Differential Influence of Demographic Variables on Dyscalculia dimensions [1]

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Abstract

Dyscalculia is a specific learning difficulty that affects an individual's ability to perform mathematical tasks. The research was aimed at investigating whether gender and age have a differential influence on the number sense, arithmetic operations, and working memory dimensions of dyscalculia. The research design was an expo facto research design. The population was all 87320 junior secondary school 1 and 2 students in Obio-Akpor local government area. The sample consists of 453 students who have been diagnosed with dyscalculia. This sample was randomly drawn using a multistage sampling procedure. A standardized instrument the Dyscalculia Test was used for data collection. High validity and reliability indices were obtained for the test. The data were analysed using mean, standard deviation, one-way, and two multivariate analyses of variance. The result showed that gender and age independently and, in the interaction, had a differential influence on dyscalculia dimensions, but this differential influence was not significant. Based on these findings, it is recommended that educators use a variety of individualized instructional strategies and materials, including visual aids, manipulatives, and adaptive technologies that are effective for different genders and age groups of dyscalculics.

Keywords: dyscalculia, gender and age, number sense, arithmetic operations, working memory

Demografik Değişkenlerin Diskalkuli Boyutları Üzerindeki Farklılaşan Etkisi

Özet

Discalculia, matematiksel görevleri yerine getirme yeteneğini etkileyen özgün bir öğrenme güçlüğüdür. Bu araştırmanın amacı, cinsiyet ve yaşın disleksinin sayısal algı, aritmetik işlemler ve çalışma belleği boyutları üzerinde farklı bir etkisi olup olmadığını araştırmaktı. Araştırma tasarımı, expo facto araştırma tasarımıydı. Popülasyon, Obio-Akpor Yerel Yönetim Bölgesindeki tüm 87320 ortaokul 1 ve 2 öğrencisini kapsamaktadır. Örneklem, disleksi teşhisi konulmuş 453 öğrenciden oluşmaktadır. Bu örneklem, çok aşamalı bir örneklem alma prosedürü kullanılarak rastgele çekilmiştir. Eteng-Uket tarafından geliştirilen bir standartlaştırılmış araç olan Dyscalculia Testi veri toplama için kullanılmıştır. Test için yüksek geçerlilik ve güvenirlik indeksleri elde edilmiştir. Veriler, ortalama, standart sapma, tek yönlü ve iki çok değişkenli varyans analizleri kullanılarak analiz edilmiştir. Sonuç, cinsiyet ve yaşın bağımsız olarak ve etkileşim halinde disleksi boyutları üzerinde farklı bir etkisi olduğunu, ancak bu farklı etkinin anlamlı olmadığını göstermiştir. Bu bulgulara dayanarak, eğitimcilerin farklı cinsiyet ve yaş grupları için etkili olan görsel araçlar, manipülatifler ve uyumlu teknolojiler de dahil olmak üzere çeşitli bireyselleştirilmiş öğretim stratejileri ve materyaller kullanmaları önerilmektedir.

Anahtar Kelimeler: cinsiyet, yaş, sayısal algı, aritmetik işlemler, çalışma belleği, disleksi

Introduction

Learning is an essential part of our lives, and it can be a fulfilling and enjoyable experience. However, for some individuals, learning can be a significant challenge due to specific learning difficulties (SLD), also known as learning disorders. SLD is a broad term referring to a diverse group of neurobehavioral disorders characterized by significant unexpected and persistent difficulties in the acquisition and application of efficient reading (dyslexia), writing (dysgraphia), and mathematical (dyscalculia) abilities Eteng-Uket (2023). That is specific learning difficulty occurs despite conventional instruction, intact senses, average intelligence, adequate motivation, and adequate socio-cultural opportunity. There are several types of SLD, including dyslexia, dyscalculia, and dysgraphia. Dyslexia is a reading difficulty that affects an individual's ability to read, while dysgraphia is a writing difficulty that makes it difficult to express thoughts and ideas in writing. Dyscalculia on the other hand is a math disorder that makes it challenging to understand mathematical concepts and perform calculations.

[1] Submission Date: May 9, 2023, Acceptance Date: June 14, 2023 **DOI: 10.47806/ijesacademic.1294709**

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The World Health Organization (2010) described dyscalculia as a specific impairment in arithmetical skills, which is not solely explicable on the basis of general mental retardation or of grossly inadequate schooling. It is a learning disability affecting the acquisition of numerical-arithmetical skills in children with normal intelligence and age-appropriate school education (WHO, 2010; McCaskey et al, 2018). Von Aster & Shalev (2007) sees it as a specific learning disability affecting the normal acquisition of arithmetic skills. The Diagnostic and Statistical Manual of Mental Disorders (2013) refer to dyscalculia as a pattern of difficulties characterized by problems processing numerical information, learning arithmetic facts, and performing accurate or fluent calculations. Dyscalculia is a complex learning difficulty that affects a person's ability to understand and work with numbers

Individuals with dyscalculia exhibit a range of symptoms including difficulties in comprehending numbers and recalling arithmetic facts, flawed mathematical reasoning and inaccurate calculations, struggles in understanding mathematical terms, operations and concepts, struggle recognizing and remembering numerical symbols and arithmetic signs leading to prolonged solution times and inability to follow the sequence of steps involved in various mathematical operations, lack of concentration on mentally intensive tasks and difficulty in retaining information just to mention a few (Geary & Hoard 2001; Shalev & Gross-Tsur 2001; Jordan et al. 2003; Dowker 2004; Geary 2004a, 2004b; Landerl et al. 2004; Beacham & Trott 2005; Doyle 2010; Looi & Kadosh 2010; Trott 2010a, 2010b; American Psychiatric Association 2013; Zerafa 2015; Pandey & Agarwal 2015; Zygouris et al. 2017; Ogbogo & Opara 2021; Ogbogo & Orluwene 2021). According to Eteng-Uket (2023), it is characterized majorly by impairment in number sense (an intuitive feel for numbers and a common sense approach to using them; like subitising and numerizing which is the ability to instantaneously recognize the number of objects in a small group without the need to count them), difficulty in arithmetic operation(four basic arithmetic operations of addition, subtraction, multiplication and division) and working memory (holding information in short-term memory and manipulating the information).

There are alternative plausible explanations that could result in characteristics similar to those associated with dyscalculia but are not. They include; Failings due to inadequate education, inappropriate schooling or prolonged school absence, brain trauma resulting in acalculia, other specific learning difficulties comorbiding with dyscalculia like dyslexia and dysgraphia, intellectual disability, learning difficulties due to neurological or sensory disorders such as paediatric stroke, traumatic brain injury, hearing impairment, vision impairment, psychosis, attention deficit hyperactive disorder, and mathematics phobia or anxiety (a state of discomfort which occurs in response to situations involving mathematics tasks which are perceived as threatening, or a negative emotional reaction to mathematics or a feeling of tension, apprehension or fear or a sense of dread that interferes with the operations of mathematical problems). (American Psychiatric Association (DSM-5), 2013; Dellatolas et al., 2000; Drew 2015; Evans, 2001; Peard, 2010; Ramaa & Gowramma, 2002; World Health Organisation (ICD-10), 1992). Some researchers have also come up with types and classification of dyscalculia, (Geary 1993, 2004; Karagiannakis et al, 2014; Kosc 1974). The Numerical Core Deficit Model by Butterworth (1999), Numerical Domain-Specific Deficit model by Dehaene's 1999)and Domain-General Deficit classification Model by Karagiannakis, et al., (2014), are some models that have been used in explain and describing it.

The significance of dyscalculia lies in its impact on a person's academic and professional success. Students with dyscalculia may struggle in math-related subjects, such as science and technology, which can limit their career choices. They may also experience low self-esteem, anxiety, and frustration when faced with math problems. The implication for such people is that they can have negative functional consequences across their lifespan, including lower academic attainment, impair personality development, high levels of psychological distress, higher rates of unemployment and under-employment, lower incomes just to mention but a few. (Buttersworth, 2003; Eteng-Uket 2023; Ogbogo & Opara 2021; Ogbogo & Orluwene 2021; Shalev & Von Aster 2008).

With such negative consequences associated with dyscalculia its one phenomenon that is not very recognized and understood generally. That is dyscalculia is often overlooked or misdiagnosed, as it is less well-known than other learning disorders, such as dyslexia. However, research shows that dyscalculia is just as prevalent, affecting approximately 4-13% of the population depending on the country of study and criteria of diagnosis. (Butterworth et al, 2011; DSM-5 2013; Haberstroh & Schulte-Körne 2019; Kaufmann 2012; Lahrichi 2008; Looi & Kadoosh, 2002; Lahrichi 2008; Mazzocco & Myers 2003; Nikolaos et al, 2017; Shalev & von Aster, 2008). This means that there are millions of people worldwide who struggle with math and may not even know they have dyscalculia. While the exact causes of dyscalculia are still unclear, researchers have identified several factors that may influence this condition. Gender and age are some factors that may influence it.

Gender and Dyscalculia Dimensions

Gender is the set of social, cultural, and psychological characteristics associated with being male or female. Gender has also been found to influence number sense in individuals with dyscalculia. Study by Rasanen et al., (2021) shows an increasing gender difference in favor of girls in number-processing skills. Although study by Hutchison et al (2019) provide strong evidence of gender similarities on the majority of basic numerical tasks

Gender has also been found to influence arithmetic operations in individuals with dyscalculia. Rasanen et al., (2021) revealed that boys showed a better performance and a larger variance in tasks measuring arithmetic fluency. Same with Hyde, et al, (1990) who found sex difference in arithmetic computation. Similarly, study by Lynn & Irwing (2008) found a male advantage in mental arithmetic. While study by Vos et al., (2023) showed that women scored significantly lower than men on the arithmetic.

Gender has also been found to influence working memory in individuals with dyscalculia. Some studies have found gender differences in working memory. For example, Lynn & Irwing (2008) and Kaufman (2007) found sex difference. Some other studies as well has revealed gender difference in working memory. Some researches have shown that men performing better in some working memory tasks in some instances (Asperholm et al 2019; Piccardi et al., 2019; Pauls et al., 2013; Zilles et al. 2016). While in other instances, it has shown that women performed better (Asperholm et al 2019a; Asperholm et al 2019b; Herlitz &Yonker 2002; Pauls et al., 2013; Robert & Savoie, 2006; Voyer et al 2021). Gender appears to plays a prominent role in working memory. However, the results of previous studies examining gender differences in working memory have yielded mixed results and it is not clear to which extent working memory affects the relation between gender and working memory.

Generally, the most common finding reported in the literature regarding the influence of gender generally on dyscalculia is that of no dyscalculia gender difference (Desoete, et al., 2004; Devine, et., 2013; Gross-Tsur et al., 1996; Hein et al., 2000; Koumoulaet al., 2004; Mazzocco & Myers, 2003). Nevertheless, some studies did report gender differences, although these studies were inconsistent in whether they reported a higher prevalence of dyscalculia in girls (Dirks, et al., 2008; Gross-Tsuret al., 1996; Landerl & Moll, 2010; Mollet al.,

2014) or boys (Badian, 1999; Barbaresiet al., 2005; Ramaa & Gowramma 2002; Reigosa-Crespoet al., 2011).

As earlier stated, the debate as to whether male and female differ with regards to dyscalculia and, if so, to what extent is one that is still on-going in the research community. However, more research is needed to establish more conclusive positions especially from areas and regions of the world where evidence of gender difference on dyscalculia is scarce and also in relation to its interaction with other factors like age that may influence the difference if at all one is observed.

Age and Dyscalculia Dimensions

Age is a measure of the time that an individual has been alive, typically measured and expressed in years. The relationship between age and dyscalculia is complex and multifaceted. Age may be a significant influence on number sense in individuals. Study by Norris et al (2015) indicated an influence of age on number sense. While study by Yilmaz (2017) indicated a significant age-related complexity and improvement of number sense. Age may have a significant influence on individuals with dyscalculia in arithmetic operations dimension. Difficulty with arithmetic operations is a common characteristic of dyscalculia. Study by Hyde, et al., (1990) found difference in arithmetic computation for respondents from different ages. Study by Thoren et al., (2016) shows that age influences mathematics operations.

Age has a significant influence on working memory in individuals with dyscalculia. Working memory is an important cognitive skill that is closely linked to dyscalculia. Younger children with dyscalculia may struggle with working memory tasks that involve numbers, such as remembering a sequence of numbers or solving a math problem in their head. But as they get older, they may develop compensatory strategies to help them overcome these difficulties Although generally research shows that Working memory functioning declines with advancing age. (Bopp & Verhaeghen 2005).

Age and gender may also have a joint influence on dyscalculia dimensions. For example, a study by Reigosa-Crespo et al. (2017) found that older boys with dyscalculia performed worse on tasks involving working memory compared to younger boys with dyscalculia, suggesting an interaction between age and gender. In a study by Hyde, et al., (1990), they found difference in arithmetical computation of boys and girls at ages 5–10 and at ages 11–14, and that there was no sex difference at ages 15–18.

In general, research studies shows that individuals with dyscalculia has impairment in number sense and numerical skills (Butterworth, 2010; Gilga & Gilga 2012; Eteng-Uket 2023; Zygouris, et al 2017; Merdian et al 2012; Olkun et al 2016; Von Aster 2001), arithmetic operations (Butterworth2003; Grégoire, et al 2015; Eteng-Uket 2023;) and working memory ((Andersson & Lyxell 2007; Bull, Espy, & Wiebe, 2008; David 2012; Geary et al., 2000; Geary & Hoard, 2001; Roselli et al 2006;Rotzer et al 2009; Eteng-Uket 2023; Swanson & Jerman. 2006).

The Present Study

As our society becomes increasingly reliant on numerical literacy, dyscalculia can have a significant impact on an individual's educational and career opportunities. Understanding the influence that socio-demographic factors like gender and age play on dyscalculia is important for a variety of purposes. Some of them include the fact that it can help educators, psychologist, school counsellors, teachers and policymakers develop more effective interventions and support systems for those affected especially in the different dimensions which can trigger specific interventions.

More so, studies on the influence of age and gender on dyscalculia is a topic that has not garnered significant attention by researchers especially in relation to its counterpart dyslexia. While there are some studies on these factors, the extent to which they influence dyscalculia is still a subject of debate. Further research is needed to better understand the factors individually as well as the interactions between these factors and the ways in which they may influence the dimensions of dyscalculia. Also, researches on the influence of gender and age on dyscalculia are based almost exclusively on results from modern western societies. Thus, research findings from developing nation like Nigeria that will take into account the peculiarities and complexities of respondents from this region of the world are important. Therefore, there is need to expand the evidence base on which policies and decisions about the influence of these variables on dyscalculia are built by including results from regions that are not in literature. All these created a gap that needed to be filled. This was what has necessitated this research which was aimed at investigating the differential influences of demographic factors of gender and age on dyscalculia dimensions of number sense, arithmetic operations and working memory.

The following research questions guided the study;

1. What is the influence of gender on the dimensions of dyscalculia?
2. What is the influence of age on the dimensions of dyscalculia?
3. To what extent does gender and age influence the dimensions of dyscalculia?

The following null hypothesis were tested at 0.05 significant level.

1. There is no significant influence of gender on the dimensions of dyscalculia
2. Age has no significant influence on the dimensions of dyscalculia
3. Age and gender does not have any significant influences the dimensions of dyscalculia

Method

Research Design

The research design was the expo facto research design or causal-comparative design. It is the design in which the investigation starts after the fact has occurred without interference from the researcher. This design examines past occurrences in order to understand a current state. It is analyzing data after they have occurred. Here the researcher investigated the influence gender and age on an already existing variable of dyscalculia (persons already having dyscalculia).

Population for the Study

The population was all 87320 junior secondary schools 1 and 2 students in the Obio-Akpor Local government area of Rivers State Nigeria.

Sampling and Sampling Technique

The sample consists of 453 students of different gender and age groups who have been diagnosed with dyscalculia. This sample was randomly drawn using a multistage sampling procedure that applied simple random, cluster, stratified, and purposive sampling techniques. At the first stage, cluster sampling was employed to create clusters based on senatorial districts in Rivers state. Then from the senatorial district cluster, one senatorial district was randomly drawn using simple random technique by balloting without replacement. At the second stage, from each of the senatorial district clusters in each state, local government clusters was created. Then from each of the local government cluster, random sampling technique by balloting without replacement was used to draw three (3) public junior secondary schools and three (3) upper primary schools from each local government in Rivers. At the third stage stratified random sampling technique based on school type, age and gender was used to draw 750 students. (300 primary school students and 450 junior secondary school students). At the fourth stage of sampling the 750 students were administered the Dyscalculia Test by Eteng-Uket (2023). They were administered this instrument to screen for those with dyscalculia. This screening was done so that only those that had moderate Dyscalculia (total scores between 23–42 formed the test). According to the Dyscalculia Test manual, a score between 23–43 indicates that an individual performed below average in the three dimensions of the test and therefore has marked difficulties learning skills in the three core dimensions. What this meant was that the 750 students were administered the Dyscalculia test and only those with scores from 43 below formed the sample. After administration and scoring, from the 750 only 510 students beat the cut off. At the sixth stage therefore, purposive sampling was employed to draw the sample size of 450. However from this 510, subject mortality (incompletely filled Dyscalculia Test) of 60 was experienced leaving a final sample size of 450. Thus, only the 450 students who scaled the cut off criteria from the dyscalculia test and had their dyscalculia test properly filled formed the final sample size. Thus purposive sampling technique was employed to draw final sample size of 450.

Instrument for Data Collection

A standardized instrument the Dyscalculia Test by Eteng-Uket (2023) was used for data collection. The Dyscalculia Test is an instrument developed to diagnose and identify persons with specific learning difficulty in arithmetic. It is designed to assess students with specific learning difficulty in arithmetic between the ages of 7-13. The Dyscalculia test items comprised of three broad dimension on which multiple choice test items was on. The domains are Number Sense, Arithmetic Operations and Working Memory. The Dyscalculia Test is a 45-minute timed test containing 85 items in an item booklet. It was designed using the multiple-choice question format with four options lettered A, B, C, and D, which has a key (correct response) and three distracters (incorrect response), and test takers are expected to provide the answer in a separate answer. A total of 85 items gives a raw score of 85 from the three domains. The total score index from the three core domains of the Dyscalculia Test is summed up to give a score representing an individual's dyscalculia score. The core domain from which an individual has the lowest score indicates the dimension on which an individual is most dyscalculic. The highest possible score from the scale is 85, and the lowest score is 0. Based on the DSM-5 recommendation on how specific learning difficulties like dyscalculia are to be categorized, scores from Dyscalculia Test are classified as follows. No Dyscalculia (total scores from 64 and above, that is an individual performed significantly above average in the three subsets of the test). Mild Dyscalculia (total scores between 43–63 that is an individual performed around average in the three subsets of the test). Moderate Dyscalculia (total scores between 23–42, that is an individual performed below average in the three subsets of the test) and Severe Dyscalculia (total scores between 0–22, that is an individual performed significantly low in the three subsets of the test).

Validity of the instrument

Face validity was ensured by seeking expert (test and measurement, counseling psychologist, Mathematics subject specialist and Language experts) opinions. These experts critically analyzed the items for the content, language, correct ambiguities and checked that all the defined objectives were tested. On the basis of criticisms and comments offered by experts only those items which received at least 70% approval of the experts were retained for item analysis. Content validity was established via the use of the content validity index obtained from experts judgment and a high content validity index of 0.94 was obtained. The construct validity of Dyscalculia Test was estimated using the multivariate factor analysis and the first factor loading for all items was significantly greater than 1. The principal component analysis was used for processing the data. The varimax Kaiser Normalization extraction method and the rotated factor loading matrix were used to estimate the construct validity. For instance, for the Number Sense dimension, rotated factor loadings ranged between 0.31 to 0.755. For the Arithmetic Operations dimension, it ranged between 0.30 to 0.54, while for the Working Memory dimension it ranged between 0.30 to 0.50. The eigenvalues of one above were used to select items that measure the similar construct. Construct validity was further established through hypothesis testing evidence.

Reliability of the instrument.

The Kuder-Richardson, KR20 internal consistency reliability of the Dyscalculia Test of 0.93, 0.91, 0.888 and 0.910 obtained for the three dimensions and the Dyscalculia test as a whole. The Split-half reliability analysis for Dyscalculia Test shows reliability estimate of the first half of the test to be .907 and that of the second part of the test to be .922. To estimate the reliability of the full test, Spearman-Brown yielded a coefficient of .886. Therefore, a split half coefficient of .886 was obtained.

Method of Data Analysis

The data were analyzed using mean, standard deviation, one-way, and two way multivariate analyses of variance (MANOVA).

Findings

Research Question 1: What is the influence of gender on the dimensions of dyscalculia?
Hypothesis 1: There is no significant influence of gender on the dimensions of dyscalculia.

Table 1. Mean, SD and One-Way MANOVA of influence of gender on Dyscalculia dimension.

Dyscalculia Dimensions	Gender	Mean	Std. Deviation	N	Univariate test (F)	Sig	Multivariate test (f)	Sig
Number Sense	male	10.21	5.291	243				
	female	9.209	4.510	225	5.196	.023		
Arithmetic Operations	male	6.613	4.241	243				
	female	6.533	3.959	225	.042	.837	2.377	.0.69
Working Memory	male	2.642	3.078	243				
	female	2.847	3.206	225	484	.487		

The table reveals that the mean score for the Number Sense dimension was higher for males (M=10.21, SD=5.291) than females (M=9.209, SD=4.510). The univariate test revealed a significant difference between genders (F=5.196, p=.023). For the Arithmetic Operations dimension, the mean score was slightly higher for males (M=6.613, SD=4.241) than females (M=6.533, SD=3.959), but the difference was not statistically significant (F=.042, p=.837).

In the Working Memory dimension, the mean score was slightly higher for females (M=2.847, SD=3.206) than males (M=2.642, SD=3.078).

The multivariate test examines the overall effect of gender on the three dyscalculia dimensions taken together. The results show no significant influence of gender on the three dimensions combined (f=2.377, p=0.069).That is across the dyscalculia dimensions of number sense, arithmetic operation and working memory, male and females does not differ significantly female as seen by the Wilk's ^=.2,377, p = .069. >.05. This simply connotes that that gender (whether one is male or female) does not have a significant influence on their dyscalculia characteristics of impairments in number sense, arithmetic operations and working memory.

In summary, the results suggest that gender may have a small influence on some dimensions of dyscalculia, but this influence is not significant. Therefore, the hypothesis that there is no significant influence of gender on the dimensions of dyscalculia is accepted

Research Question 2: What is the influence of age on the dimensions of dyscalculia?

Hypothesis 2: There is no significant influence of age on the dimensions of dyscalculia.

Table 2. Mean, SD and One-Way MANOVA of influence of Age on Dyscalculia dimension.

Dyscalculia Dimensions	Age	Mean	Std. Deviation	N	Univariate test (F)	Sig	Multivariate test (f)	Sig
Number Sense	7-10yrs	9.516	4.658	186				
	11-13yrs	9.962	5.173	267	.885	.347		
Arithmetic Operations	7-10yrs	6.381	3.670	186				
	11-13yrs	6.711	4.390	267	.706	.401	1.477	0.22
Working Memory	7-10yrs	2.554	2.992	186				
	11-13yrs	2.737	3.136	267	2.219	.137		

The results show that for the Number Sense dimension, the mean score was slightly higher for the 11-13 years age group (M=9.962, SD=5.173) than the 7-10 years age group (M=9.516, SD=4.658). However, the univariate test did not show a significant difference in the scores between age groups (F=.885, p=.347).

For the Arithmetic Operations dimension, the mean score was slightly higher for the 11-13 years age group (M=6.711, SD=4.390) than the 7-10 years age group (M=6.381, SD=3.670), but the difference was not statistically significant (F=.706, p=.401).

In the Working Memory dimension, the mean score was slightly higher for the 11-13 years age group (M=2.737, SD=3.136) than the 7-10 years age group (M=2.554, SD=2.992), but the difference was not statistically significant (F=2.219, p=.137).

The multivariate test examines the overall effect of age on the three dyscalculia dimensions taken together. The results show no significant influence of age on the three dimensions combined (f=1.477, p=0.220).That is across the dyscalculia dimensions of number sense, arithmetic operation and working memory, students aged 7-10 and 11-13 did not differ significantly as seen by the Wilk's **^**=.1.477, p = 0.220. >.05. This simply connotes that that age (whether one is between age 7-10 or 11-13) does not have a significant influence on their dyscalculia characteristics of impairments in number sense, arithmetic operations and working memory. The results suggest that age may have a small influence on the dimensions of dyscalculia, but this influence is not statistically significant. Therefore, the hypothesis that there is no significant influence of age on the dimensions of dyscalculia is upheld.

Research Question 3: What is the interaction influence of gender and age on the dimensions of dyscalculia?

Hypothesis 2: There is no significant interaction influence of gender and age on the dimensions of dyscalculia.

Table 3. Mean, SD and Two-Way MANOVA Analysis of interaction influence of Gender and Age on Dyscalculia dimension

Dyscalculia Dimen.	Gender	Age	Mean	Std. Deviation	N	Uni	Sig	Mult	Sig
		7-10yrs	10.1111	4.51326	90				
	male	11-13yrs	10.3660	5.71212	153				
		Total	10.2716	5.29153	243				
		7-10yrs	8.9583	4.74600	96				
	female	11-13yrs	9.4211	4.31276	114	.048	.827		
Number sense		Total	9.2095	4.51090	210				
		7-10yrs	9.5161	4.65830	186				
		11-13yrs	9.9625	5.17354	267				
	Total	Total	9.7792	4.96802	453				
		7-10yrs	6.3667	3.52344	90				
	male	11-13yrs	6.7582	4.61694	153				
		Total	6.6132	4.24149	243				
		7-10yrs	6.3958	3.82094	96				
	female	11-13yrs	6.6491	4.08533	114				
Arithmetic		Total	6.5333	3.95928	210				
		7-10yrs	6.3817	3.67011	186			1.209	.306
		11-13yrs	6.7116	4.39018	267				
	Total	Total	6.5762	4.10876	453	.031	.861		
		7-10yrs	2.5889	2.62612	90				
	male	11-13yrs	2.6732	3.32421	153				
		Total	2.6420	3.07875	243				
		7-10yrs	3.3854	3.83987	96				
Working Memory	female	11-13yrs	2.3947	2.48400	114	3.208	.074		
		Total	2.8476	3.20669	210				
		7-10yrs	3.0000	3.32395	186				
	Total	11-13yrs	2.5543	2.99245	267				
		Total	2.7373	3.13690	453				

For the number sense dimension, the mean scores for male and female participants were 10.2716 and 9.2095, respectively. The mean scores for participants aged 7-10 years and 11-13 years were 9.5161 and 9.9625, respectively. Female participants aged 7-10yrs had the least scores while male aged 11-13yrs had the highest scores on the number sense dimension. The univariate test showed that there was no significant interaction influence between gender and age on number sense dimension ($p = .827$, $p > .05$).

For the arithmetic dimension, the mean scores for male and female participants were 6.6132 and 6.5333, respectively. The mean scores for participants aged 7-10 years and 11-13 years were 6.3817 and 6.7116, respectively. Female participants aged 7-10yrs had the least scores while male aged 11-13yrs had the highest scores on the arithmetic dimension. The univariate test showed that there was no significant interaction influence between gender and age on arithmetic operations dimension ($p = .861 > .05$)

For the working memory dimension, the mean scores for male and female participants were 2.6420 and 2.8476, respectively. The mean scores for participants aged 7-10 years and 11-13 years were 3.0000 and 2.5543, respectively. Female participants aged 7-10yrs had the least scores while male aged 11-13yrs had the highest scores on the number sense dimension.

The univariate test showed that there was no significant interaction influence between gender and age on working memory dimension (p = .074, p > .05).
The results indicate that there were slight differences in mean scores between male and female participants and between age groups for each of the dyscalculia dimensions (number sense, arithmetic operations, and working memory). However, the univariate tests showed that these differences were not statistically significant. This suggests that gender and age does not have a significant influence on dyscalculia characteristics in terms of impairments in number sense, arithmetic operations, and working memory.
The results suggest that male participants tended to perform slightly better than female participants on all three dyscalculia dimensions. Additionally, participants aged 11-13 tended to perform slightly better than participants aged 7-10 on the number sense and arithmetic operations dimensions with exception on the working memory dimension. However, these differences were not statistically significant.
The two way MANOVA multivariate test examines the overall influence of gender and age on the three dyscalculia dimensions taken together. The results show no significant influence of age and gender on the three dimensions combined (f=1.209, p=.306).That is across the dyscalculia dimensions of number sense, arithmetic operation and working memory, male and female students aged 7-10 and 11-13 do not differ significantly as seen by the Wilk's **^**=.1.209, p = 0306. >.05. This simply connotes that that age (whether one is between age 7-10 or 11-13) and gender(whether one is male or female) jointly does not have a significant influence on the their dyscalculia characteristics of impairments in number sense, arithmetic operations and working memory. Therefore, the hypothesis that there is no significant interaction influence of gender and age on the dimensions of dyscalculia is upheld.

Discussion
The results presented in the given finding indicate that there is a significant difference in mean scores between males and females in the Number Sense dimension, with males scoring higher on average. This difference was found to be statistically significant. This finding is similar with the Study by Rasanen et al., 2021 whose studies showed gender difference number-processing skills although in the favor of female. This implies that female students are more susceptible to dyscalculia in terms of impairments in number sense. On the other hand, for the Arithmetic Operations dimension, although males scored slightly higher on average than females, this difference was not significant. This finding is similar with the Study by Rasanen et al., 2021 whose studies showed gender difference in arithmetic. This finding is also similar to studies by Vos et al., (2023), Lynn & Irwing (2008) and Hyde, et a., (1990) who found sex difference in arithmetic computation. Although there exist a bit of difference as the sample in these studies were not dyscalculic. In the Working Memory dimension, females scored slightly higher on average than males, but this difference was not significant either. Some studies have found gender differences in working memory just like this study. For example, Lynn & Irwing (2008) Kaufman (2007), Piccardi et al., (2019) Pauls et al., (2013), Robert & Savoie, (2006) and Zilles et al. (2016)
These gender differences may be attributed to differences in brain structure and function, as well as sociocultural factors such as stereotype threat (Hornung et al., 2014). That is factor that could contribute to the gender differences in dyscalculia is the societal expectation that males are better at math than females. This stereotype can lead to unconscious bias in teachers and parents, who may be more likely to identify and support males with dyscalculia than females. This bias can also affect females' confidence in their math abilities and

discourage them from pursuing careers in math-related fields. When examining the three dimensions together, the multivariate test showed that gender did not have a significant influence on the dimensions of dyscalculia taken together. Therefore, the results reveals that although gender may have a small influence on some dimensions of dyscalculia, this influence is not significant when considering all dimensions together.

The results presented also indicate that there is a difference in mean scores between students aged 7-10 and ages 11-13, with students aged 11-13 scoring higher on all the three dimensions. This difference was found not to be statistically significant. When examining the three dimensions together, the multivariate test showed that age did not have a significant influence on the dimensions of dyscalculia taken together.

Related in a way to this study's findings is the Study by Yilmaz (2017). The study indicated a significant age related complexity and improvement of number sense. Also Study by Hyde, et al., (1990) found difference in arithmetic computation for respondents from different ages same with study by Thoren et al., (2016) that showed that age influences mathematics operations. The reason for these results could be that younger children with dyscalculia may struggle with basic number sense skills, such as counting and understanding numerical magnitudes. How be it, as they get older, they may develop compensatory strategies to help them overcome these difficulties, such as using finger counting or visual aids. Also younger children with dyscalculia may struggle with basic arithmetic operations, such as addition and subtraction. However as they get older, they may develop compensatory strategies to help them overcome these difficulties, using calculators or memorizing multiplication tables. However, these strategies may not be as effective as developing a strong understanding of arithmetic concepts and procedures

The results indicate that there were slight differences in mean scores between male and female participants and between age groups for each of the dyscalculia dimensions (number sense, arithmetic operations, and working memory). However, the univariate tests showed that these differences were not statistically significant. This suggests that gender and age do not have a significant influence on dyscalculia characteristics in terms of impairments in number sense, arithmetic operations, and working memory.

The two-way MANOVA test examined the overall influence of age and gender on the three dyscalculia dimensions taken together. The results indicate that there was no significant interaction effect of gender and age on dyscalculia dimensions. This means that age and gender do not have a significant influence on the overall dyscalculia characteristics of the participants in this study.

The results suggest that male participants tended to perform slightly better than female participants on all the dyscalculia dimensions with the exception of working memory. Additionally, participants aged 11-13 tended to perform slightly better than participants aged 7-10 on the number sense and arithmetic operations dimensions, while participants aged 7-10 tended to perform slightly better than participants aged 11-13 on the working memory dimension. However, these differences were not statistically significant. A bit divergent to this study's finding is study by Reigosa-Crespo et al. (2017) which found that older boys with dyscalculia performed worse on tasks involving working memory compared to younger boys with dyscalculia, suggesting an interaction between age and gender. Also similar is the study by Hyde, et al.,(1990), they found difference in arithmetical computation of boys and girls at ages 5–10 and at ages 11–14, and no sex difference at ages 15–18. Reasons for these divergent could be the difference in the scale as well as difference in the demographic profile of the respondents.

Generally, the findings suggest that dyscalculia characteristics are not significantly influenced by age and gender. This implies that dyscalculia interventions should focus on individualized assessment and treatment plans that consider factors beyond age and gender, such as specific strengths and weaknesses in number sense, arithmetic operations, and working memory.

Conclusion and Recommendation

The result suggests that there is no significant difference in dyscalculia characteristics between male and female students aged 7-10 and 11-13 on all the dimensions independently and jointly. Except for number sense where there was a significant influence. This implies that male and female students are not equally susceptible to dyscalculia in terms of impairments in number sense.

The result also shows that there is no significant difference in dyscalculia characteristics between male and female students aged 7-10 and 11-13. This means that both male and female students within these age groups are equally susceptible to dyscalculia in terms of impairments in number sense, arithmetic operations, and working memory. The lack of significant influence of gender and age on dyscalculia characteristics could help inform educators, parents, and clinicians in their efforts to identify and support students with dyscalculia. The results suggest that intervention strategies for dyscalculia should be age and gender-neutral, and that attention should be focused on the specific impairments in number sense, arithmetic operations, and working memory regardless of age or gender except in the dimension of number sense.

Based on the results, the following are recommended;

Early screening and detection.

Given that dyscalculia can affect academic performance and success, it is important to identify children with dyscalculia as early as possible to provide appropriate interventions and support. Therefore, it is important for school psychologist, counselors and educators to promptly identify students with this difficulty.

Individualized interventions.

Based on the specific needs of each student, individualized interventions can be developed by educators and counsellors to address their difficulties in number sense, arithmetic operations, and working memory. These interventions could include.

The use of manipulatives.

Manipulatives refer to physical objects such as blocks, cubes, and counters that can be used to help students visualize and understand mathematical concepts.

Visual aids such as diagrams, charts, and graphs can also be used to enhance students' understanding of mathematical concepts.

Use of adaptive technology

In the context of dyscalculia, adaptive technology can be used to provide customized support to students with difficulties in number sense, arithmetic operations, and working memory. Some examples of adaptive technology that can be used for dyscalculia include:

Virtual manipulatives: These are digital versions of physical objects such as blocks, tiles, or counters, that can be manipulated on a computer screen to help students visualize and understand mathematical concepts.
Math software: There are various math software programs available that can be used to provide personalized instruction and practice to students with dyscalculia.
Text-to-speech software: This type of software can be used to read math problems and instructions aloud to students who have difficulty reading or comprehending written text.
Speech recognition software: This software can be used to allow students to verbally answer math problems and have their responses converted into text or numerical form.
Electronic calculators: These can be used to help students perform calculations more accurately and efficiently.

Some specific interventions that could be suggested for the number sense, arithmetic, and working memory dimensions are;
Number sense: Teachers and parents can use visual aids to help students develop a stronger understanding of numbers and their relationships
Arithmetic: Teachers and parents can use real-life situations and word problems to help students understand how arithmetic operations work in practical situations.
Working memory: Teachers and parents can help students improve their working memory skills by providing regular practice with memory tasks. Counsellors can also teach students memory-enhancing strategies.
In addition, students who struggle with dyscalculia may benefit from individualized or small group instruction, additional support from a learning specialist or tutor.

Teacher training and Parents Involvement
Teachers can be trained to recognize the signs of dyscalculia and to provide appropriate support to students with dyscalculia in the classroom and parents too can be informed about the signs and resources needed.

School Administrators and Policy Makers
School administrators can consider implementing early screening measures for dyscalculia. Policy makers can also consider allocating resources for dyscalculia intervention programs, such as specialized math support services, assistive technology, and targeted teacher training.

Limitation of the study; The study was conducted using certain demographics such as students aged 7-13yrs and then male and female students from junior secondary school. Although the actual population characteristics is not limited to these groups studied, a representative sample was obtained. Thus, the above limitation notwithstanding, the findings were not affected and therefore valid enabling generalization

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Author Contributions
All of the authors have contributed equally to this article.

Conflict of Interest

The authors declare there is no conflict of interest in this study.

Funding
The authors has not received funding from any institution for this article.