026

INFLUENCE OF NON-SPEECH ORAL MOTOR EXERCISE (NSOMES) THERAPY ON ARTICULATION SKILLS IN LEARNERS WITH DOWN SYNDROME IN MACHAKOS COUNTY, KENYA

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Abstract:
Down Syndrome is a genetic condition caused by an extra copy of chromosome 21. This then makes the individual have 47 chromosomes instead of the typical 46. In most cases, individuals with the condition also have mild to moderate intellectual disability. Other conditions include low muscle tone and developmental delay. Children with Down Syndrome often experience delayed speech development and articulation difficulties. This necessitates specialized interventions by Speech-Language Pathologists (SLPs). While various speech therapy intervention techniques are employed, the effectiveness of Non-Speech Oral Motor Exercises (NSOMEs) in improving articulation remains debated and under-researched, particularly in low-resource settings. This study examined the influence of NSOMEs on articulation skills among children with Down Syndrome in selected primary schools in Machakos County, Kenya. The study was guided by Social Learning Theory and employed a mixed-methods approach. It combined a quasi-experimental design and descriptive qualitative analysis. A total of 26 participants were purposively selected, comprising 20 children with Down Syndrome (10 in the experimental group and 10 in the control group) and 6 speech-language pathologists. Data were collected through articulation pre- and post-tests (adapted from the GFTA-3 tool), in-depth interviews with SLPs. Quantitative data were analyzed using descriptive statistics and paired t-tests via SPSS, while qualitative data were processed through thematic analysis. Findings revealed that 90% of the children had below-average articulation scores at baseline, with the experimental group showing a significant mean

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gain of 26.2% after six weeks of NSOME intervention ($p = 0.001$), compared to a negligible improvement in the control group. Observational data supported these findings, with improvements noted in lip strength, tongue coordination, and speech clarity. Interviews with SLPs highlighted that NSOMEs are perceived as clinically beneficial, especially when integrated with other speech therapy techniques. The study concludes that NSOMEs are an effective early intervention strategy for improving articulation skills in children with Down Syndrome and recommends their integration into multimodal therapy programs.

Keywords: Down Syndrome, moderate intellectual disability, trisomy 21, low muscle tone, multimodal therapy

1. Introduction

Down Syndrome is caused by a chromosomal aberration that leads to the duplication of chromosome 21; hence, the affected individual has 47 chromosomes instead of the typical 46. Individuals with the condition may have physical traits like a flattened facial profile.

On the same note, individuals with the condition may have other health challenges, like heart defects. Another common challenge is articulation difficulties. While DS causes lifelong developmental delays, early intervention and regular therapies can lead to improved and fulfilling quality of life. Among the risk factors are advanced age, though more than 80% of individuals with the condition are born to parents under the age of 35. Inheritance can also be a risk factor, but very rarely. Only the translocation Down Syndrome type is known to be commonly passed over.

Non-speech oral motor exercise (NSOMES) comprises techniques that manipulate a child's lips and jaws as well as her tongue, an activity aimed at improving awareness and mobility without necessarily producing speech sounds. Common exercises include waging of the tongue and cheeks and blowing of bubbles to improve motor control (Lee & Gibson, 2015).

2. Methodology

Baseline data on articulation skill deficit were collected, after which the intervention was done as explained below. There were two groups in the research. This included the experimental group and the control group.

2.1 Speech Production Level Before Use of Non-Speech Oral Motor Exercise

Before any intervention, the researchers collected baseline data on the Speech Production level. To achieve this, a pre-test assessment was conducted for all 20 children in both the experimental and control groups using the Goldman-Fristoe Test of Articulation, Third Edition (GFTA-3), adapted for local use. The tool assessed each child's ability to articulate

a variety of speech sounds, categorized by consonant groups and blends. Scoring was based on articulation intelligibility as follows: 0 – Not able to articulate; 1 – Articulates with less than 20% intelligibility; 2 – Articulates with more than 40% intelligibility, and 3 – Clearly able to articulate. The scores for each child were converted into a percentage, then categorized into four performance bands:

2.2 Pre-Test Results (Experimental and Control Combined)

The table below summarises the findings.

Table 1: Pre-Test Results (Experimental and Control Combined)

Score Range (%)	Interpretation	Frequency (N=20)
0–40%	Very Low Articulation Skills	12
41–60%	Below Average	6
61–80%	Moderate Articulation	2
81–100%	Competent Articulation	0

The analysis of the pre-test scores shows a distinctive tendency of high levels of articulation among these children with Down Syndrome which were involved in this study. Of the total twenty participants, 12 participants (60 percent) fell between 0 and 40 percent, which is generally considered to be very poor articulation ability. These children could not articulate most speech sounds intelligibly. Six more children (30%) were at the scale of 41-60%, which is below average. This implies that although such children may have been able to express themselves by mentioning at least one or two speech sounds with some degree of correctness, they were not very clear and consistent. Only 2 children had moderate articulation skills (10%), and, importantly, no child met competent scores (81-100%).

These results indicate the nature and seriousness of speech production disorders in this group of people prior to any form of therapeutic intervention. The fact that 90 percent of the children received low scores on the lower side proves that articulation disorders are a major impediment to communication among children with Down Syndrome in this aspect. Such children will find it hard to express themselves (verbally), and as a result, they will mostly be unable to socialize, express their needs, and also operate well in academic institutions. This is therefore a problem of significant concern in society.

For purposes of triangulation, qualitative data were also collected through interviews, and the following were the responses from some of the SLPs.

> *"I have worked with these individuals for quite some time. The majority of them have very poor articulation abilities. I would say almost half of them. Some are almost speechless. None of my learners has competent articulation. Basically speaking, all our learners in this sample require significant intervention. They have serious articulation problems."* (SLP1)

"In this group, almost three-quarters of them are below average in their ability to articulate. You can barely hear what they are saying. You need to have really worked with the same individuals for a long time to be able to tell what they are saying. Sometimes we just infer. I have not experienced competent articulation from any of the learners. Some of their caregivers also complain of the same." (SLP2)

"Most of these children have great articulation challenges. One really has to struggle to hear what they are communicating. However, working collaboratively with parents has been of great use in helping us to figure out what they are saying. We hardly have any of them articulate competently. However, intervention is for sure needed because when they transition to society, they will need to cope and fit." (SLP3)

"Almost all of these individuals have below-average articulation abilities. I really struggle to work with them. However, with experience, I can easily infer that learners with this condition have challenges with Articulation." (SLP4)

"*Sadly, the majority of my learners with Down Syndrome have major articulation problems. Only a few are moderate. For many years that I have worked with these learners, most of them are below average in articulation."* (SLP5)

"Everyone in this group has significant articulation challenges. It is difficult to work with them. Almost everyone's articulation ability in this group is below average. This is such a serious concern." (SLP6)

Looking at both qualitatively and quantitatively collected data above, it is clear that all learners under investigation lack competent articulation. These observations are in line with results from previous research, such as Kimani *et al.* (2019) and Luzzini-Seigel *et al.* (2020), who reported that children with Down Syndrome frequently experience delays in acquiring speech sounds due to low muscle tone, oral cavity structural anomalies, and motor planning/coordination difficulties.

It is common to have articulation problems in learners with Down Syndrome due to protruding tongue, low muscle tone and hearing difficulties (Thomson, 2001). Both phonological and articulation research show that speech patterns in learners with Down Syndrome are due to errors not seen in typically developing learners, as well as delayed development. Further, stuttering and /or cluttering occur at the rate of 10 to 45% of learners with Down Syndrome compared to only 1% in the general population (Kent & Vorperlian, 2014). Research further indicates that despite a wide range of individual differences in children with Down Syndrome, almost all learners with Down Syndrome have delayed language development and equally take long in saying their first word. On the same note, vocabulary grows more slowly than that of typically developing counterparts (Buckley, 1993). In the research by Foda *et al.* (2020), it was found that

learners with Down Syndrome have either or both expressive and receptive language challenges. On the same note, they were found to have at least one speech intelligibility disorder compared to their typically developing peers.

2.3 Breakdown by Sound Categories

To provide a more granular view of the children's speech production abilities before the intervention, the pre-test articulation data were analysed according to sound categories. This analysis focused on five primary speech sound groups: **plosives, nasals, fricatives, affricates**, and **blends**. Each child's articulation accuracy for the target sounds within each category was scored on a standardized 0–3 scale and then averaged across the sample to determine group-specific performance.

The results are summarized in the table below:

Table 2: Breakdown by Sound Categories

Sound Group	Mean Pre-Test Score (0–3 Scale)
Plosives (e.g., /p/, /b/, /t/)	1.1
Nasals (e.g., /m/, /n/)	1.4
Fricatives (e.g., /f/, /s/, /v/)	0.8
Affricates (e.g., /ʤ/, /tʃ/)	0.6
Blends (e.g., /str/, /sn/)	0.5

It shows considerable disparity in the number of hits on pre-test articulation between various sound categories. With means between 1 and 1.5, nasals (/m/, /n/) were ranked first among the five groups tested, which shows that children have been relatively better at producing these sounds, though not very clearly. Generally, nasal sounds need simpler oral-motor coordination and are among the first sounds a child acquires when learning to talk.

The mean score of plosives (/p/, /b/, /t/) that appear after nasals was 1.1. These sounds are somewhat more challenging in terms of oral-motor control because of the requirement of building up and letting go of pressure, but they, too, are early-acquired sounds. Nevertheless, the low score of 1.1 is still below the 2.0 mark (more than 40 percent is intelligible) in this case, which emphasizes the fact that the children were unable to make these sounds articulately and consistently.

Fricatives showed a large performance decrease, with a mean score of 0.8. These sounds involve fricatives (/f/, /s/, and /v), which are even more demanding because of airflow control and coordination with the tongue, teeth, and lips, thus being more difficult to master by the children with Down syndrome, who tend to have oral-motor hypotonia and structural abnormalities, like a high arched palate, or macroglossia.

Affricates (/ʤ/, /tʃ/) and consonant blends (/str/, /sn/) had the lowest mean scores of 0.6 and 0.5, respectively. These systems require a high degree of oral motor accuracy and timing, as well as the complexities of articulatory sequences, which are usually acquired later in normal development. The lack of high score points to the extreme

articulatory demands and to the fact that the participants were not generating sufficient speech motor control to attain these complex combinations of sounds.

Qualitative data were collected through interviews with SLPs. The following were the responses:

> *"Due to challenges in motor skills, all my learners have difficulties in literally all sound groups, but the worst of all is fricatives. Equally challenging are affricates. Technically speaking, this is a big challenge because learning can hardly take place with these challenges."* (SLP1)

> *"For plosives and nasals. I cannot complain much, but this is a relative statement. It is not like they are perfect, but they have great challenges in blends and affricates."* (SLP2)

> "*My learners are fairly competent in plosives and nasals. They have great challenges in blends and affricates. They really need this worked on. They have auditory processing difficulties that need intervention."* (SLP3)

> "*My learners generally have challenges in blends, affricates, and fricatives. I am not very sure they are perfect in any sound grouping, though."* (SLP4)

> "*My learners have challenges in all sound groups. I cannot say they are perfect in any. This is mostly due to muscle tone-related challenges. Some of the sound classes require complex muscle programs."* (SLP5)

> "*I report challenges in all sound categories. In my opinion, there is a concern in all of them. Intervention is critical. There is little communication that takes place in my learners."* (SLP6)

Reviewing the above data, there is consistency between both qualitative and quantitative data. The learners do not seem to be perfect in either sound group. Overall, the split by sound category provides a better understanding of the nature of articulation impairments in children with Down syndrome. Simpler sounds with fewer articulatory features (such as nasals and plosives) appear to be more accessible to these learners, but complicated articulations (fricatives, affricates, and blends) remain considerably hindered. These findings are consistent with previous research showing that children with Down Syndrome frequently experience delays in acquiring high-complexity sounds due to a combination of cognitive, motor, and anatomical factors (Forrest, 2020; Kimani *et al.*, 2019). Research has well documented that learners with DS have challenges with speech production. They present it with reduced intelligibility (Wood, 2010). Precisely, speech challenges in individuals with Down Syndrome stem from anatomical variation in the oral cavity and from low muscle tone affecting the speech muscles. Fricatives, for

example, are complex in articulation and require a complex motor program. That is why many individuals with Down Syndrome have a challenge with it (Timmins *et al.*, 2014). On the same note, learners with Down Syndrome have challenges in blends due to poor working memory, auditory memory, and auditory processing. This makes phonological awareness harder (Burygoyne *et al.*, 2013).

2.4 Post-Intervention Performance – NSOMEs Influence

NSOMEs intervention was done, and similar data were collected to see the effect of the intervention. The ten children in the experimental group participated in a systematic NSOMEs therapy program for six weeks, with treatment twice a week. Following the intervention, a post-test examination was given using the same GFTA-3 tool. The resulting scores were compared to their pre-test performance as well as the scores of the control group, who did not receive NSOMEs over the same time period. Below are the findings.

2.4.1 Mean Improvement Scores

Table 3: Mean Improvement Scores

Group	Mean Pre-Test (%)	Mean Post-Test (%)	Mean Gain (%)
Experimental	38.4	64.6	**26.2**
Control	39.0	41.1	**2.1**

The results indicate that there was a significant increase in the performance of articulation of children who were treated under NSOMEs. Mean gain was 26.2% since in the experimental group, the mean pre-test score rose to 38.4%, and the mean post-test score rose to 64.6%. On the other hand, the control group that was not exposed to NSOMEs experienced a very slight increment of only 2.1 percent (39.0% to 41.1%). Such a slight variation indicates that the process of natural development or non-focused interactions in the classroom were not the major factors contributing to the improvement of their speech articulation over the same time frame. Thus, the high difference in the change of the two groups is associated with the organized NSOMEs intervention.

2.4.2 Paired Sample t-Test Results (Experimental Group Only)

A **paired sample t-test** was conducted using SPSS version 26 to statistically assess whether the difference between pre- and post-test scores in the experimental group was significant.

Table 4: Paired Sample t-Test Results

Test	Mean Difference	t-value	p-value
Pre vs Post	26.2%	4.72	**0.001**

The paired sample t-test results indicate a difference of the mean as 26.2% and the t-value as 4.72, and a p-value of 0.001. As the value of p is less than 0.05, this result is statistically significant.

The considerable rise in post-test results is strong evidence that NSOMEs produced positive, differentiable effects on the experimental group's children's ability to produce speech sounds. This finding is consistent with previous studies suggesting that non-speech oral motor training can build oral musculature, enhance coordination, and increase motor planning needed to produce speech sounds, particularly among children with neurodevelopmental disorders such as Down Syndrome (Lof & Watson, 2008; Kumar & Bhat, 2020).

Qualitative data were also collected through interviewing SLPs. They were required to compare improvements in both groups of learners after the intervention. The control group and the experimental.

> *"I found a very great difference between the experimental group and the control group. Due to improved use of muscle tone, colligability significantly improved. There was a slight improvement in the control group as well, but this was negligible compared to the experimental group."* (SLP1)

> *"I found improvement in both groups, but that of the control group was negligible. This rules out the possibility that the improvement in the control group was by mere chance."* (SLP2)

> *"I can confirm that there was a great improvement in the experimental group. I did not find much improvement in the control group. I am now a strong advocate of NSOMEs. There was a great improvement in the effective use of articulators."* (SLP4)

> *"It is very clear that the experimental group improved in comparison to the control group. I believe the positive change in the experimental group was not by chance. We should embrace NSOMEs"* (SLP4)

> *"I am not very conversant with NSOMEs, but I can observe that there was limited improvement in the control group as compared with the experimental group. This cannot be just by chance, but the effectiveness of the intervention strategy."* (SLP5)

> *"There was a great improvement in the experimental group. This is not possible by accident. The intervention worked perfectly well. While I have in the past talked against the strategy, it is scientifically evident that it works".* (SLP6)

Observational data supported these findings, with improvements noted in lip strength, tongue coordination, and speech clarity.

3. Brief Discussion

Non-speech oral motor exercises precisely involve a therapist helping the child with a speech problem by strengthening their lips, tongue and jaw, but do not involve producing speech. These are non-traditional therapy techniques meant to improve the learner's articulation abilities, just as the traditional therapy (O'Donnell, 2009). They include activities like making facial expressions, blowing bubbles, and sticking out the tongue. Their main purpose is to strengthen muscle articulators, including the jaws, lips and tongue.

Other parts targeted include the soft palate, larynx, and general respiratory muscles. This is intended to indirectly influence the physiological underpinnings of the oral pharyngeal mechanism. This, in turn, influences its function. In the process, the speech therapist is involved in activities such as active muscle stretching, related passive exercises and sensory stimulation (Lee, 2021). This ensures high-quality clinical care. Research has indicated that the techniques have been commonly and successfully used in Canada, the UK and the USA (Thomas & Kaipa, 2015). Research by Rumbach *et al.* (2016), however, found that most SLPs lacked clarity in the use of NSOMEs in each of their area of practice. This is a major concern in that the majority of respondents confirmed that they were not properly exposed to it during their training, yet they are in the field practicing (Rumbach *et al.*, 2015). In the same vein, research by Rocha et al. (2022) found that, among 184 SLP participants in Portugal, the majority understood and used NSOMEs successfully. Out of the total, 80.2% considered it effective. Of the total participants, 98.2% considered them successful in improving the motor functions of the articulators. It is necessary to embrace the practice locally as well.

4. Conclusion

Following the findings of this research, it is clear that NSOMEs improved articulation in the experimental group of learners with NSOMEs. While many speech therapists are inclined toward traditional speech therapy, it is necessary to embrace NSOMEs. On the same note, it can be used antagonistically with traditional speech therapy. Speech therapist training institutions also need to modify their curriculum to ensure that trainees are exposed to both theory and practice of NSOMEs. During their practicums, they should work under the supervision of experienced and seasoned speech therapists.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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