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Analyzing educational big data to determine effect of family factors on student performance

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Abstract

The performance of 25.776 students from Oman's education big data is analysed in this study. The data analysed through descriptive statistics and Multi liner regression methods. To investigate the effects of family factors on student performance. Four family factors—family size, number of brothers, number of sisters, and birth order—were used for this study. The result of study shows that birth order, family size, and the number of brothers and sisters have significant effect on student performance. The results of the analysis indicated that three family children have optimal student performance in Sultanate of Oman. In addition, children born into small families performed better than children born into large families. Regarding the birth order result revealed that second born child has showed better performance compared to other children. Finally, the number of brothers showed the most effect variable among four family factors. The importance of this study to maximize student performance, our findings highlight the significance of integrated measures that improve family-school partnerships while also encouraging participation and confidence. The study concludes that family size, number of brothers, number of sisters, and birth order are critical, interrelated factors in student performance and recommends that educators and policymakers should consider the family size and birth order of students' families in order to provide appropriate parental counselling, which would enable them to enhance their children's academic performance in general.

Keywords: *big data; birth order; family size; number of brothers-sisters, student performance*

INTRODUCTION

The rapid development of computers, connectivity, sensors, and other information technologies has ushered in the big data era. Today, robots and people across many industries generate massive volumes of data every day. Digital learning environments in the field of education, such as massive open online courses, learning management systems, virtual learning systems, and student information systems, are constantly producing educational big data. Big data can be described and discussed using the "5V": volume, variety, value, velocity, and veracity. Researchers and educational institutions have a daunting problem in thoroughly analysing educational big data and revealing hidden

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information that might be helpful to management and instructors. The foundation of educational systems is the student, and analysing large amounts of data on student performance may result in better results for all students.

One important way to evaluate students' achievements is through their performance, and schools usually try to help students improve their test scores. Many academics studying education are looking for methods and factors that can improve student performance. A student's performance has been found to be influenced by a number of factors, including gender, high school grade, financial status, teaching medium, family status, residence, test score, attendance, study habits, family support for learning, parent's occupation, and parent's qualifications (Husaini, 2022). A student's family is the most important factor in their growth, and their family environment can have a big influence on how well they perform, claim Gu et al. (2024). Certain unique familial circumstances may cause students to perform differently on examinations and in their studies.

Family factors include the size of the family, the number of siblings, their gender, age, and the age gap between them, as well as the birth order within the family and other aspects of family life, according French et al. (2023). The family is a significant factor in children's education (Tomul et al., 2021). Larger families usually have scholastic difficulties, which provide little time for parents to be involved in their children's education. The factors influencing student accomplishment have long caught the attention of scholars and educators. The relationship between student performance and family characteristics has piqued the interest of education policymakers throughout the years (Guo, 2021; Unugo, 2021). Recent study supports this idea by suggesting that family factors may influence student achievement more than those of communities or schools (von Stumm et al., 2022).

Family size

According to French et al. (2023), family size is the number of children in a family. This study places a lot of weight on family size because it is believed that children from small families are more likely to achieve academically than those from large households. In recent years, economists have focused on the connection between family size and student performance, specifically as indicated by educational results years (Lao & Lin, 2022: Shen, 2017). One factor contributing to its popularity is the fact that education is a fundamental component of national development and that developing nations with significantly higher birth rates tend to have lower levels of education than developed nations. In terms of individual success, education has a significant impact on living standards and professional results. Therefore, determining how family size affects children's education is crucial for both parents who are considering the quantity-quality trade-off for their children and policymakers who need to create appropriate policies to achieve balanced socioeconomic development (Lao & Lin, 2022).

According to Ali et al. (2019), the negative impact of family size may be seen as supporting the child quality-quantity approach. Parents trade off having more children for better "quality," as measured by academic results. Family size is likely to limit the amount of money per person that can be allocated to educational investments for a given level of parental income. According to Yang (2019), children from smaller households typically receive more attention from their parents than those from bigger households. According to the same findings, family size accounts for approximately 45.32% of the variances or dependencies in academic achievement (Aguboshim & Otuu, 2023).

Lao and Lin (2022) examine the causal relationship between only child status and academic achievement in Chinese families, specifically focussing on junior high school

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students from two-child and only-child households. Students from two-child families achieve much better educational achievements than those of only children, according to the findings. Look into how family structure affects student performance in the US (Schlecht, 2024). Students who live with two biological parents generally do better academically and have better general health, according to the findings. Students who live with only one biological parent, on the other hand, suffer in the classroom and in terms of their general wellbeing. The most disadvantaged students are those without biological parents. According to the study conducted by Onyiorah (2023) , family size had a good impact on their learning. The results showed that family size has a significant positive impact on students' academic performance in business studies and that there is no difference in the academic performance of male and female students in upper basic education in Adamawa State, Nigeria.

Number of brothers or sisters

Number of (brothers or sisters) is a significant element in the study of how family history affects student performance (Aslanova et al., 2024). Brothers and sisters are created from the same mother's body. The family's riches will be distributed according to the number of children. Gaining knowledge on the relationship between sibling count and academic achievement might help one better understand the dynamics of home settings and educational results. According to certain research, a student's life is considerably improved by having both male and female siblings student's (Yang, 2019). First-born children frequently exhibit better levels of achievement compared to later-born siblings, according to other studies that demonstrate a substantial relationship between the number of siblings in the family and student performance (Wijanarko & Wisana, 2019). The ideal family size is two, according to a study by Guo (2021), which also shows that academic achievement is initially positively connected with family size but later negatively. Furthermore, siblings can generally help kids improve academically, although having younger sisters lowers a boy's test score.

The impact of sibling size on children's educational attainment in Indonesia is examined by (Feng, 2021). The findings indicate that sibling size has a negative correlation with educational attainment, the number of years of education completed, and the probability of attending school. This is further supported by the subsample analysis, which shows that the adverse effect is greater for Muslim children, children whose mothers have lower levels of education, and children from earlier birth cohorts. Shi et al. (2021) demonstrated that adolescents with siblings outperformed lone children in terms of academic achievement, desk ownership, parents' academic expectations, and kindergarten level. However, they looked at how sibling size affected happiness in China (Li & Hiwatari, 2024). They discovered an indirect link between happiness and sibling size. An individual's degree of education was negatively impacted by the number of siblings, which consequently resulted in a decrease in satisfaction. Additionally, it shows that there is no meaningful correlation between academic achievement and family size.

Birth order

The rank a person holds among his siblings based on age is known as his birth order. According to French et al. (2023), it is also a child's place in his family. A child's familial status is a strong indicator of both personality and academic success. In order to raise children who will succeed in school, parents and educators must take this into account. Numerous studies indicate that a child's birth order plays a significant role in determining their traits. Specifically, it has been asserted that it influences both personality type and academic performance. There are several possible explanations for the observation that

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educational achievement is decreasing in birth order (Premnath et al., 2021). They attribute the negative consequences to the fact that mothers are older when they have higher-order children than lower-order children, as well as to the fact that lower-order children receive more parental time endowments and responsibility devolution. Birth weight had a nonlinear relationship with academic performance, while birth length had a linear relationship (Silventoinen et al., 2023). These correlations were partially explained by socioeconomic, gestational, and demographic variables. Within sibships, similar but weaker relationships were discovered.

The impacts of birth order on educational outcomes, however, vary between low- and middle-income nations, according to the literature. According to Mendolia and Vidal-fernández (2024), for instance, 32 out of 35 countries have negative birth order effects on educational achievement, with little change by gender, wealth, location, or time in the majority of these countries. However, in nations with disparities, children from rural and impoverished households are more negatively impacted. A study conducted in Pakistan by Atta et al. (2023) examines the relationship between students' academic achievement and their birth order. The results of the study provide compelling evidence that a person's first birth has a big impact on academic achievement. There were 400 secondary school pupils in the sample. The findings showed that birth order and academic success were clearly and favourably related. A Saudi Arabian study (Albarkheel et al., 2019) examines the relationship between academic achievement and birth order in relation to other factors such sibling size, gender, age, parent education, parent employment, and family monthly income. According to the study, when compared to other birth order groups, middle-born guys demonstrated the best academic performance. Regardless of their birth order or family size, females did not exhibit the same propensity and are willing to attain high levels in academic education.

Results from other studies suggest that birth order has no effect on student performance (Reyes-Baybay, 2018). Study from Albarkheel et al. (2019) found no significant difference in mean CGPA across the birth order groups. Also study from Kim (2021), he find that no significant correlation between the respondent's order of birth and their corresponding academic performance. One possible explanation is that older children are likely to receive more resources, not just financial ones, but also prompt responses to their needs, more emotional support, more patience, and more psychological assistance. Such comprehensive parental care could enhance the development of elderly children. Additionally, in the Indian setting, Premnath et al. (2021) found no correlation between birth order and academic performance. Participants who were middle-born appeared to possess academic credentials in comparison to those from other birth groups. Male participants' attempts to gain more attention by working hard and performing at their highest level could be one cause.

To the best of our knowledge, no research has yet identified the family factors that influence the Sultanate of Oman's students' educational attainment. In light of this, the current study's goal is to investigate how family characteristics affect student performance using big data in education. We specifically look at factors like family size, number of brother and sister and birth order. In this work, we make advantage of analysing enormous dataset from Oman's educational big data. This can help policymakers and teachers understand how family size affects student performance.

The primary objective of the study was to examine Oman's educational big data in order to determine the impact of family variables on student achievement. The following research issue is attempted to be addressed by this study: What effect does family size have on Sultanate of Oman students' academic performance?

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Based on the above explanation, the following hypotheses:

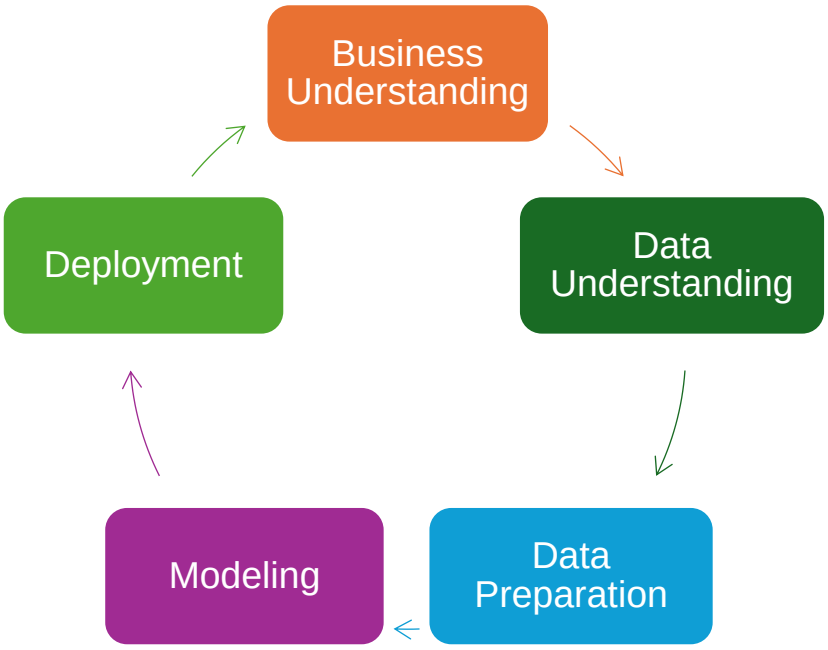
1. Family size has no significant effect on students' performance in South al Sharqia province, Sultanate of Oman.
2. Number of brothers has no significant effect on students' performance in South al Sharqia province, Sultanate of Oman.
3. Number of sisters has no significant effect on students' performance in South al Sharqia province, Sultanate of Oman.
4. Birth order has no significant effect on students' performance in South al Sharqia province, Sultanate of Oman.
5. Most family factors contribute significantly to the student performance

METHOD

In this study, we employed Staneviciene et al. (2024) concept of data mining. This study was analyzed using the Cross-Industry Standard Process for Data Mining (CRISP-DM) stages. The enhanced CRISP-DM model, shown in Figure 1, guides the project through every stage of its life cycle, from comprehending business and data to preparing, modelling, and deploying it.

Figure 1

Modified CRISP-DM Model (Staneviciene et al., 2024)



Business understanding

In this paper that would be an increasing understanding the impact of family factors on students' performance. This study's primary goal is to determine whether family size, the number of brothers and sisters, and birth order have an impact on students' achievement.

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Data understanding

The data set used in this study was obtained from Oman education Portal database, which regularly keeps all student data in electronic form. These data can be of various types and volumes, from student personal information, Parents information and academic achievement. The data contain 25.776 students records who started their studies in the school year of 2022/2023 from grade 1 to 10 in all schools in South al Sharqia province.

This study used mean of grades of all school subjects in final exam as student performance. Mean of grades are a common metric for evaluating student performance, providing a snapshot of their achievement. They are typically calculated by summing a student's scores on various subject and dividing by the number of subjects. It is calculated as follows:

$$G = \frac{\sum_{i=1}^{n} w_i * g_i}{\sum_{i=1}^{n} w_i}$$

Note: n is the total number of subjects, g is the grade for a single subject, and w is the number of subjects.

Data preparation

The student's data was kept in an Oracle data warehouse. Data from two tables in this warehouse was extracted using SQL queries. The information is derived from two distinct tables: the Student Result table and the Parents table. The Student Result table includes first and second semester student results, total final grades, and the average of all grades. Information about the parents' educational background, employment status, size of the family, number of brother and sister, and birth order were all included in the Parents table. Two tables were combined in the data preparation process to create a single dataset that was prepared for analysis. The dataset come in excel sheet file to be ready for analysis using JASP software. JASP (Jeffreys's Amazing Statistics Program) used to analysis data in this study. JASP is a free and open-source program for statistical analysis supported by the University of Amsterdam.

Modelling

The data analysis techniques in this study are conducted through systematic stages aimed at answering the research questions and testing the hypotheses. Analyses were conducted in three stages. Frist, descriptive analyses used (mean, standard deviation, minimum, and maximum) to explore the dataset Second, ANOVA was performed to determine if there was a significant difference between independent variables (family size, number of brothers, number of sisters and birth order) and dependent variable student performance. Third, multiple liner regression to determine the order of the factor's importance among four variables.

RESULTS AND DISCUSSION

Results

Descriptive Statistics

This study investigates factors that impact in student performance. We examined four important characteristics of family impact: family size, number of brothers, number of sisters and birth order on academic performance in public schools in Sultanate of Oman on 100 sampled schools, with 25.776 students from 2022/2023 school year.

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The characteristics of dependent and independent variables are demonstrated in table (1). The total number of students in this dataset was 25.776. The mean value of an independent variable of this study student performance was 87.34. Among the four factors that impact in student performance, we can see the average of family size in Sultanate of Oman was six children, and regarding the number of brothers the mean value was 2.56, the mean value of number of sisters was 2.6, the mean value of birth order was 3.6.

Table 1

Descriptive Statistics

	Valid	Mean	Std. Deviation	Minimum	Maximum
Family Size	25.776	5.805	2.513	1	23
Number of Brother	25.776	2.564	1.55	1	13
Number of Sister	25.776	2.633	1.629	1	14
Birth Order	25.776	3.57	2.541	1	19
Student Performance	25.776	87.342	10.371	0	100

Hypothesis 1: There is no significant differences between family size and student performance of school students in South al Sharqia in Sultanate of Oman

This was done by use of a One-way between groups analysis of variance (ANOVA). Family size variable was from 1-child family to 23- child family. Scores on the performance scale was ranging from 0 to 100 with high scores indicating higher levels of performance. ANOVA was used to establish whether there are significant differences in the overall performance mean scores among students across the groups of family size. The ANOVA results are summarized as shown in the JASP output in Table 2.

Table 2

ANOVA for Differences of Mean Student Performance Scores Based on Family Size

Cases	Sum of Squares	df	Mean Square	F	p
Family Size	78,221	20	3,911.00	37.39	< .001
Residuals	$2.694\times10^{+6}$	25,755	104.6		

From Table 2 it was found significant with F value =37.39, p value < .001 which implies that the group of independent variables does show a statistically significant differences with the dependent variable. Therefore, the null hypothesis which states that there is no significant differences of family size on student performance is rejected. It means that since the mean score for students from small families is greater than those from large families. It can be clear in line graph 2 presented in Figure 2.

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Figure 2

Line Graph Showing the Mean Student Performance Scores Based on Family Size

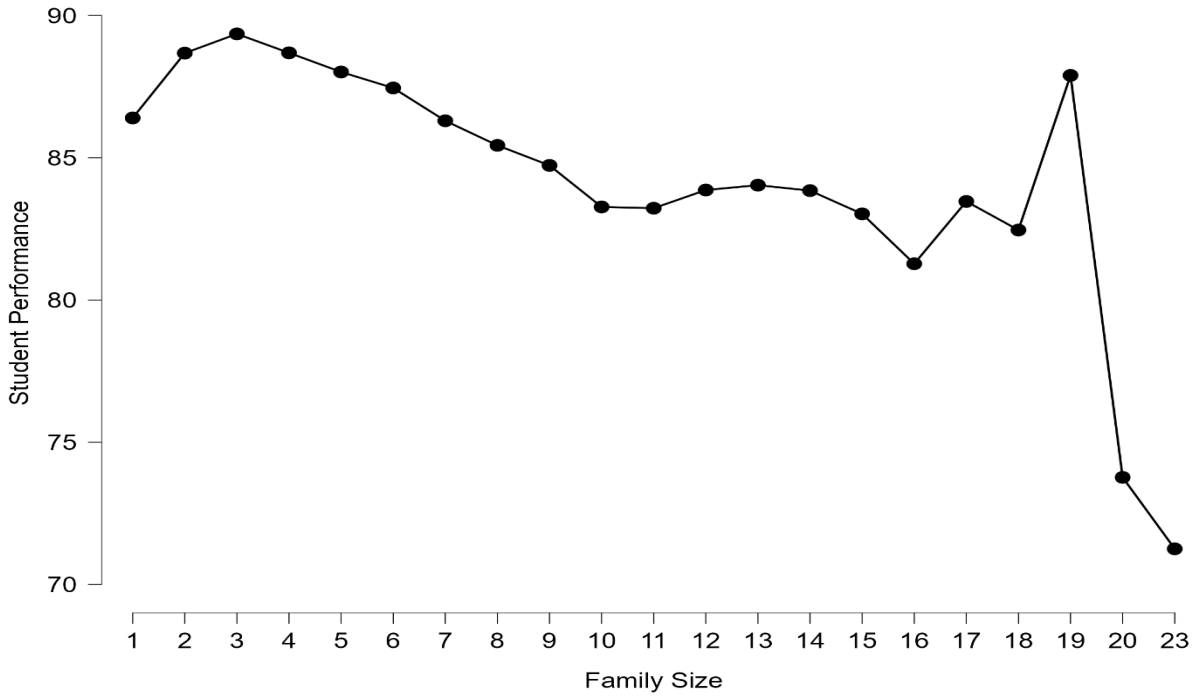

Figure 2 shows that the highest student performance was (Mean = 89.35) from 3-child family while the 23- child had the least performance (Mean =71.26). In general, we can see that small families have better student performance, as families become more larger the student performance was negatively affected.

Hypothesis 2: There is no significant differences between number of brothers and student performance of school students in South al Sharqia in Sultanate of Oman

To address hypothesis of the study which stated: to find out the effect number of brothers on student's performance. One-way ANOVA was used to establish whether there are significant differences in the student mean scores across the groups of number of brothers. The ANOVA results are summarized as shown in the JASP output in Table 3.

Table 3

ANOVA for Differences of Mean Student Performance Scores Based on Number of Brothers

Cases	Sum of Squares	df	Mean Square	F	p
Number of brothers	65,376	12	5,448.00	51.85	< .001
Residuals	$2.707 \times 10^{+6}$	25,763	105.1		

The result presented in Table 3 indicates a significant difference between number of brother groups and student performance ($F = 51.85$, $p < .001$). This indicates significant differences for

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number of brothers in student performance because the p-value is less than the .05 level of significance. Hence, the hypothesis is retained. Further analysis was conducted to explore the specific differences in student performance among number of brothers categories. However, the more brothers associate with low student performance as revel by line graph below. It can be clear in line graph 3 presented in Figure 3.

Figure 3
Line Graph Showing the Mean Student Performance Scores Based on Number of Brothers

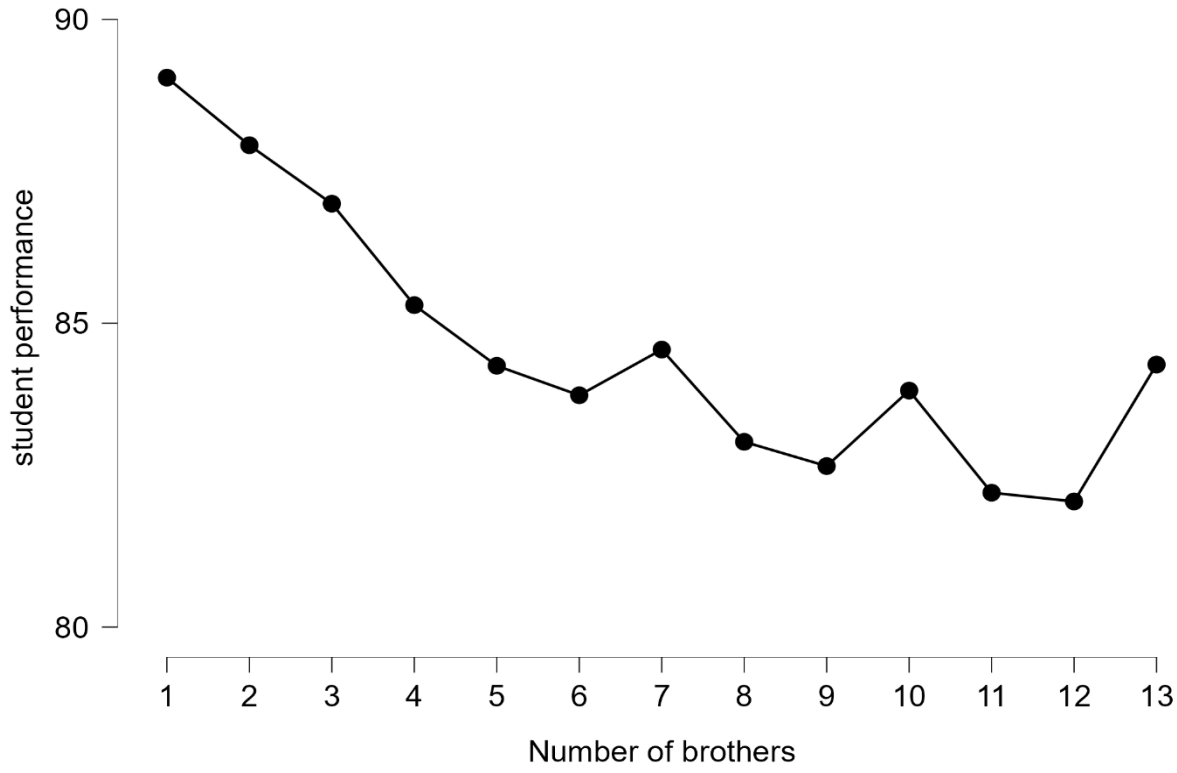

Figure 3 illustrates the mean student performance scores based on number of brothers siblings. Families with one brother (Mean = 89.04) reported higher performance among the other families while the 12th -brother family had the least overall performance (Mean =82.07). The figure revealed that increasing in brothers' siblings have negative effect on student performance.

Hypothesis 3: There is no significant differences between number of sisters and student performance of school students in South al Sharqia in Sultanate of Oman
Table 4

ANOVA for Differences of Mean Student Performance Scores Based on Number of Sisters

Cases	Sum of Squares	df	Mean Square	F	p
Number of sisters	34,927	13	2,686.70	25.28	< .001
Residuals	$2.737 \times 10^{+6}$	25,762	106.3		

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Meanwhile, another significant factor that differences students' performance number of sisters as revealed in this study. The results show that this factor has a F-value of 25.28 and p< .001. Hence, the hypothesis is reserved. Further analysis was conducted to explore the specific differences in student performance among number of sisters categories, as depicted in Figure 4 below.

Figure 4
Line Graph Showing the Mean Student Performance Scores Based on Number of Sisters

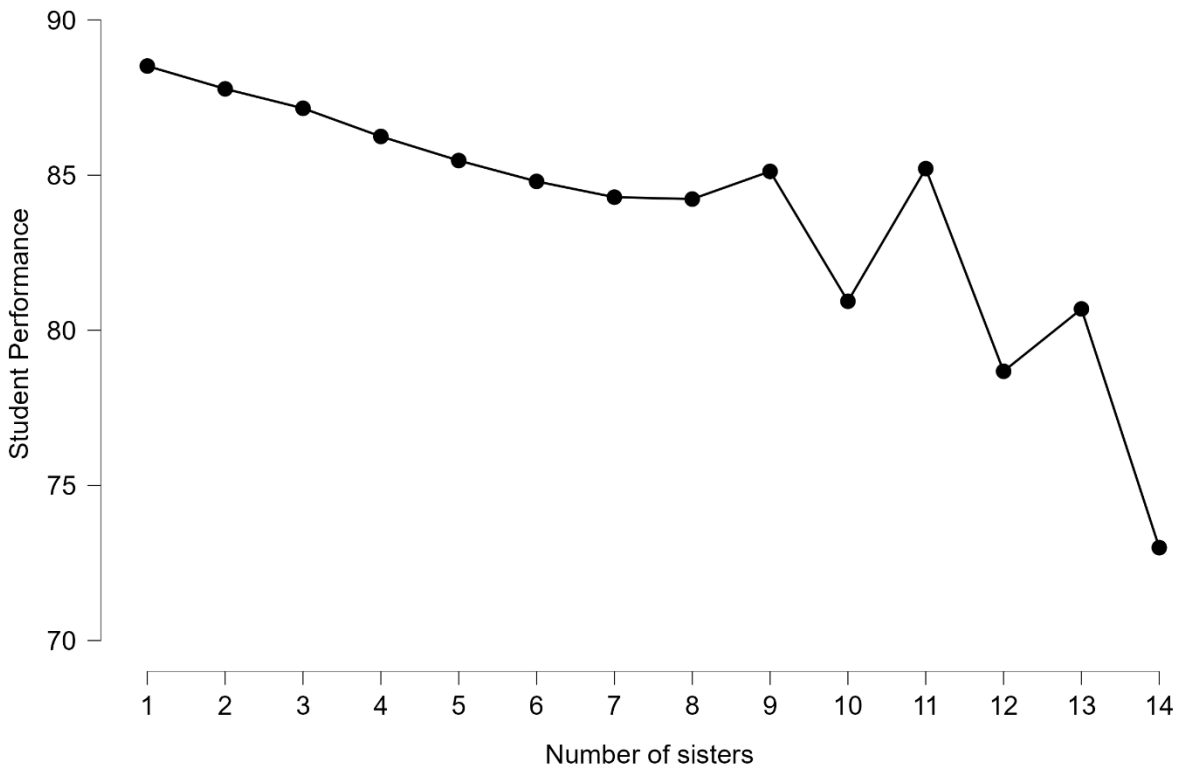

Figure 4 illustrates the mean student performance scores based on number of sisters. It is show that families with one sister (Mean = 88.52) reported higher performance among other groups, (p < .001) while the 14th -sister family had the least performance (M=73) also, fig show that have decreased in student performance when the family extended with more members.

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Hypothesis 4: Birth order has no significant differences on students' performance in South al Sharqia province, Sultanate of Oman.

Table 5

ANOVA for Differences of Mean Student Performance Scores Based on Birth Order

Cases	Sum of Squares	df	Mean Square	F	p
Birth order	41,166	18	2,287.00	21.57	< .001
Residuals	$2.731 \times 10^{+6}$	25,757	106		

Birth order ($F = 21.57$, $p < 0.001$) shows significant differences on students' performance as revealed in this study. Based on these findings, there is a significant influence between student performance and birth order categories among secondary school students in South al Sharqia, Sultanate of Oman. Therefore, the null hypothesis is rejected. Further analysis was conducted to explore the specific differences in student performance among different categories of children. The effect can present clear in line graph 5 below.

Figure 5

Line Graph Showing the Mean Student Performance Scores Based on Birth Order

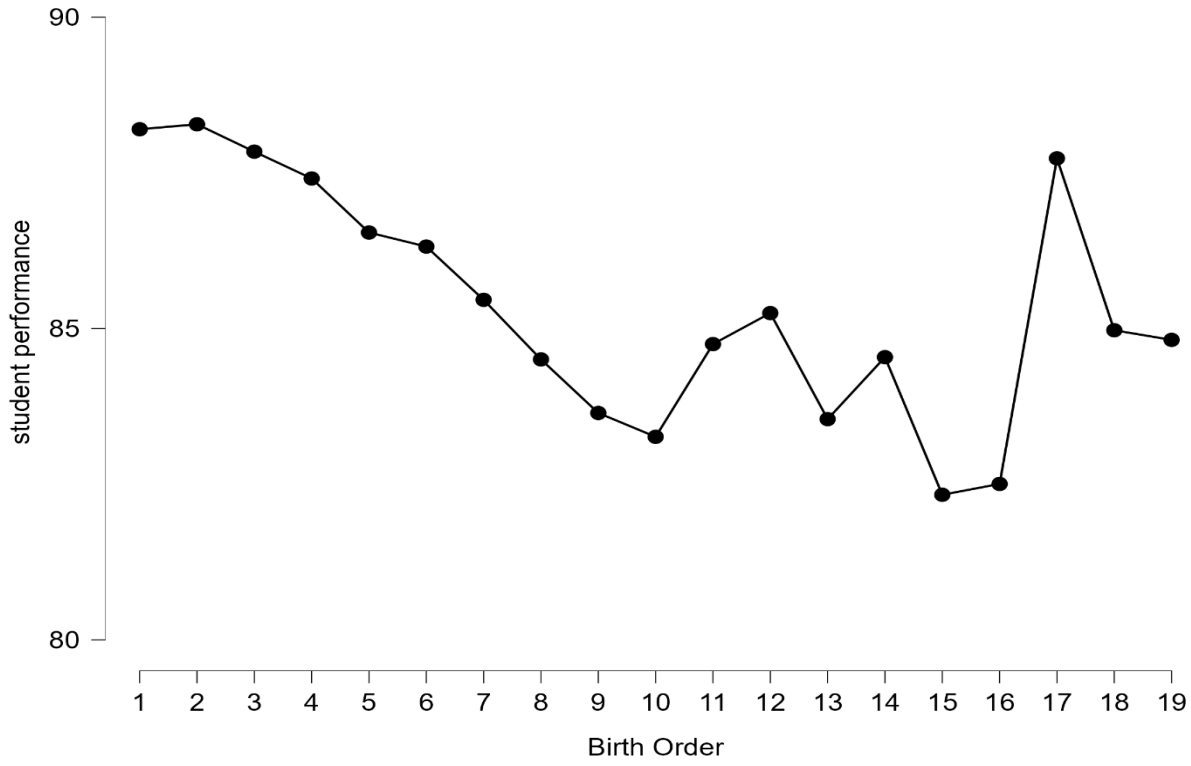

Figure 5 reflects the optimal birth order is number two in Sultanate of Oman. This conclusion is interesting because first born should perform better than second according to

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quantity and quality resources. The result show that Second born child (Mean = 88.28) reported higher performance than all Childs. Third born child (Mean =87.84) become slightly lower than first and second born child. However, we can observe that student performance has decreased gradually until tenth born child. The worst student performance was fifteen born child (Mean = 82.33). In general, older child have better performance compared to the younger member of the family. We may assume that older child asses themselves more often as more successful at school while youngest children feel more often less successful than their sibling (compared with other categories).

Hypothesis 5: Most family factors (family size, number of brothers, number of sister and birth order) have significant effect on students' performance in South al Sharqia province, Sultanate of Oman.

When examining a quantitative variable (the dependent) in connection to any other factors (represented as independent or predictor variables), multiple regression is a flexible method that may be appropriate. Nonlinear relationships, quantitative or qualitative independent variables, and the impacts of one or more variables, with or without the effects of other factors taken into consideration, can all be examined.

Table 6

Summary of Coefficients Showing the Rank of Family Factors to Effect in Student Performance

Rank	Variables	Unstandardized	Standard Error	Standardized	t	p
1	Number of Brothers	-0.764	0.093	-0.114	-8.209	< .001
2	Number of Sisters	-0.392	0.091	-0.062	-4.32	< .001
3	Family Size	-0.246	0.085	-0.06	-2.893	0.004
4	Birth Order	0.165	0.041	0.04	4.021	< .000

Based on Table 6, it shows that number of brothers is the most effect in student performance with (Beta= - 0.114). Number of sisters and family size have become second and third effect on student performance with (Beta= - 0.062 and - 0.06) respectively. That means if the number of brothers, sisters and family size increased, student performance will be decrease. Birth order has a lowest effect with student performance (Beta= 0.04).

Discussion

Our study's conclusion that students from small families outperformed those from large families suggests that households with fewer siblings can supply enough educational resources and study space, which lessens crowding and improves student performance. On the other hand, children who have a sibling may frequently vie for the few resources available to them, which might result in a more egocentric attitude and poorer performance (Walter, 2020). Therefore, it is conceivable that children who have a sibling may struggle academically due to the decreased parental care they receive. This finding supported by Njonge (2023) indicating that significant relationship between family size and academic performance. Studies like those by Van Winkle and Monden (2022) and Guo (2021) contend that students from larger households perform worse academically than students from smaller homes, which may be due to this. The cause is that parents who have a large family are unable to spend enough time with their kids. Conversely, parents who have few kids can afford to provide their kids enough time for their schoolwork.

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Number of brothers relationships are considered a significant factor influencing student performance (Fan & Liu, 2024). This finding was support by AL-Qadri et al. (2025). Study by Yang (2019) indicates that when student has few siblings, the number of siblings has a positive effect on their academic performance regardless of the gender makeup of the siblings. The study of Guo (2021) revelled that siblings can help student grow academically, however having younger sisters causes a boy to perform lower on tests.

This issue observed again among other two variables number of brothers and sisters. It is confirmed that family with large number of siblings (brothers or sisters) face decrease their children performance. This result come with previous research indicating that low family members often exhibit more sources and drive to succeed. The heightened expectations placed on oldest children may fuel their performance to excel academically, as they strive to meet or exceed these expectations. Fan and Liu (2024) indicate an expected negative effect for increasing number of siblings particularly when children originate from families with a lower educational background. Also, according to AlSaleh et al., 2021) students from smaller families had higher GPAs compared with those from larger families. Another support come from Indonesia (Feng, 2021) as shows that the negative impacts of sibling size among children at secondary school.

In term of birth order position, the result shows that there are statistically significant differences of birth order position on student performance. It showed that decrease on student performance for the later-born children compare to their older siblings. This finding supported by Mendolia and Vidal-fernández (2024) as they finding that negative birth order effects on educational attainment in 32 out of 35 countries. Our study shows that second born receives the highest average score. However, suggests that although the firstborn can use the family's resources, they miss out on opportunities to teach and care for younger siblings, and the advantage cannot make up for the loss. Additionally, since parents of two children will find methods to cut back on entertainment and work harder, the investment in education is not strictly limited. When the birth order increases to three, the strain of raising several children becomes so great that family resources restrict the children's intellectual growth, at which point both number and quality of resources are effective.

This is corroborated with the outcome of the study conducted by Aguboshim and Otuu (2023) who study 600 students from three tertiary institutions in Enugu, Nigeria. They are agreeing that the mean academic performance of elder siblings was significantly higher than those of younger siblings. Similarly, Aloka (2023) posits that lastborn children may lack performance due to lower educated of the families. Instead, later-born children in less educated families perform worse than first-borns, even when the number of siblings is held constant. Therefore, the resource dilution argumentation on birth order seems to be relevant only when cultural resources are limited, as less educated families cannot compensate for effects of birth order position. In regard the most effect variables among family factors on student performance. Our study reveals that number of brothers is the most effect variable in student performance among the four variables.

CONCLUSION

The study concludes that family size, number of brothers, number of sisters and birth order have effects on student performance of South al Sharqia in sultanate of Oman. The study also concludes, family size has effect student performance negatively, with children born into small families performed better academically than children born into large families. The study concludes that birth order explained a significant variability in student performance

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among the school students. Therefore, the second-born students have the highest performance compared to another student.

There are some limitations to this study that are noteworthy. First, our study only examined family factors and did not include other components, such as school factors. Second, only focused on South al Sharqia in sultanate of Oman. Future studies could focus on other provinces in Oman to discover more knowledge. In light of this study, some recommendations seem to be mentioned as follows: for parents need to providing more supportive home environment that supports exploration and self-directed, that will greatly increase the chances of having an academic success child. For policy makers are required to eliminate all forms of bias and discrimination based on student family background. They must encourage students to engage in all academic activities and allow them to enjoy the levelled field of learning process. However, this study has significant implications for student success in their learning. First, the educator should pay more attention to family factors, as it has a huge impact on student success and future development. Second, parental awareness of family size and birth order can help children on their success.

AUTHOR CONTRIBUTION

Author 1: Conceptualization, methodology, data analysis and writing manuscript
Author 2: Methodology and proofreading
Author 3: Review and Supervision

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