Relationship Between Physical, Environmental and Sociodemographic Factors and School Performance in Primary Schoolchildren

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Summary

Poor primary school performance is a risk factor for low high-school and university graduation, as well as poverty in later life. In this case-control study, the relation between a variety of physical, environmental and sociodemographic factors, and primary school performance was investigated. Grade one students with good and poor school achievement, from different socioeconomic levels were studied. A questionnaire about the sociodemographic characteristics and child's medical history, together with a Child Behavior Checklist, was filled out by parents. Physical examination, visual and hearing screening were performed. Blood count and blood lead levels were determined. Wechsler Intelligence Scale for Children-Revised (WISC-R) was performed to determine the IQ. A total of 177 students participated in the study. Stepwise logistic regression revealed an independent positive relation between duration of study (OR, 2.69; Cl, 1.19–6.05; $p = 0.016$), maternal education (OR, 1.47; Cl, 1.14–1.87; $p = 0.002$), full scale score of WISC-R (OR, 1.08; Cl, 1.03–1.3; $p = 0.002$) and school performance. Multinomial logistic regression revealed that the risk of having a below average full scale WISC-R score was higher among children having a hearing loss, uncorrected vision loss, heating house with stove, cigarette smoking of both parents, and low paternal education (less than 8 years). The chance of having an above average full scale WISC-R score was lower among children whose either parent smoked cigarettes, height-for-age percentile was below 10, and maternal education was less than 8 years. Policies for increasing male and female education, growth monitoring, appropriate feeding (breastfeeding and weaning), well-baby and child follow-up and clean environment (indoor and outdoor) will not only promote the physical health but also promote the cognitive development of the new generations.

Introduction

Grade retention during the early years of education may have detrimental results such as increased drop-out rate and decreased self-esteem.[1] Retention also creates a burden on the community. It has been estimated that developing countries have to spend four times more to produce a graduate after retention.[2]

Grade retention rates during primary school were reported to be 7.6 per cent in the USA.[3] In Turkey the grade retention rate among primary school students between 1994 and 1995 was 2.5 per cent (341 379 students).[4] As retention is costly and long-term consequences are detrimental, it has become a policy in many countries to make the student go through grades as much as possible during the primary school years. As a result there are many more students with low school performance than those repeating a grade. Decreased primary school performance is a risk factor for low high-school and university graduation, as well as an increased risk for poverty in later life.[5]

In this study we aimed to define the relationship and interaction between several physical, environmental and sociodemographic factors, and primary school performance in a developing country using physical examination, laboratory tests, Child Behavior Checklist (CBCL), Wechsler Intellegence Scale for Children-Revised adopted for Turkish Children (WISC-R), as well as parent interviews.

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Patients and Methods

The study population of this case-control study consisted of grade one children attending public schools during 1998 in Ankara, Turkey. It had been planned to recruit 100 students from each (low and high) socioeconomic status. Expecting a 20 per cent dropout rate, 120 students from each socioeconomic status were included in the study. The socioeconomic status of the students was determined on the basis of the school district. Schools were chosen using a list of random numbers. From each school the entire first grade classes were included in the study. From each class the teachers were asked to determine the most successful 10 per cent (good achievers) and the least successful 10 per cent (poor achievers) of their class. Finally, four schools from low socioeconomic status and three schools from high socioeconomic status were included in the study.

In order to decrease bias, researchers were unaware of the student's school performance until the end of the study.

The study was approved by Hacettepe University Institute of Health Sciences.

After selection of the children, the study details were explained to the families and they were invited to Hacettepe University Institute of Child Health Department of Social Pediatrics to participate.

On admission oral informed consent was taken from parents and they filled out a questionnaire to determine the sociodemographic factors, medical history, and personal habits of children.

A complete physical examination was performed. The height and weight percentiles were determined by using NCHS (National Centre for Health Statistics) data.[6]

Venous blood samples were taken for hemoglobin, hematocrite, and blood lead level determination. Hemoglobin and hematocrite was determined by coulter counter. Anemia was defined as a hemoglobin level below 11 g/dl.[7] Venous blood collected to metal free Beckton-Dickonson Vacutainers with EDTA was analysed by Perkin-Elmer SIMAA 6000 atomic absorption spectrophotometer equipped with a graphite furnace and Zeeman background correction (Perkin-Elmer, Norwalk, CT, USA) for lead level determination.[8]

Visual screening was performed using a Snellen hand-chart in a well-illuminated room at a distance of 35–40 cm.[9] All children with a problem were referred to an ophthalmologist (EÖ) for further evaluation.

Hearning screening of children was conducted in Industrial Acoustics Company (IAC) sound-treated rooms by an audiologist (MEKK). Pure tone hearing sensitivity of 15 dB HL for frequencies 500, 1000, 2000, and 4000 Hz was screened,[10] using Interacoustics Audiometer AC30 and AC5 with Telephonics TDH 39P ear phones. If any of the pure tone stimuli was not heard by one of the ears, hearing loss was considered in that ear.[10]

Psychometric evaluation was made by a psychologist (ŞS). WISC-R (Wechsler Intelligence Scale for Children—Revised, adopted for Turkish Children) was used for evaluation. Performance, verbal, and full-scale scores were determined. Children were also grouped as average (full-scale score between 90 and 110), below average (full-scale score below 90), and above average (full-scale score above 110)[11] according to their WISC-R full-scale score.

Children's behavior was evaluated by a parent-completed Child Behavior Checklist (CBCL).[12] The *T*-score values for only total competence (consisting of activity, social and school achievement subscale scores), internalization (consisting of anxious and withdrawn subscale scores), externalization (consisting of delinquent behavior and aggressive behavior subscale scores), and total problem scores were used for analysis in order to limit the number of variables.

Statistical analysis was performed by SPSS version 10.0 (SPSS Inc. Chicago, IL). All data was analysed by univariate analysis using Student's *t*-test and the chi-squared test where appropriate. Multivariate analysis was made by step-wise logistic regression, considering the good achievers as the control group.

Results

In this case-control study, 111 (92.5 per cent) students from high socioeconomic level and 66 (55 per cent) students from low socioeconomic level ($p < 0.05$), admitted to Hacettepe University Ihsan Doğramacı Children's Hospital, participated in the study. Among the high socioeconomic level 72 children were good achievers (64.9 per cent) and 39 (35.1 per cent) were bad achievers. In the low socioeconomic level group, 32 (48.5 per cent) were good achievers and 34 (51.5 per cent) were bad achievers ($p > 0.05$).

The questionnaire and CBCL was filled out by 177 families and all children went through a complete physical examination, visual screening, and hemoglobin and hematocrite determination on admission. Audiological examination was performed on 167 students. Psychometric evaluation was performed on 107, and blood lead level was determined for 113 children. The socioeconomic characteristics and school achievement were similar for the children who completed all the tests or not ($p > 0.05$).

The comparison of the sociodemographic characteristics and medical history of good and poor achievers are displayed in Tables 1 and 2.

The reported, duration of home work study time was longer, and play and television viewing time was shorter in good achievers compared with poor achievers (2.1 ± 0.9 h/day vs. 1.4 ± 0.8 h/day, $p < 0.0001$; 2.1 ± 1.1 h/day vs. 2.7 ± 1.3 h/day, $p = 0.001$;

TABLE 1
Sociodemographic characteristics of children according to school performance

	Good achiever (n = 104)	Poor achiever (n = 73)	p
Mother's age (years)	32.6 ± 4.8	31.9 ± 5.5	0.42
Father's age (years)	37.5 ± 5.3	36.9 ± 9.9	0.63
Maternal education (years)	9.3 ± 4.0	5.2 ± 2.8	<0.0001
Paternal education (years)	10.5 ± 3.4	6.7 ± 3.0	<0.0001
Maternal occupation			0.001
Housewife	71 (68.3)	66 (90.4)	
Official	14 (13.5)	1 (1.4)	
Laborer	6 (5.8)	5 (6.8)	
Profession with career	13 (12.5)	1 (1.4)	
Paternal occupation			0.022
Official	24 (23.1)	11 (15.1)	
Laborer	20 (19.2)	27 (40.0)	
Tradesman	35 (33.6)	29 (39.7)	
Profession with career	22 (21.2)	5 (6.8)	
Unemployed	3 (2.9)	1 (1.4)	
Mother/father being married	96 (92.3)	68 (93.1)	0.63
Consanguinity	23 (22.1)	26 (35.6)	0.079
Alcohol use of parents	26 (25)	13 (17.8)	0.63
Cigarette smoking of parents	69 (66.3)	53 (72.6)	0.24
Mode of heating			0.021
Stove	51 (49)	49 (67.1)	
Central heating	53 (51)	24 (32.9)	
Room no. of house	2.7 ± 0.8	2.4 ± 0.7	0.005
No. of people living in house	4.3 ± 1.2	4.8 ± 1.2	0.01
No. of siblings	1.1 ± 0.9	1.6 ± 1.1	0.003
Having a private room	31 (29.8)	11 (15.1)	0.031

Percentages given in parentheses.

and 2.0 ± 1.1 h/day vs. 2.4 ± 1.4 h/day, p = 0.034, respectively). The percentage of children who attended kindergarten was also higher among good achievers (65/104 vs. 22/73, p = 0.003).

Both groups had similar physical examination findings except for anthropometric measurements. The poor achievers had smaller mean head circumference (51.4 ± 1.5 cm vs. 52.2 ± 1.3 cm, p < 0.0001) and were shorter (122.5 ± 5.7 cm vs. 124.6 ± 5.3 cm, p = 0.013). Also the percentage of children with height (15.3 per cent vs. 3.8 per cent, p = 0.005) or weight percentile (12.5 per cent vs. 2.9 per cent, p = 0.035) below 10 were higher among poor achievers.

The mean hemoglobin and hematocrite were similar in both groups (p > 0.05) and anemia was detected in three (2.7 per cent) and two children (2.7 per cent), respectively in the good and poor achievement groups. The mean blood lead level of the children were low (3.9 ± 2 μ/dl), and blood lead levels were similar in both performance groups (p > 0.05).

Although the percentage of children with hearing loss was similar in both achievement groups (p > 0.05), only in the poor achievement group were there children with uncorrected refractive error (five myopia, nine hypermetropia, one retinitis pigmentosa) (p < 0.0001).

The full scale scores of the WISC-R test were significantly lower in poor achievement students (85.5 ± 21.1 vs. 113.4 ± 15.9, p < 0.0001). The CBCL T-scores are displayed in Table 3.

Multivariate analysis

All factors that differed significantly among the groups were analysed by stepwise logistic regression. The duration of maternal education (for each year), duration of study at home (for each hour), and the IQ (full scale score of WISC-R) (for each one unit) of the child (Table 4) were found to be the independent factors affecting school achievement. The sensitivity of this model was found to be 89.2 per cent and specificity 78.6 per cent).

We further continued to analyse our data for the independent factors that may be related to the WISC-R full-scale score of the child. The children were classified into three groups according to their full scale WISC-R score: average (n = 39), below average (n = 25), and above average (n = 43). The average group was considered as the control group and comparisons were made with the other two groups separately. Multinomial logistic regression was used for analysis. The factors included in the analysis were determined either from the earlier

TABLE 2
Past medical and family history of children according to school performance

	Good achiever (n = 104)	Poor achiever (n = 73)	p
Prenatal history			0.65
Normal	912 (87.5)	58 (79.4)	
Preterm labor	3 (2.9)	2 (2.7)	
Preterm delivery	3 (2.9)	4 (5.5)	
Hyperemesis gravidarum	3 (2.9)	3 (4.1)	
Other	4 (3.8)	6 (8.2)	
Mode of delivery			0.57
NSV	82 (78.8)	61 (83.6)	
C/S	18 (17.3)	11 (15.1)	
Other	4 (3.8)	1 (1.4)	
Birthweight (g)	3276.4 ± 556.9	3154.3 ± 715.6	0.22
No. with birthweight <2500 g	12 (11.5)	14 (19.2)	0.13
Postnatal problem			0.083
None	84 (80.8)	61 (83.5)	
Anoxia	2 (1.9)	6 (8.2)	
Hyperbilirubinemia	12 (11.5)	4 (5.5)	
Meconium	4 (3.8)	0	
Other	2 (1.9)	2 (2.7)	
Duration of breatfeeding (mother)	10.7 ± 7.2	13.8 ± 11.1	0.024
Age of talking (months)	15.1 ± 4.6	20.1 ± 12.4	<0.0001
Age of walking (months)	12.3 ± 3.1	14.7 ± 6.1	0.001
Past disease			0.63
None	84 (80.8)	59 (80.8)	
Freq. of lower RTI	2 (1.9)	3 (4.1)	
Freq. of upper RTI	3 (2.9)	2 (2.7)	
Urinary tract infection	2 (1.9)	1 (1.4)	
Febrile convulsion	2 (1.9)	2 (2.7)	
Epilepsy	1 (0.96)	2 (2.7)	
Other	10 (9.6)	4 (5.5)	
Past operation			0.95
None	94 (90.4)	65 (89.0)	
Inguinal hernia	4 (4.8)	2 (2.7)	
Tonsillectomy	3 (2.9)	2 (2.7)	
Other	3 (2.9)	4 (5.5)	
Past accident	3 (2.9)	5 (6.8)	0.27
Chronic medication	3 (2.9)	2 (2.7)	0.42
Sibling deaths	9 (8.6)	14 (19.2)	0.043
Maternal disease	15 (14.4)	10 (13.7)	0.86
Paternal disease	13 (12.5)	13 (17.8)	0.23

Percentages given in parentheses.
RTI, respiratory tract infection.

studies or were chosen among factors that were found to be related to school achievement in our study. Included in the multinomial analysis were: socioeconomic status (low, high); vision (normal or corrected, uncorrected); hearing loss (no, yes); mode of heating (central, stove); private room (yes, no); smoking (either parent, both parents, none); duration of breastfeeding (<3 months, 3–8 months, >8 months); height-for-age percentile (<10 p, ≥10 p); maternal education (<8 years, ≥8 years); paternal education (<8 years, ≥8 years); duration of watching television (<2 h, ≥2 h); birthweight (<2500 g, ≥2500 g); and blood lead level (≤4 μg/dl, >4 μg/dl). The results of the association are given in Table 5. The goodness-of-fit chi-square of the model was 120.79, p = 0.99 (LR = 103.18, df = 30, p > 0.05). Having a hearing loss, uncorrected vision loss, heating house with stove, smoking of both parents, and low paternal education, were significantly related to the risk of having a below average WISC-R score. On the other hand, smoking of either parent, height-for-age percentile below 10, and low maternal education were related to a decreased chance of having an above average WISC-R score.

TABLE 3
Child Behavior Checklist (CBCL) scores of children according to school performance

	Good achiever (n = 104)	Poor achiever (n = 73)	p
Total competence	17.3 ± 8.8	12.0 ± 3.1	<0.0001
Internalization	9.9 ± 7.1	15.9 ± 10.6	<0.0001
Externalization	8.8 ± 6.5	14.8 ± 9.9	<0.0001
Total problem	29.7 ± 17.8	50.0 ± 27.7	<0.0001

TABLE 4
Association between maternal education, duration of study, full scale WISC-R score and school achievement

	OR	95% Cl	p	Power
Duration of study	2.69	1.19–6.05	0.016	0.99
Maternal education	1.47	1.14–1.87	0.002	0.92
Full scale score (WISC-R)	1.08	1.03–1.13	0.002	0.97

Discussion

Several studies have been conducted on school achievement. Most of them examined the effect of single, high-risk factors, either disease, nutrition, toxicants or sociodemographic characteristics on school achievement.[13–19] Studies taking into account a variety of several factors at the same time are limited.[3,19] The number of studies correlating achievement with both WISC-R scores and several physical and demographic factors are also scarce. This study combined them all. One of the constraints of this study is its cross-sectional design, which limits us from drawing cause–effect relationships (hour of study at home, watching TV). Also some data (breastfeeding, age of walking/talking, prenatal and natal history, etc) depends just on history, which may lead to memory bias. Also, due to the limited number of cases, parametric variables were converted to non-parametric variables to decrease the number of variables for multivariate analysis. However, the power analysis show that the findings of our study are reliable. WISC-R and blood lead levels could not be determined for all subjects but there was no difference between the determined and not determined cases for socioeconomic status and school achievement.

Another controversial point of the study may be the criteria for achievement. In Turkey there is no national achievement test for primary schoolchildren, therefore the teacher's scoring for achievement was accepted.

This study had two parts. In the first part, the factors related to school achievement were determined. In the second part, the factors related to full scale WISC-R score, which was one of the independent factors related to school achievement, were analysed.

Of the factors that differed significantly among the achievement groups only three, i.e., full scale WISC-R score, duration of maternal education, and the duration of study at home, were found to be independently related to school achievement in the multivariate analysis.

In a study[3] conducted in the USA using the National Health Survey data on 9996 children where WISC-R score was not considered and data was obtained by interview, poverty, male gender, low maternal education, less than two parents at home, black race, household cigarette exposure, low birthweight, hearing loss, recurrent ear infections, speech defects, and enuresis were found to be the factors related to grade retention. In our study, poverty was not considered separately. Due to our study design the impact of socioeconomic status on achievement could not be assessed.

The limited number of single-parent families, low birthweight, and anemia cases in our study, may have prevented us from detecting a relation between these factors and school achievement, as reported in other studies.[3,20–23]

In most of the studies about development or cognitive function of children, parental education is considered and maternal education seems to be more important.[3,19,24] In our study we found maternal education but not paternal education to be an independent factor directly affecting school achievement. However, low paternal education (less than 8 years) was related to an increased risk of having a below average IQ. On the other hand, the chance of having an above average IQ was lower among children with low maternal education (less than 8 years). In a recent study conducted in Peru about cognitive function, stunting, and diarrhea,[25] paternal education was found to be an independent factor affecting the IQ of children.

In our study many factors, such as hearing loss,[3] malnutrition,[26,27] uncorrected visual problems,[28] and parental cigarette smoking,[3,29,30] which was reported to be related to school underachievement in earlier reports, were not found to be independently related to achievement but instead were found to be related to WISC-R scores. In turn, IQ has already been demonstrated both in this and in other studies[31] to be an important factor affecting achievement.

In this study, stove heating was found to be an independent factor that was related to an increased risk of having a below average IQ. In the literature we could not find any study related to child development according to the mode of heating of house. The result may be related to indoor air pollution or other confounding variables, such as poverty or factors not addressed in this study.

It has already been demonstrated that lead levels

TABLE 5
The correlates of several factors in below average and above average WISC-R full scale score children compared with average WISC-R total scale score children

	OR	95% Cl	*p*	Power
(a) Below average children				
Socioeconomic status				0.97
High	11.4	0.68–190.0	0.090	
Low	–	–		
Maternal education				0.98
<8 years	6.98	0.17–284.11	0.30	
≥8 years	–			
Paternal education				0.99
<8 years	56.55	2.46–1300.11	0.012	
≥8 years	–	–		
Private room				0.97
No	4.13	0.19–87.97	0.36	
Yes	–	–		
Mode of heating				0.98
Stove	41.89	1.40–1251.05	0.031	
Central	–	–		
Cigarette smoking				
Either parent	8.56	0.53–136.98	0.129	0.97
Both parents	166.53	2.61–1063.94	0.016	0.96
None	–	–		
Birthweight				0.98
<2500 g	7.65	0.51–115.94	0.14	
≥2500 g	–	–		
Breastfeeding duration				
<3 months	0.67	0.002–16.94	0.81	0.91
3–8 months	0.98	0.14–6.73	0.99	0.90
>8 months	–	–		
Height-for-age percentile				0.98
<10 p	17.14	0.71–413.67	0.080	
≥10 p	–	–		
Visual problem				0.98
Uncorrected	2857.14	$4–10^4$	0.008	
None or corrected	–	–		
Hearing loss				0.99
Yes	27.28	2.21–335.82	0.01	
No	–	–		
Blood lead level (μg/dl)				0.98
>4	8.33	0.87–833.3	0.066	
≤4	–	–		
Watching television				0.95
≥2 h	9.11	0.84–1111.1	0.069	
<2 h	–	–		
(b) Above average children				
Socioeconomic status				0.30
High	0.40	0.0077–2.04	0.4	
Low	–	–		
Maternal education				0.76
<8 years	0.0083	0.0015–0.46	0.004	
≥8 years	–	–		
Paternal education				0.54
<8 years	1.34	0.31–5.83	0.7	
≥8 years	–	–		
Private room				0.82
No	3.22	0.58–17.69	0.2	
Yes	–	–		
Mode of heating				0.55
Stove	0.87	0.19–3.84	0.85	
Central	–	–		

TABLE 5
continued

	OR	95% CI	*p*	Power
Cigarette smoking				
Either parent	0.11	0.0022–0.62	0.012	0.81
Both parents	1.96	0.24–15.83	0.52	0.62
None	–	–		
Birthweight				0.61
<2500 g	0.21	0.0012–3.66	0.28	
≥2500 g	–	–		
Breastfeeding duration				
<3 months	1.65	0.19–13.85	0.64	0.65
3–8 months	1.67	0.37–7.66	0.50	0.67
>8 months	–	–		
Height-for-age percentile				0.68
<10 p	0.0068	0.00052–0.87	0.039	
≥10 p	–			
Visual problem				0.87
Uncorrected	4.17	0.12–1408.45	0.42	
None or corrected	–	–		
Hearing loss				0.81
Yes	2.73	0.73–10.24	0.14	
No	–	–		
Blood lead level (μg/dl)				0.53
>4	0.59	0.13–2.63	0.49	
≤4	–	–		
Watching television				0.73
≥2 h	0.42	0.106–1.67	0.21	
<2 h	–	–		

above 10 μg/dl cause decreased IQ as well as behavioral problems.[17,32] Recent studies have brought the level of lead with deleterious effect even lower.[33] In our study population, the mean blood lead level was found to be around 4 μg/dl. At this low level no relation with school achievement could be demonstrated. However, it was shown that the risk of having a below average IQ increased with blood lead levels above 4 μg/dl, although the relation was not statistically significant ($p = 0.066$).

We have also compared the parent-reported Child Behavior Checklist (CBCL) scores of the two achievement groups. We could not find any study comparing the behavioral outcome of children using CBCL according to school achievement. Scores for all scales were available but since the number of cases in our study population was limited we only used four scores for comparison. We have shown that the total competence scores of poor achievers were lower than in the good achievers, and they also had higher scores for internalization, externalization, and total problem scores. In multivariate analysis these scores were not found to be independently related to school achievement, suggesting that these may be either related to IQ or parental education.

In conclusion this study supports policies for increasing male and female education (at least 8 years), growth monitoring, appropriate feeding (breastfeeding and weaning), and well-baby and child follow-up. Furthermore, screening and clean environment (indoor and outdoor) will not only promote the physical health of children but will also promote the cognitive development of new generations.

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