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Research Article

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The Effect of Consanguineous Marriages on Arab Offspring in the Arab Community

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Abstract

To better understand the effect of intergenerational consanguineous marriages on the onset and severity of dyslexia, this study focused on investigating the frequency of dyslexia in diverse family backgrounds, including consanguineous and non-consanguineous spouses. Despite the advance of modernization and globalization, certain cultures that are mainly focused in North Africa, the Middle East and South Asia, continue to prioritize and practice family marriage and this is despite the warnings and recommendations of global health organizations.

Dyslexia is a common learning disability that affects the development of language, and its main effect appears as difficulties in reading, spelling and decoding. This disability is related to phonological problems and not to intellectual ability. The reading and spelling errors are strongly influenced by heredity and genetics, with approximately 50% hereditary influence and genetic variables that contribute to the appearance of the disability among the offspring.

The study compares the ability to deal with phonological and orthographic challenges in dyslexic children born from marriages from different marriage backgrounds, relatives and non-relatives, to peers. Phonological coding, spoken language abilities, working memory and reading comprehension are among the genetic and neurological aspects that have been studied.

Keywords: Dyslexia, Consanguineous Marriage, Arab Community, Phonology, Orthography, Phenomenon

Introduction

The present study examined the reading disabilities in offspring of couples who are relatives, offspring of parents from consanguineous marriages, offspring of unrelated parents and peers of reading age. It examines whether the rate of reading disabilities is higher among offspring of consanguineous marriages.

It is estimated that over a billion people live in communities with consanguineous marriage preferences [1]. These marriages are mostly traditional in North African, Middle Eastern and South Asian communities and can account for up to half of all marriages in these communities [2]. The prevalence of family members' marriages is based on different and diverse variables in proximity and quantity, which are influenced by geographic culture, ethnicity and religion [3]. Although the expectation was that education, progress and technology would reduce such marriages due to smaller family size, closed communities can promote the revival of traditional customs [4].

Children usually acquire reading skills by first learning the different phonemes and then reaching the understanding that complex words are constructed by these phonemes, and that the letters that constitute the words are actually the symbols that represent these sounds [5]. Deficits of phonological awareness, poor short-term verbal memory and slow lexical retrieval are among the most common indicators associated with dyslexia and are consistent with phonological deficits [6]. Phonological deficits can arise from various factors and are not necessarily related to dyslexia. When dyslexia can appear in non-linguistic problems such as motor skills and temporary memory problems [7].

Reading disability, or developmental dyslexia, is one of the most common of the complex neuro-behavioral disorders, with incidence rates ranging from 5% to 17%. This disorder is characterized by impaired reading ability in individuals with normal intelligence and adequate educational opportunities [8].

The explanation for this difficulty is not attributed to a sensory,

mental, emotional or environmental defect, but rather to a neurobiological source, since the difficulty is usually expressed in inaccuracy and/or lack of fluency of words or sentences [9]. The causes of dyslexia are attributed to a wide range of genetic problems, neurocognition, neurophysiology, and a host of other direct and indirect causes and factors [10].

The present study focused on this dysfunction and examined the phonological and orthographic difficulty in recognizing words among dyslexic individuals born in repeated intergenerational marriages, dyslexic individuals born in consanguineous marriages and dyslexics born in non kinship marriage compared to same age peers.

Literature Review

Consanguineous Marriages

Marriage between family members is mainly due to religious, cultural, traditional or financial factors [11]. Most societies and communities prohibit incest, although the degree of forbidden sacrifice varies. While parent-child-sibling marriages are rare, unions such as uncle-niece and cousin marriages are more common [12]. High-kinship marriages in some communities contribute to marital stability because they are strengthened by shared social ties before and after marriage, along with adjustment within the extended family [13].

In Arab and Islamic societies, unions such as parent-child, sibling and nephew marriages are prohibited but cousin marriages are accepted and valid [14]. Although the negative effects of consanguineous marriages have received medical criticism, consanguineous marriages persist among about a fifth of the world's population and have spread due to immigration [7,14].

Social and economic stability drives the marriage of family members in certain communities, and fosters conformity within shared family norms based primarily on in-law relations and solidarity [15,16]. These marriages facilitate financial marriage arrangements and ensure property preservation and intergenerational support [3,17]. Marriage patterns of family members are influenced by demographic factors and are attributed to economic development, level of education, industrialization, economic costs and cultural tradition [18]. This type of marriage is more common in communities based on agriculture and grazing such as communities in Arab states. The percentage of consanguineous marriage in these areas is still high in comparison to Western society and the industrialized countries [19].

Health and Medical Parameters

Electrophysiological brain studies show clear differences in event-related potentials (ERP) among dyslexic readers, the differences being characterized by their lower left hemisphere activity compared to typical readers [20]. In family marriages, the fertility, abortion and infant mortality rates are almost the same as in normal marriages, but from consanguineous marriages birth defects are 2-3% higher [3].

Consanguineous marriage increases the risk of autism spectrum disorders due to increased inheritance of recessive genetic mutations. Increased genetic closeness between spouses increases the likelihood of sharing recessive genes associated with autism [21]. Clinical genetics defines consanguineous marriage as marriage between second cousins or closer, which contributes to autosomal recessive diseases, including autism, hearing loss, and dyslexia [22,23].

Pairs of first-degree relatives, such as cousins, are almost twice as likely to have offspring with defects if there is no known genetic disorder [24]. Consanguineous unions carry a higher risk of birth defects in offspring, with rates up to three times higher than in the general population [25]. In marriages between first cousins, infant mortality rates are 1.1% higher than those of unrelated couples, rising up to 1.7 times in Norway, for example [18,26].

While the causes of dyslexia are complex, the emergence of phonological and orthographic processing deficits are central and often prominent [5]. Consanguineous offspring may face an increased risk of recessive disorders due to shared autosomal recessive genetic mutations of the parents. Chain biological ties that are closer between parents increase the probability that offspring will inherit harmful recessive genes [21]. Researchers argue that consanguineous marriages specifically affect genetic health, foster genetic diseases and risks, and outweigh social benefits [27].

Consanguineous Marriage in Arab Society

About 10.4% of the world's population were born to consanguineous parents, with marriage rates among consanguineous members varying around the world based on religion, culture and geography [26]. The highest prevalence of consanguineous marriages is found in North Africa, the Middle East, and Central/South Asia, with over 50% of marriages there occurring between first or second cousins [26].

Marriage between family members is still considered a common practice in the Middle East and the North African region and especially in Arab countries with an overall prevalence ranging from 20 to 50% [28]. Marriages of first cousins predominate, accounting for about 20%-30% [26].

The approval rates for these marriages vary in Arab countries. In Lebanon the rates range from 12.8% to 48%, while in Syria they are between 22% and 67.5%. Saudi Arabia sees 42.1% to 66.7%, Jordan ranges from 28.5% to 63.7%, and Egypt's rates range from 20.9% to 80.4%. Qatar and Oman report rates of 54% and 56.3%, respectively [29].

Arab societies share common values, which see the extended family as a central social structure. Strong community ties and interdependence foster an activist, family-centered culture that encourages kinship and property preservation and preserves the custom of marriage within the family [30]. In Arab societies, marriages between first cousins are the most common among

close marriages, especially among the offspring of siblings on the father's side [15]. The highest rates of consanguineous marriage are among Arab Muslims and some other Muslim communities and despite the higher risk of adverse health effects in offspring the phenomenon of kinship marriage is deeply rooted in the culture of these communities and is widely believed to have many social and economic benefits [31].

Consanguineous Marriage among the Arab community in Israel

Family marriages are common among Israeli Arab communities, especially among Bedouin families in the south. A comprehensive study by the Galilee Society in 2004 found that marriages of family members make up 60% of Bedouin unions, 47% among the Druze, 37% among Muslims who are not from the Bedouin community, and 22% among the Christian communities [32]. Another survey between the years 2003-2005 indicated a rate of 58% consanguineous marriages among the Bedouin, while in half of these marriages the spouses are cousins [33].

In Arab society in Israel, matrimonial decisions are still made on a family basis, although marriage rates among family members are decreasing due to higher education and the expansion of the method and manner of choosing spouses [21]. A study conducted on over 3,000 Arab Israeli couples who married between 1948 and 2007 indicates a downward trend in marriages between relatives after 1980, but despite this the rates remain high compared to Western communities in the world [34].

The Arab population in Israel is about 2 million, of which 85.1% are Muslims, 7.6% are Druze and 7.3% are Christians. This society is characterized by similarity to other Arab societies around the world, in this population there are relatively small and undeveloped villages with a high rate of consanguineous marriages [35].

Between 2007 and 2017, the prevalence of consanguineous marriages among the Arab population in Israel increased significantly from 36.3% to 41.6%, with reference to religion and area of residence. And as mentioned, this trend, similar to other Arab societies, contributes to genetic disorders, birth defects and infant mortality (Hativ, 2021). Despite efforts to reduce the phenomenon, treatment of these issues is met with resistance due to limited genetic literacy and concerns about family stigma [36]. Health services genetic screening and counseling programs have been introduced in some communities where rates of consanguineous marriage are high. In the next study, carriers of four rare hereditary diseases were tested, which demonstrated a higher expression among offspring born to close parents [37].

Studies have highlighted medical challenges facing Arab families as a result of consanguineous marriages. The studies revealed that the rates of birth defects were 15.8% in consanguineous families, compared to 8.7% in non-consanguineous couples and 6.9% when one of the parents was a relative from another region [38].

A study conducted among the Bedouin population in the Negev showed that the marriage of first cousins negatively affects the weight of the infants by about 110 grams less than the average, which may lead to future deformities and chronic diseases as a result of genetic problems [39].

Dyslexia

Dyslexia is defined as a learning disability characterized by difficulties in language development that mainly affect accurate or fluent reading and word recognition, spelling abilities and poor decoding. These difficulties are often in contrast with intellectual potential and other normal cognitive abilities [40]. The current definition of dyslexia according to DSM-5 is a difficulty in accuracy and reading fluency that does not correspond to the chronological age of the individual despite a focused intervention throughout this chronological period. Dyslexia is the most common phenomenon among people with learning disabilities and affects more than 10% of children in varying degrees of severity. Children with dyslexia encounter difficulties in acquiring proficiency in elementary school and usually acquire these capabilities towards the end of elementary school [6].

In his study Hulme [41] supports the possibility that the main explanation for the phenomenon is a defect in the functioning of the phonological coding system. In addition to deficits of spoken language skills and deficits working memory that affect reading comprehension, vocabulary and general knowledge skills adult dyslexic readers may be more limited than normal readers mainly because they read less due to the difficulty they experience in the process [42]. Sure, here is the full text of the literature review you provided.

Wilson et al. [43] highlight that adult dyslexic readers develop compensatory strategies, improving capabilities despite dyslexia. Dyslexia's secondary effects include slow material processing, handwriting issues, weak word and phoneme memory, and a gap between listening and reading comprehension. Reading difficulties can lead to poor academic outcomes and motivation [44]. Developmental dyslexia entails learning, reading, writing, and spelling challenges despite conventional learning conditions [8]. This isn't due to sensory or environmental factors but a neurobiological source, often resulting in reading and spelling inaccuracies [45].

Dyslexia's hereditary likelihood is around 50%, with genetic impact primarily on phonological coding [46]. A phonological deficit might contribute to 30-70% of reading and spelling errors [47]. Dyscalculia involves significant underachievement in arithmetic tests [48]. Reading processes encompass word recognition, orthographic coding, phonological decoding, and phonetic awareness. Genetic factors influence these reading skills, causing deficits [49]. Dyslexic readers face error detection and correction challenges due to working memory characteristics, impacting short and long-term memory [50]. Dyslexic students exhibit slower responses across reading levels [51,52]. Phonological issues result from various factors, compounded by non-linguistic deficits like

motor dysfunction [53].

Dyslexia and Genetics

Dyslexia, marked by issues in procedural learning and memory, impedes reading and writing acquisition [54]. John Stein's "The Magnocellular Theory of Developmental Dyslexia" posits a magnocellular system defect affecting rapid stimulus processing and spatial diagnosis [55]. This flaw, possibly in the thalamus, hampers sensory processing, leading to perceptual deficits in dyslexia [55]. Another perspective links dyslexia to cerebral dysfunction disrupting learning and automation after skill acquisition [53]. Dyscalculia involves procedural math issues and neurological dysfunction [56].

Cerebellar defects impact auditory, letter, and eye movement skills, requiring conscious and extended training for automation in dyslexics [57]. Genetic mutations from consanguineous marriages might increase dyslexia risk [17]. While genetic factors contribute to reading issues, specific genes responsible for phonological deficits remain unidentified due to phenotypic complexity [58]. Imaging studies reveal phonological processing difficulties and genetic influence on reading problems [38,59].

The study explores the impact of consanguineous marriages on dyslexia onset, comparing dyslexic children from these marriages with those from first-degree kinship and unrelated parents.

Research Question

"What is the relationship between consanguineous marriages and the onset of dyslexia in children, comparing dyslexic children born to parents of consanguineous marriages, dyslexic children born to parents from first-degree kinship marriages, and dyslexic children born to non-relative parents?"

The present study aims to examine the effect of consanguineous marriages on the onset of dyslexia comparing dyslexic children born to parents of consanguineous marriages dyslexic children born to parents from first-degree kinship marriage and dyslexic children born to non-relative parents.

Research Hypotheses

1. The proportion of children with dyslexia among parents from repetitive intergenerational marriages within the family of first-degree relatives (grandparents and parents are first-degree relatives) is higher than the proportion of children with dyslexia among non-relative parents.
2. Dyslexic children born to first degree-relative parents from repetitive intergenerational marriages will suffer from severe disabilities in phonological language processing and decoding processes compared to dyslexic children born to non-relative and peers of reading age.
3. Dyslexic children born to parents from a chain of first-degree relatives will suffer from severe disability in phonological language processing and decoding processes compared to dyslexic children not born in repetitive intergenerational marriages and compared to peers of a reading age.
4. Dyslexic children born to parents from repetitive intergenerational marriages within the family will exhibit more severe cases of dyslexia than other dyslexic children in the study.

Methodology

Participants and Design

Participants

Age and grade: The research focused on 4th, 5th and 6th grade students, especially 9, 10 and 11 year olds. Geographical locations: The data collection took place in three cities and Arab villages in the north and center of the country. These locations were chosen to represent different communities.

School selection: In each location, one elementary school with standard education was selected for the study. These schools contained about 30 students of both sexes in each class.

Inclusion criteria: the participants were classified as regular education students, not including special education or students with special needs.

Participant groups: Division of groups: the participants were divided into three groups based on the degree of familial closeness of their parents, their age and gender.

Group 1: 30 dyslexic students born to parents from repeated marriages of family members.
Group 2: 30 dyslexic students born to parents from the marriage of first degree relatives.
Group 3: 30 dyslexic students born to parents who are not relatives.
Selection criteria: To ensure valid group assignments, the study selected schools in communities that still practice consanguineous marriage.

Tools

For the purpose of examining the hypotheses and the research question, a battery of tests was constructed by Author and Maroon [60] and were used to assess the phonological and orthographic processes among the target children. After identifying the children with reading difficulties based on reading comprehension tests (students who received a score of 20-40 on the test), data recorded by the parents in a questionnaire, and the teachers' evaluation, the children were divided into three groups: The first group included children whose parents are married in a repetitive intergenerational consanguineous marriage, the second group included children of non repetitive consanguineous marriage. The third group included children whose parents are not relatives.

A comparison then was made between the experimental groups and the control groups in reading ability and included phonological awareness indices, phonological decoding and orthographic knowledge.

Phonological Ability Testing

Phonemic Awareness Test: The phonological test was assembled of five sub-tests: initial word sound, final word sound, addition

of missing phoneme, analysis of phonemes and synthesis of phonemes. In each test there is an example, after the example there are 20 words. Participants will be asked to read the items aloud and accurately. The test is designed to assess mastery of the phonemic skill.

The test metrics for each skill are the number of correct answers [60].

Short Term Memory Test: The words chosen were frequently-used words in Arabic, ensuring that all participants are well acquainted with the words.

The list consisted of 10 series of words, starting with series consisting of three words and increasing up to series consisting of seven words.

Each participant individually listened to the words that were reading aloud by a staff member, and was asked to repeat aloud the words he or she heard. The participant hade to pronounce the words correctly and quickly.

The index: Total number of the correct words remembered correctly and in order [60].

Pseudowords Reading Test: Consisted of 20 nonwords. Each real word was changed to a pseudoword by replacing letters and vowels but conserving the morphological word pattern. Participants was asked to read each item aloud.

The assumption behind this task is that these pseudowords are unfamiliar to the children and therefore cannot be read according to orthography skills. Therefore, to read them one must rely on grapheme-phoneme correspondence rules [61].

Reading Words in Context

The test consists of 10 sentences in which one target word does not fit the context. The participants read the sentence aloud and tried to identify the target word. The test measures the accuracy of recognizing the target words [60].

Reading Skills

Examining Orthographic Knowledge Orthography is the spelling system of a language. Orthographic processing is defined as the ability of the skilled reader to access the orthographic codes of specific words, directly, without relying on the phonological structure, which brings him to automatic and rapid fluent reading by retrieving the orthographic representation of the word from the mental lexicon [62].

Word Recognition: The participant was required to silently read 100 high frequency and vowelized real Arabic words and then circle the words indicating food within a time limit [60].

Word Recognition: The test consisted 20 real words depending on the reading age level of the participant. The participant was required to read the words aloud [60].

Fill in the Missing: This task presented 8 sentences with a missing a word. The participant had to choose one of two possible words to fit the context [60], (See Appendix L).

Orthographic Choice: This test features, 40 pairs of words, with one word spelled correctly and the other misspelled . The participant was required to encircle the correctly spelled word [60].

Reading Comprehension: This reading comprehension test is adapted to the age of the participant. Participants were requested to read the text silently and then were required to answer 20 multiple-choice comprehension questions with 4 options. The time allotted for completing the task is 30 minutes [60].

Procedure: The required approvals were obtained from the Ministry of Education and University, as well as approvals of the school principals. The parents of the target students filled out two forms.

Participation Consent and a Questionnaire

The participation consent form included an explanation regarding the purpose of the research and the required tests. The questionnaire consists of questions regarding the nature of the biological relationship between the participant's parents and information about possible problems or reading disabilities. After obtaining parental consent, the students were presented with reading comprehension tests and orthographic word recognition tests.

After identifying students with reading difficulties and dividing the participants into three groups, as mentioned above, the groups passed tests relating to phonological awareness and orthographic knowledge. All tests were conducted in a way that ensures privacy in a learning supportive environment and a quiet learning atmosphere. Students received clear instructions and explanations before each test. The tests were administered individually to each participant in two sessions of 25 minutes each, and held in their schools in a quiet, secluded room.

Results: The results section includes a presentation as well as testing of study hypotheses. Scores represent the participants' average performance on each study test.

Data Analysis: Descriptive analysis was calculated showing means and standard deviations of all variables across the groups. Further, the data was further analyzed by MANOVA showing the differences between the groups. Finally, Post Hoc tests was applied to show the source of the differences.

Hypothesis 1: The proportion of dyslexic children of parents who have repeated intergenerational marriages within first-degree relatives (RIMWFFDR) is higher than the proportion of dyslexic children of unrelated parents.

To test this hypothesis, MANOVA (difference) analyzes were performed on all study tests and subtests.

Test\ Group	Mean (0-36)	Standard Errors
RIMWFFDR N = 38	7.24	.59
First-degree relatives N = 34	8.71	.41
Non-relatives N = 35	9.98	.23
Control group N = 42	34.88	.30

RIMWFFDR = Repetitive intergenerational marriages within the family of first-degree relatives

Table 1: Means and standard errors of the three study groups and the control (typical readers) group in the World Recognition Test.

Regarding the Word Recognition Test, the results showed a significant difference between the study groups (F (2, 106=9.53, p< .001). The Bonferroni post hoc analysis indicated that the non-relatives group bested the repetitive intergenerational marriages within the family of first-degree relatives group (p< .001).

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Test\ Group	Mean (0-100)	Standard Errors
RIMWFFDR N = 38	37.02	1.86
First-degree relatives N = 34	50.62	1.11
Non-relatives N = 35	56.37	1.63
Control group N = 42	90.74	1.04

RIMWFFDR = Repetitive intergenerational marriages within the family of first-degree relatives

Table 2: Means and standard errors of the repetitive intergenerational marriages within the family of first-degree relatives and the three study groups and the control (typical readers) group in the Reading Comprehension Test.

Considering the Reading Comprehension Test, the results showed significant differences between the study groups (F (2, 106 = 19.91, p< .001). Bonferroni's post-hoc test showed that the mean scores of the repetitive intergenerational marriages within the family of first-degree relatives group were significantly lower than the non-relative group's mean scores (p< .001).

When examining the difference in scores on the word recognition and reading comprehension tests, the results showed no significant difference between the three grade levels; fourth grade (M, SE)=17.31, 1.67; fifth grade (M, SE)=16.73, 1.73; and sixth grade (M, SE)=13.17, 1.69 in the Word Recognition Test (F (2, 106)=1.30, p < .278). However, significant differences between the study groups emerged; fourth grade (M, SE)=59.53, 3.34; fifth grade (M, SE)=59.88, 3.48; and sixth grade (M, SE)=60.15, 3.20 in the Reading Comprehension Test (F (2, 106)=3.97, p< .022).

Bonferroni's post-hoc test showed that the sixth-grade group outperformed the fourth-grade group (p< 0.018) while there was no significant difference between the fifth and fourth-grade groups

(p<0.717) and between the fifth and sixth-grade group (p< .314). A Pearson correlation test was applied to explore if there is a correlation between the Word Recognition and Reading Comprehension Test. The Pearson correlation test showed a significant positive correlation between the two Tests (r =.84, p<.001).

Regarding the Phonological Ability Testing

Test\ Group	RIMWFFDR *N* – 38 *M (SD)*	First-degree relatives *N* – 34 *M (SD)*	Non-relatives *N* – 35 *M (SD)*	Control group *N* – 42 *M (SD)*	*p*
Phonemic Awareness Tests					
Initial word sound (0-21)	20.11 (1.52)	20.71 (.58)	20.51 (1.04)	20.95 (.52)	Typical > RIMWFFDR ($p < .001$).
Final word sound (0-21)	19.37 (2.59)	20.18 (1.45)	19.94 (1.47)	20.95 (1.21)	Typical > RIMWFFDR ($p = .005$).
Addition of missing phoneme (0-20)	12.55 (3.82)	12.94 (4.13)	13.71 (4.23)	18.90 (2.53)	Typical > RIMWFFDR ($p < .001$).
Analysis of phonemes (0-20)	6.87 (4.80)	8.50 (4.99)	10.60 (5.24)	17.90 (2.54)	Typical > RIMWFFDR, First-degree relatives and Non-relatives ($p < .001$, for all).
Synthesis of phonemes (0-20)	17.84 (2.82)	18.53 (1.99)	18.02 (2.71)	19.55 (2.02)	Typical > RIMWFFDR and Non-relatives ($p = .005$ and $p = .20$; respectively).
Short-Term Memory Test (0-50)	26.68 (7.12)	26.47 (8.27)	27.46 (8.98)	37.36 (6.11)	Typical > RIMWFFDR, First-degree relatives and Non-relatives ($p < .001$, for all).

Note: **RIMWFFDR –** Repetitive intergenerational marriages within the family of first-degree relatives. *p* – Differences between the control group and the three study groups

Table 3: Means and standard errors of the three study groups and the control (typical readers) group in The Phonological Ability Testing and Differences between the control group and the three study groups.

The results of the MANOVA testing showed significant differences between the study groups in the analysis of phonemes test (F (2, 106) =5.06, p< .008) and near significant differences between the study groups in the initial sound test (F (2, 106)=2.67, p< .074). However, there were no significant differences between the three study groups in the other three Phonemic Awareness Tests; final sound (F (2, 106)=1.06, p< .351), addition of missing phoneme (F (2, 106)=7.68, p<.466), and synthesis of phonemes (F (2, 106)=.688, p< .805) tests.

The Bonferroni post hoc test revealed that the non-relative group was significantly, better than the repetitive intergenerational marriages within the family of first-degree relatives group in the analysis of phonemes test. However, although the non-relative group outperformed the repetitive intergenerational marriages within the family of first-degree relatives group, this advantage was not statically significant (p<.397).

Non-significant difference between the three study groups was found in Short-Term Memory Test (F (2, 106)= .13, p<.887)

Test\ Group	**RIMWFFDR** *N* – 38 *M (SD)*	First-degree relatives *N* – 34 *M (SD)*	Non-relatives *N* – 35 *M (SD)*	Control group *N* – 42 *M (SD)*	*p*
Pseudowords Reading Test (0-22)	13.26 (4.82)	14.44 (3.59)	13.69 (5.30)	20.43 (2.75)	Typical > RIMWFFDR, First-degree relatives and Non-relatives ($p < .001$, for all).
Reading words in context (0-10)	5.16 (1.88)	5.35 (1.77)	5.71 (1.72)	9.31 (1.09)	Typical > RIMWFFDR, First-degree relatives and Non-relatives ($p < .001$, for all).

Note: **RIMWFFDR** – Repetitive intergenerational marriages within the family of first-degree relatives. *p* – Differences between the control group and the three study groups.

Table 4: Means and standard errors of the three study groups and the control (typical readers) group in the Decoding Skills Tests.

Regarding decoding, no significant differences were found among the three study groups in the two decoding skills tests; Pseudowords Reading Test (F (2, 106)= .59, p< .558) and Reading Words in Context Test (F (2, 106)=.89, p< .413) (see Table 4).

For the Reading Skills Tests, the results (See Table 5) showed significant differences between the three study groups in the Fill the Missing Test (Orthographic choice in context) (F (2, 106)= 8.39, p< .001). However, no significant differences between the three study groups emerged in the Reading Real Words Test (Word Recognition) (F (2, 106) =.74, p< .497) and the Orthographic Choice Test (F (2, 106)= 1.32, p< .271).

Bonferroni post hoc test indicated that the non-relative group's performance was greater than the repetitive intergenerational marriages within the family of first-degree relatives group in the Fill the Missing Test (p< .001).

Test\ Group	**RIMWFFDR** *N* – 38 *M (SD)*	First-degree relatives *N* – 34 *M (SD)*	Non-relatives *N* – 35 *M (SD)*	Control group *N* – 42 *M (SD)*
Reading skills				
Reading Real Words (0-20)	15.74 (2.96)	15.65 (3.06)	16.57 (3.48)	19.48 (2.11)
Fill in the Missing (0-8)	4.94 (1.52)	5.91 (1.42)	6.42 (1.75)	9.00 (.91)
Orthographic Choice (0-20)	13.98 (3.99)	14.59 (3.46)	15.40 (3.75)	19.26 (1.19)

Note: **RIMWFFDR** – Repetitive intergenerational marriages within the family of first-degree relatives. *p* – Differences between the control group and the three study groups.

Table 5: Means and standard errors of the three study groups and the control (typical readers) group in the Reading Skills Tests.

Hypothesis 2 dyslexic children born to first degree-relative parents will suffer from severe disabilities in phonological language processing and decoding processes compared to dyslexic children born to non-relative and peers of reading age. The results showed non-significant differences between the first-degree relatives group and the non-relatives group in the Word Recognition (p<.158) and the Reading Comprehensions Tests (p< .239). Furthermore, no significant differences were found between the first-degree relatives group and the non-relatives group in any of the Phonological Ability Tests, and in both Decoding Tests; Pseudowords Reading Test (p< .999) and Reading Words in Context Test (p< .999).

Likewise, no significant differences between the two groups in the Reading Real Words Test (Word Recognition) (p< .829), Fill the Missing Test (p< .526), and the Orthographic Choice Test (p< .999) emerged.

Hypothesis 3 dyslexic children born to parents from a chain of first-

degree relatives will suffer from severe disability in phonological language processing and decoding processes compared to dyslexic children not born in repetitive intergenerational marriages and compared to peers of reading age. The results of the current study indicated the first-degree relatives group outperformed the repetitive intergenerational marriages within the family of first-degree relatives group in the Reading Comprehension Test ($p< .001$). In addition, the first-degree relatives group outperformed the repetitive intergenerational marriages within the family of first-degree relatives group in the Word Recognition test, however, this advantage was not significant statically ($p<.067$). Furthermore, the Bonferroni post hoc test revealed no significant differences between the first-degree relatives group and the repetitive intergenerational marriages within the family of first-degree relatives group in any of the Phonological Ability Tests and in both Decoding Tests; Pseudowords Reading Test ($p< .855$) and Reading Words in Context Test ($p<.999$).

Notably, the Bonferroni post hoc test indicated that the performance of the first-degree relatives group was better than the performance of the repetitive intergenerational marriages within the family of first-degree relatives group in the Fill the Missing Test ($p<.032$). Nevertheless, no significant differences between the two groups in the Reading Real Words Test (Word Recognition) ($p<.999$) and the Orthographic Choice Test ($p < .999$) were found.

The Differences between the Typical Readers and Study Group

To test for differences between the typical readers (control) group and the study groups in all study measures, the control group was included in the data analyses and here the MANOVA analyses contain a comparison of four groups. The results showed significant differences between the study groups in the Word Recognition Test ($F (3, 148)=1119.66$, $p<.001$) and Reading Comprehension Test ($F (3, 148)=146.82$, $p<.001$). Bonferroni post hoc analyses showed that the typical readers (control) group outperformed the other three study groups ($p<.001$, for all).

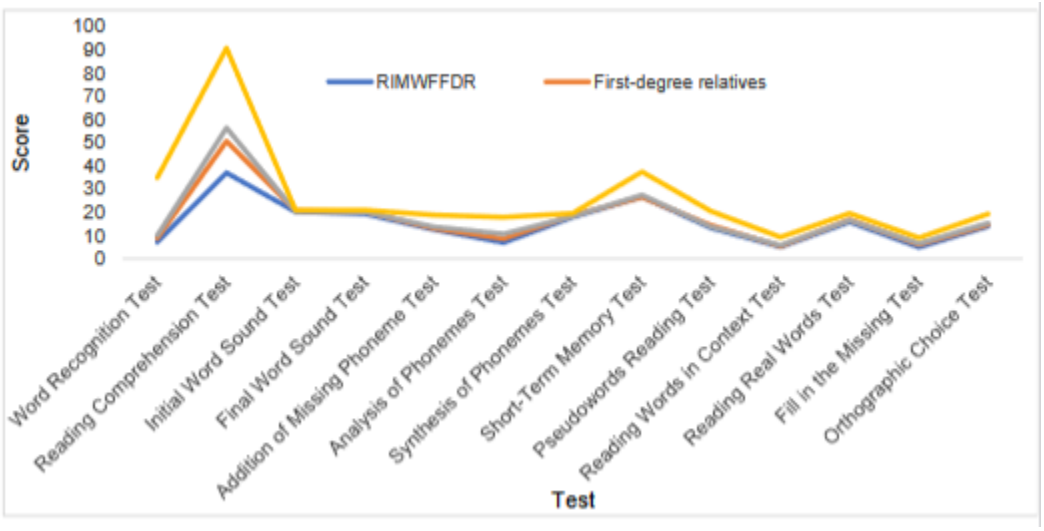
For the Phonemic Awareness Tests, the MANOVA testing showed significant differences between the study groups in the initial sound ($F (3, 148)=5.39$, $p<.002$), final sound ($F (3, 148)=4.02$, $p< .009$), addition of missing phoneme ($F (3, 148)=29.70$, $p<.001$), analysis of phonemes ($F (3, 148)=51.06$, $p<.001$), and synthesis of phonemes ($F (3, 148)=4.74$, $p<.003$) tests. Bonferroni post hoc analyses indicated that regarding the initial sound test, the control group outperformed the repetitive intergenerational marriages within the family of first-degree relatives group. For the final sound test, the mean score of the control group was higher than the mean score of the repetitive intergenerational marriages within the family of first-degree relatives group. The same pattern of results emerged in the addition of missing phoneme test, with better performance in the control group than the repetitive intergenerational marriages within the family of first-degree relatives group was shown. Concerning the analysis of phonemes test, the control group outperformed the three other groups. Regarding the synthesis of phonemes test, the scores of the control group were superior to the scores of the repetitive intergenerational marriages within the family of first-degree relatives group and the non-relatives group (See Table 3).

The results of the Short-Term Memory Test showed significant differences between the three study groups $F (3, 148)=18.92$, $p< .001$). The control group outperformed the three other groups (See Table 3).Significant differences between the four groups in the two Decoding Skills Tests; Pseudowords Reading Test ($F (2, 106)= 27.77$, $p< .001$) and Reading Words in Context Test ($F (3, 148)=58.56$, $p< .001$) emerged. Bonferroni post hoc analyses indicated the control group outperformed the three dyslexic groups in the two tests (see Table 4).

The results (See Table 5) showed significant differences between the study groups in the Reading Real Words Test (Word Recognition) ($F (3, 148)=14.05$, $p<.001$), Fill the Missing Test (Orthographic choice in context) ($F (2, 106)=60.14$, $p< .001$), and the Orthographic Choice Test ($F (3, 148)=21,69$, $p< .001$). The Bonferroni post hoc test indicated the control group outperformed the three study groups in the three tests ($p< .001$, for all tests).

Summary of Results

Figure 1 presents the Performance of the study and the control groups on each of the study test



Note: RIMWFFDR: Repetitive intergenerational marriages within the family of first-degree relatives.

Figure 1: Performance of the study and the control groups on each of the study tests.

The first hypothesis was partially confirmed. The failure on word recognition test in the repetitive intergenerational marriages within the family of first-degree relatives group was significantly higher than in the non-relatives group. Similarly, the reading comprehension, analysis of phonemes, and fill the missing tests results indicated significantly lower results for the repetitive intergenerational marriages within the family of first-degree relatives group in comparison with the non-relatives group. There were no other significant differences between the two groups.

The second hypothesis was not proven. No significant differences between dyslexic children born to first degree-relative parents and dyslexic children born to non-relative parents in any of the study measures were found.

The third hypothesis was partially confirmed. The results showed that the first degree-relative group was superior to the repetitive intergenerational marriages within the family of first-degree relatives group in word recognition, reading comprehension, and fill the missing tests. No significant differences emerged in the other study tests.

Furthermore, the results showed that the typical readers (control) group outperformed the three study groups in word recognition, reading comprehension, analysis of phonemes, synthesis of phonemes, short-term memory, pseudowords reading, reading Words in context, and the three reading skills tests. Notably, the control group outperformed the repetitive intergenerational marriages within the family of first-degree relatives group in the initial sound, final sound, and addition of missing phoneme, in addition, the control group was superior to the repetitive intergenerational marriages within the family of first-degree relatives and the non-relatives groups in the synthesis of phonemes test.

Discussion

This study aimed to examine the impact of consanguineous marriages on Arab offspring in the Arab community. The research confirmed two hypotheses: children from repetitive intergenerational marriages within the family of first-degree relatives had a higher proportion of dyslexia compared to non-relative parents, and dyslexic children from such marriages exhibited more severe cases of dyslexia. However, the study did not find evidence to support the remaining two hypotheses, which suggested that dyslexic children with first-degree relatives would have more significant difficulties in phonological language processing and decoding compared to unrelated parents or peers of reading age. Despite this, the first-degree relatives group performed better than the repetitive intergenerational marriages within the family of first-degree relatives group in word recognition, reading comprehension, and reading skills tests.

Hypothesis 1

According to which the proportion of children with dyslexia among parents from repetitive intergenerational marriages within the family of first-degree relatives (grandparents and parents are first-degree relatives) is higher than the proportion of children with dyslexia among non-relative parents, was confirmed. These findings of the current research do confirm the greater hazard of genetic disorders appearing in offspring of consanguineous cousins. There are several shared characteristics observed among individuals, which encompass autism, intellectual disability, learning disability, developmental delay, and behavioral issues. Additionally, certain cases have exhibited challenges with motor skills, muscular dystrophy, ADHD, as well as delays in language and speech development [63].

Children born from repeated intergenerational marriages among first-degree relatives had noticeably greater failure rates than

control groups on all administered exams.. Similar results were observed in a study conducted by Abu-Rabia and Maroon [60], among Israeli Arabs, which involved 814 students from the 4th, 5th, and 6th grades. According to previous studies consanguineous marriages contribute to an increased manifestation of autosomal recessive diseases, which are inherited disorders caused by mutations in genes located on autosomes [3,21].

The results of this study offer additional evidence that dyslexia is genetically based, specifically its impact on phonological coding and orthographic knowledge associated with spelling. These findings align with the studies conducted by [38,58]. Moreover, these results also highlight the increased risk of genetic diseases in children with consanguineous cousin ties. Consanguineous marriages have been found to be associated with a higher incidence of speech and language disorders compared to non-consanguineous marriages. Research has shown an increased frequency of these disorders within the context of consanguinity, suggesting a potential genetic component in their etiology [64]. Previous studies have shown that mastering decoding abilities is essential for efficient reading comprehension. Individuals diagnosed with dyslexia commonly face challenges in accuracy and/or fluency, which directly impact their reading and spelling abilities [8,41,42,45]. While genetic factors contribute to dyslexia, particularly in the domain of written language, it is believed that the genetic impact manifests as a higher-level phonological impairment [46]. The study revealed a higher rate of word recognition difficulties among children born from repetitive intergenerational marriages within the family of first-degree relatives compared to children with unrelated parents. The degree of biological relatedness was found to be a contributing element to the variances seen between various groupings. This discovery strengthens the body of research that indicates consanguineous unions are harmful for children with reading problems. Certain genes have been identified as playing a role in neurodevelopment and human growth. Although few genetic variants have been linked to language disorders, autism spectrum disorder, and dyslexia, their direct association is not as strong as that of FOXP2 with language alterations. Studies suggest that this gene is important for language development, including spelling, phonological recognition, and mathematical skills [65].
Numerous studies have highlighted a significant distinction in the responses of students with dyslexia, characterized by slower reaction times in comparison to proficient readers across various reading levels. These levels include the recognition of graphics, phonemes, isolated words, as well as word and context reading [51,52]. Without proficient decoding skills, the comprehension of reading material remains inadequate. Therefore the ability to decode efficiently and automatically is a fundamental requirement for comprehension [49,51,52]. The current findings back up the findings of Author and Maroon [60], who discovered a link between word recognition and the growth of reading comprehension abilities in skilled readers.

Consanguineous marriages have been identified as a contributing factor to the prevalence of hereditary diseases, health-related problems, and genetic disorders among offspring. These marriages appear to increase the risk of hereditary diseases in the next generation, emphasizing the connection between consanguinity and the transmission of genetic disorders [66].

Hypothesis 2

The second hypothesis of the present study proposed that dyslexic children with first-degree-relative parents would exhibit more pronounced impairments in phonological language processing and decoding compared to dyslexic children with non-relative parents and peers of the same reading age.

In addition to the primary effects of dyslexia, such as difficulties with phonological processing and decoding, there are secondary effects such as slower processing speed, handwriting difficulties, poor working memory, and a significant gap between listening and reading comprehension. It is important to acknowledge the psychological impact of these difficulties, as reading challenges can quickly lead to academic struggles and negative motivation to study [44].

Numerous studies have found notable disparities in the answers of students with dyslexia compared to typical readers across a range of reading levels. Learning difficulties are often regarded as situational, meaning they are perceived to originate outside of the child and are influenced by various specific factors, including physical, educational, emotional, and environmental causes [56]. These differences manifest in slower response times in tasks involving graphic recognition, phoneme recognition, word recognition, and reading in both isolated word and contextual settings [51,52]. However, the results of the current study did not reveal any significant differences between the group of dyslexic children with first-degree relatives and the group with non-relatives in the Word Recognition Test. Dyslexia, a learning difficulty in reading, writing, and spelling, often stems from a phonological deficit. It is often overlooked by teachers and parents. Early detection is vital to reduce its impact and improve skills in approximately 10% of the global population affected by dyslexia. Researchers have proposed various techniques for identifying dyslexia in children [67].

Common indicators associated with dyslexia include deficits in phonological awareness, poor short-term verbal memory, and slow lexical retrieval. These indicators align with phonological deficits, which are consistently observed in individuals with dyslexia [6]. Nonetheless, the study's findings revealed no significant differences in the Reading Comprehension Test or the Phonological Ability Tests, which included the Pseudowords Reading Test, Reading Words in Context Test, Reading Real Words Test, Fill the Missing Test, and Orthographic Choice Test between the groups of dyslexic children with first-degree relatives and those without. The variations become evident through slower response times in tasks related to graphic recognition, phoneme recognition, word recognition, and reading, both in isolated word scenarios and in contextual settings. These difficulties can have a psychological

impact, as reading challenges often result in academic difficulties and a decline in motivation to study [68].

It is worth noting that children with dyslexia often face challenges in acquiring reading proficiency during elementary school, but they typically develop these skills towards the end of this period [6].

Hypothesis 3

The third hypothesis of the study suggested that dyslexic children born to parents in repetitive intergenerational marriages within the family would experience more severe impairments in phonological language processing and decoding compared to dyslexic children born outside such marriages and to non-relative peers of the same reading age. Dyslexia can be caused by a variety of factors, and people with dyslexia frequently have non-linguistic deficiencies such as motor dysfunction and momentary processing problems, which further limit their capacity to cope with phonological challenges [53]. However, the results of the study indicated that the group of dyslexic children born to first-degree relatives performed better than the subgroup of dyslexic children born within repetitive intergenerational marriages in the reading comprehension test. These findings provide additional evidence for the genetic basis of dyslexia, particularly its impact on phonological coding and orthographic knowledge related to spelling. These findings are consistent with previous studies conducted by Author & others [38] and Bishop and Snowling [58]. Furthermore, the group of dyslexic children born to first-degree relatives showed slightly superior performance compared to the subgroup of dyslexic children born within repetitive intergenerational marriages in the word recognition test, although this advantage did not reach statistical significance. Although learning letters and sounds tends to be a simple task, some children struggle with it and are diagnosed with developmental dyslexia, which is defined as difficulties in learning, reading, writing, and spelling despite access to appropriate learning opportunities [8].

In any of the Phonological Ability Tests, Pseudowords Reading Test, Reading Words in Context Test, Fill the Missing Test, Reading Real Words Test Word Recognition, or Orthographic Choice Test, the Bonferroni post hoc test revealed no significant differences between the group of dyslexic children born to first-degree relatives and the subgroup of dyslexic children born within repetitive intergenerational marriages. Hulme [41] agrees that the major reason for this phenomenon is a faulty phonological coding scheme. The findings indicate that accuracy-only and rate-only dyslexic subtypes should be regarded as distinct and meaningful subtypes, not merely relative differences. Furthermore, the accuracy-only subgroup exhibits various language weaknesses, particularly in phonological skills, along with non-phonological aspects [69].

Hypothesis 4

The fourth hypothesis of the study proposed that dyslexic children born to parents from repetitive intergenerational marriages within the family would exhibit more severe cases of dyslexia compared to other dyslexic children in the study. Dyslexic children born to parents from repeated intergenerational marriages within the family display a higher likelihood of experiencing more severe cases of dyslexia in comparison to other dyslexic children [70].

The control group was included in the data analysis to assess the differences in the measured variables between the normal reader (control) group and the study groups. This resulted in a comparison of four groups. In the word recognition exam, there were substantial disparities between the research groups. The Bonferroni post hoc analysis revealed that the normal readers (control) group performed better than the other three research groups, demonstrating significant differences between the groups. The control group's mean scores were much higher than the other groups. Significant differences were also observed between the study groups in the initial sound, final sound, addition of missing phonemes, analysis of phonemes, and synthesis of phonemes tests. In the Short-Term Memory Test, significant differences were found between the three study groups. These findings align with previous studies conducted by Abu-Rabia and Maroun (2005) and Bishop and Snowling [58].

Specifically, the Bonferroni post hoc test revealed that in the initial sound test, the control group outperformed the repetitive intergenerational marriages within the family of first-degree relatives group. In the final sound test and the addition of missing phoneme test, the control group had higher mean scores compared to the repetitive intergenerational marriages within the family of first-degree relatives group. Similar patterns have been observed in the phoneme analysis and phoneme synthesis tests, where the control group outperformed all of the other groups. The control group likewise outperformed the other three groups on the short-term memory test. The results further demonstrated significant differences between the four groups in the Pseudowords Reading Test and Reading Words in Context Test, both assessing decoding skills. The learners characteristics that contribute to their difficulties or disabilities encompass various aspects, such as cognitive and neuropsychological profiles, limited linguistic skills, a lack of prerequisite knowledge and skills for learning, as well as other learning difficulties or disabilities [56].

The Bonferroni post hoc test indicated that the control group outperformed the three dyslexic groups in these two tests. Additionally, genetic factors were found to contribute to reading and writing problems in roughly 50% of the variables that cause difficulties among individuals with dyslexia. Furthermore, significant differences in the Reading Real Words Test word recognition. Fill the Missing Test orthographic choice in context and Orthographic Choice Test were observed between the study groups. In these assessments, the control group outperformed all three study groups. According to the results of the Bonferroni post hoc test observed similar findings in the study they conducted acording to a study by [53].

General Discussion

This study examined the impact of intergenerational marriages within the family of first-degree relatives on dyslexia and phonological processing difficulties. The findings partially confirmed the hypothesis, showing that individuals from intergenerational marriages within the family of first-degree relatives had higher failure rates on word recognition and poorer scores on reading comprehension, phoneme analysis, and fill in the blanks tests, supporting the theory that dyslexia is caused by phonological processing difficulties.

A longitudinal study provided evidence supporting the hypothesis of neuroanatomical anomalies in children with a familial risk of dyslexia, leading to difficulties in acquiring literacy skills. The study revealed that typically developing readers show notable brain activity in the posterior, left side during reading. However, children with a familial risk of dyslexia face challenges in learning to read and may exhibit gaps in achievement that become apparent when they enter kindergarten. Deficits in letter knowledge, phonological awareness, and rapid automatic naming reach clinically significant levels, indicating the need for screening batteries to identify and address these difficulties [71]. However, the study found no significant differences between dyslexic children born to first-degree relative parents and those born to non-relative parents, suggesting that a familial history of dyslexia may not lead to more pronounced difficulties. Genetic factors were found to play a significant role in dyslexia, as demonstrated by the superior performance of the first-degree relative group. Additionally, the study highlighted significant differences between individuals with dyslexia and normal readers in various aspects of language processing and decoding skills, emphasizing the need for further research and interventions in these areas.

This study aligns with existing research indicating that children with first cousin parents have an elevated risk of reading difficulties compared to children with second cousin parents, distantly related parents, or unrelated parents [72-77].

Limitations of the Study

1. Sample Size: The study's sample size may have been restricted, affecting the generalizability of the findings. A bigger and more diversified sample would allow us a more thorough understanding of the consequences of consanguineous marriages on dyslexia in the Arab community.
2. Lack of Longitudinal Design: The study utilized a cross-sectional design, which limits the ability to establish causal relationships and determine the developmental trajectory of dyslexia. Longitudinal research would give a better understanding of how dyslexia develops and evolves over time in individuals from consanguineous marriages.

Conflict of Interest

The author declares that there is no conflict of interest.

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