The effects of birth interval on intellectual development of Saudi school children in Eastern Saudi Arabia

Hassan Bella, *MD, PhD,* ***Mohamed S. Khalil,*** *PhD,* ***Sameeh M. Al-Almaie,*** *MD, FFCM,*
Nabil Y. Kurashi, *MD, FFCM,* ***Saeed Wahas,*** *PhD.*

ABSTRACT

Objective: The primary aim of this study was to investigate the effect of birth intervals on some aspects of intellectual ability of Saudi primary school boys.

Methods: This is a cross-sectional study of Saudi school children comparing their intellectual ability (general intelligence) in relation to the length of the birth interval before and after the birth of the index child. The study area comprised 3 townships in the eastern province; Khobar, Thogba and Dhahran. The study was conducted in 2000/2001 and the study population comprised Saudi primary school boys aged 9-10 years from a middle class background. A 2 stage random sampling technique was adopted. Data were collected using student data sheet, a family questionnaire and the Standard Progressive Raven Matrices Test of intellectual ability, standardized for use in Saudi Arabia. Data were analyzed using SPSS software.

Results: More than 90% of children born after a birth interval greater than 35 months were classified as average and above according to the Raven Matrices Test, compared to 79% of children born after a birth interval of less than 19 months ($p<0.03$). Analysis of variance showed that test scores increased consistently as the succeeding birth interval increased. Multivariate analysis showed the most import predicting variables in the Raven Matrices Test to be family income and height.

Conclusions: Longer birth intervals were shown to be associated with higher general intelligence levels in the 9-10 year olds. These results confirm those obtained in a previous study in Singapore conducted more than 2 decades ago. Our results have also shown that the succeeding birth interval is more significant than the preceding interval in relation to perceptive ability of children. The findings enable us to advise parents that by observing a birth interval between 2-3 years would make their children grow and do better at school.

Saudi Med J 2005; Vol. 26 (5): 741-745

The effects of birth intervals (BI) on the health of a child of school age are under-studied. However, there is non-conclusive evidence from previous studies that the length of the BI can influence the intellectual development of children.[1,2] The most important study on this issue, was based on the hypothesis that the shorter the BI the less is the intellectual and physical development of the child.[1] There is little evidence to confirm this hypothesis. Most of the studies on BI dealt with the effects of BI on perinatal outcomes and maternal health. Almost all published results are on the relationship of BI with perinatal outcomes,[3] low birth weight, preterm birth and intra-uterine growth retardation,[4-7] and childhood mortality.[8-10] A study on BI conducted in rural Saudi Arabia by Al-Nahedh[11]

From the Departments of Family and Community Medicine (Bella, Al-Almaie, Kurashi), and Psychiatry (Khalil, Wahas), College of Medicine, King Faisal University, Dammam, *Kingdom of Saudi Arabia*.

Received 16th August 2004. Accepted for publication in final form 19th December 2004.

Address correspondence and reprint request to: Prof. Hassan Bella, College of Medicine, King Faisal University, PO Box 2114, Dammam 31451, *Kingdom of Saudi Arabia*. Tel/Fax. +966 (3) 8588318. E-mail: hassanbella@yahoo.com

addressed the effects of socio-demographic variables on the spacing of pregnancies. In another study carried out in the Taif area, the authors found that the mean and standard deviation (SD) lactational amenorrhea period and BI interval were 5.95 (5) and 26.8 (14.1) months.[12] No details were given in the study as to whether this mean referred to preceding or succeeding birth intervals. The primary aim of the current study is to investigate the effect of birth interval on some aspects of intellectual ability of 9-10 year old Saudi primary school boys in the Eastern Province of Saudi Arabia. For the purpose of this study BI's are categorized into 2 main types: B_1 - The preceding BI, namely, the interval between the birth of the index child and the immediate older sibling, and B_2 - the succeeding BI, namely, the interval between the birth of the index child and its immediate younger sibling. The terms birth interval and birth spacing are synonymous. This study is part of a larger one in which the effects of the BI on physical growth, and other variables were investigated. The results of these are reported elsewhere.

Methods. This is a cross-sectional study of Saudi school children comparing their intellectual ability in relation to the length of the birth interval before and after the birth of the index child. The study area is made up of 3 adjacent modern townships, namely; Khobar, Thogba and Dhahran which constitute a metropolitan complex in the Eastern Province of Saudi Arabia. Together they form typically new, fast growing urbanized townships with a middle class Saudi population made up of all socioeconomic groups. The study population comprised Saudi primary school boys aged 9-10 years. The student lists obtained from schools by the principal investigator, contained student's name, class, and date of birth and the birth order of the student. These lists were checked by the investigators for inclusion and exclusion criteria. Only those satisfying inclusion criteria were investigated. The first born child, 5th and above birth order, twins, stepbrothers, children in special education schools; were all excluded from the study. Because Saudi Arabia is a polygamous society, half-brothers (from father) were not included. Private schools were excluded from the sample to remove the confounding effect of a very high-socioeconomic class, high levels of parents education and income which may influence the physical and intellectual state of the children. In private schools, students may get special additional educational facilities not available in government schools. Schools included in the sample were randomly selected. A 2 stage sampling technique was adopted. In the first stage of sampling, schools in the 3 townships were divided into large and small according to number of enrolled children. In the second stage of sampling 9-10 year old children were randomly selected. The geographical locations of the selected schools covered mostly a middle class population. Three tools for data collection used were. 1. Student Data Sheet: This is a one page, 15 item sheet with child's name, birth date and order, class and other demographic variables. 2. Family Questionnaire: A questionnaire was sent to the families of the children in the study with a covering letter signed by the school headmaster. The letter explained the study objectives and encouraged enquiries and cooperation. The questionnaire had items about the student that had to be answered by parents. These included child's birth weight, abortions, stillbirths, breastfeeding, presence or absence of house maid, child toys, use of contraceptives and some data on housing and family income. These variables were asked in order to remove their effects as possible confounding factors. The family questionnaire was kept anonymous and confidential to encourage candid responses. It was designed for self-administration as it was unrealistic to invite families to schools. Some of the data such as birth date, birth order of index child and his siblings were obtained from student files and identification at school. 3. The Standard Progressive Raven Matrices Test: The third tool for data collection was the Raven Matrices Test (SPM) and its answer sheet to be filled by the children. This test is one of the best known and most widely used of the nonverbal group tests of intellectual abilities. It also represents one of the most commonly referenced tests of the culture-free tests of intellectual ability. It can be used as an individual or as a group test, and it covers a range of ages from 8 years through elderly adults.[13] It is a culture free test of general intelligence, because it was designed to eliminate influence of language, as well as the effect of education on intellectual ability. The SPM consists of 60 items grouped into 5 sets (A to E), each set containing 12 items. Each item contains a problem situation in which a picture pattern with a missing part and 6 to 8 parts inserts, one of which is to be chosen by the subject as the missing part to complete the picture. The items become increasingly more difficult, from reasoning by concrete thinking and by analogy, to reasoning by abstract thinking. The test was standardized in Saudi Arabia, and a Saudi norm was developed[14] and was used in the present study. The test was carried out by 2 psychologists who also scored it. The study population was grouped according to the preceding (B_1) and succeeding (B_2) birth intervals into 4 age groups. One consisted of those with BI $\leq$13 months; group 2 of those with BI 13-18 months, groups 3 of those with BI 19-24 and group 4 of those with BI >24 months. Based on the frequency distribution of birth intervals, children in the upper quartile (>31 months) and children in the lower quartile (<17

months) were identified for the preceding BI. Children in the upper quartile (>35 months) and children in the lower quartile (<19 months) were identified for the succeeding BI. Data were analyzed using SPSS. One and 2 way analysis of variance and Duncan multiple tests was used to assess differences between more than 2 groups. Two way analysis of variance was used to study the effect of preceding and succeeding birth intervals on the SPM test. Linear and logistic regression analyses were used to evaluate the role of certain variables in predicting continuous and dichotomous outcomes (physical and intellectual performance). A *p*-value of less than 0.05 was used as the statistical level of significance. Assessments were repeated for 15% of the total sample, namely, every seventh student was assessed again (total of 78 students). These repeated measurements were taken by 2 of the team members who had not taken part in any of the original measurements. The questionnaires for this sub-sample were also repeated.

Results. The relationship between birth interval and the level of general intelligence was examined. **Table 1** shows the effect of birth interval on the general intelligence level as assessed by the Standard Progressive Matrices test (SPM). This table shows that more than 90% of children born after a BI (B_2) of >35 months were classified as average and above according to the Raven Matrix Test compared to 79.7% of children born after a birth interval (B_2) of <19 months (p<0.036). No significant difference was noted between the 2 groups (upper and lower quartiles) with respect to the effect of the preceding birth interval (B_1) on the SPM. The analysis of variance (ANOVA) technique was applied to the SPM scores for all children in relation to the length of the BI (**Table 2**). The scores increased consistently as the succeeding birth interval (B_2) increased. However, this increase was not significant. Multivariate analysis showed that the most important predicting variables in the SPM

Raven Matrices Test group	Preceding interval B_1 <13 months n (%)	Preceding interval B_1 >31 months n (%)	Succeeding interval B_2 <19 months n (%)	Succeeding interval B_2 >35 months n (%)
Average and above	72 (86.7)	77 (85.6)	63 (79.7)	74 (91.4)
Below average	11 (13.3)	13 (14.4)	16 (20.3)	7 (8.6)
P-value	NS	NS	0.036	0.036

NS - not significant

Table 1 - Birth intervals and general intelligence as assessed by the Standard Progressive Raven Matrices test.

Birth interval (in months)	Mean Ravin Matrix Score ± SD: Preceding B_1 n	Preceding B_1 B_1 ± SD	Succeeding B_2 n	Succeeding B_2 B_2 ± SD
<13	-	-	2	13±1.4
13-18	12	26.3±9.5	14	23.8±11.7
19-24	23	25.3±13.1	16	24.2±14.5
>24	40	24.4±11.5	43	26.3±10.5

Table 2 - One way analysis of variance for Standard Progressive Raven Matrices scores by the upper and lower quartile of preceding birth interval (B_1) and succeeding birth interval (B_2) for children in the study.

Dependent variable	Independent variable	Regression coefficient	95% confidence interval	*P*-value	R^2
Raven Matrix Test Score	Income	2.92	0.95-4.89	0.003	-
	High	0.48	0.14-0.81	0.005	0.11
	Constant	-38.32	-	-	-

Table 3 - Results of the multiple regression analysis for the Standard Progressive Raven Matrices test total scores of children.

test total score were; the family income and height. Only 11% (R^2) of the variation was explained by these 2 variables leaving 89% of the variation unexplained (**Table 3**).

Discussion. Our results have consistently shown that longer birth intervals were associated with higher general intelligence levels in the 9-10 year olds. These results confirm the positive effect of longer birth intervals on the observational and perceptive abilities of children as assessed by the SPM test, which is considered a satisfactory measure for comparing children's capacity for immediate observation and clear thinking. However, a significant correlation between longer preceding birth interval (B_1) and high scores in the SPM test were not found. Martin remarked that in her study, children after whom the birth interval (B_2) was short did not have problems with perceptive ability.[1] Our results have shown the contrary, that children whose birth was followed by a short interval had problems with regards to perceptive ability. Indeed, our study has shown B_2 to be more significant than B_1 in this respect. In both study cases, no significant interaction between B_1 and B_2 was noted. Even though in the ANOVA analysis the increase in scores of the SPM test was not significant, the scores tended to consistently increase as the succeeding BI (B_2) increased. This means that the intellectual development of Saudi children in the sample is in line with their pattern of physical development, both of which are related to the length of birth intervals.

The findings of the multivariate analysis that height and income were the most predictive variables for the Raven Matrix test are consistent with the findings of Martin.[1] However, whereas there was a progressive increase in height with the preceding BI (B_1) and not with the succeeding BI (B_2) in Martin's study, our study has shown a progressive increase with B_2.

We demonstrated that longer succeeding birth intervals were associated with higher scores in the SPM Test. In the Singapore study[1] only the preceding interval was found to be associated with better scores in the SPM Test. The confirmation of the Singapore study conducted more than 2 decades ago, by the result of this study has the following implications: 1. The time factor did not affect the original hypothesis or nullify it. 2. The author of the Singapore study thought her results were due to the very special characteristics of the Chinese population of Singapore, however, our study has proved that her conclusions are equally valid for the Saudi population

Before we conclude, it is worthy noting that several studies have found a significant relationship between birth weight and cognitive development.[15-19] Further studies have found similar relationships between low birth weight and short birth intervals.[20-21] Taken together, these findings are consistent with the present results in supporting the relationships between short birth intervals and poor performance in cognitive ability. In this connection, Pinto-Martin et al[22] indicated that low birth weight infants, short interpregnancy interval appeared to represent a significant risk for the development of disabling cerebral palsy. These findings have important implications. They can enable us to tell mothers that by observing a birth interval of more than 24 months would make their children grow physically better and be more intelligent. This is more likely to convince and appeal to the mothers than any amount of health education on family planning.

The findings are also important for nurses, primary health care and hospital physicians, pediatricians and obstetricians who have contact with mothers. There is the need to convey the results to these groups, particularly primary health care personnel who have longitudinal contact with mothers and potential mothers.

In conclusion, the current study has confirmed the results obtained by Martin[1] and her original hypothesis that children born after longer birth intervals are more intelligent than children born after shorter birth intervals. Finally, the long-awaited confirmation from the Middle East is now available in Saudi Arabia. Our study has also confirmed the importance of the succeeding birth interval B_2 which was not emphasized in the Singapore study.

Acknowledgment. The authors wish to express their appreciation for the support of King Abdul-Aziz City for Science and Technology for funding this research. We are also grateful for the technical assistance from Dr. Hafiz Omer in data analysis.

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