Original Article

Prevalence of Mathematic Disability in Primary Schools

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Background: One of the issues that have consistently been the concern for the health affair specialists and cure and massive social governors in health fields is the rate of disorders prevalence, diseases and the related subjects to epidemiology. Purpose of this study was to estimate the prevalence of mathematic disability amongst primary schools of Karaj.

Method: totally 432 students were selected with multi-stage sampling method. Participants completed Raven test, Frostig Visual-Perception test and Wepman Auditory discrimination test, Rutter behavioral questionnaire and Iran Key-math test. In order to diagnosis mathematic disability, inter criterion was normal quotient intelligence and out criteria were to have one of visual perception, auditory and behavioral problems. The participants whose total standard scores in Iran Key-math test were one standard deviation below the mean were selected as a mathematical disability (MD).

Findings: the mathematic disability prevalence in primary students was estimated 0.46%. In addition, proportion of mathematic disability prevalence was not function of gender or grade.

Conclusion: the findings demonstrated that the prevalence of mathematic disability is much less than the previous researches. A possible explanation was that inappropriate screening co morbid disorders with the mathematic disability. The theoretical implications of findings are discussed in detail.

. **Key words:** mathematics; learning disorder, prevalence

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Introduction

One of the issues that have consistently been the concern for the health affair specialists and cure and massive social governors in health fields is the rate of disorders prevalence, diseases and the related subjects to epidemiology. Awareness of the rate of prevalence provides possibility for budget incorporation, systematic intervention or prevention for educational and health governors (1).

Since 1950, instructors, psychologists and medical practitioners have paid more attention to a specific group of children and their education. That group of learners who have not any specific mental and physical disease but have specific learning disabilities that it is impossible to treat with common methods. There has been different terminology used for children's disabilities in psychological and educational scientific books. Terms like "brain Lesion", "minimal brain lesion" and "neural injury" have been used in different studies. This group of children shows some difficulties in educational tasks such as: listening, thinking, speaking, writing, spelling and counting (2).

Learning disability can be attributed to the factors such as intelligence quotient, medical history, age and family history. Most of children with learning disabilities are divided in two main categories: dyslexia and nonverbal learning disability (LD) categories (3).

Some of the children with learning disabilities have no problem with learning language and reading but they have deficit in mathematics and learning quantities. Calculation and mathematic logic, that both prevent promotion in school and life, are two problems for students with mathematic disability in revised law education of members with disability (4). There is consensus among researchers with regard to learning problems and remembering arithmetic facts of children with dyscalculia. Problem in calculation procedures, high error rates, long time for problem solving and immature problem solving strategies are other probabilities (5).

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In a longitudinal study, Desoete and Gregoire found that children with learning disabilities have had these problems with themselves since lower ages, as if arithmetic problems in kindergartens are associated with delay in arithmetic in 1st grade (6). The children with dyscalculia have deficit in symbolic and non symbolic learning processing. These cognitive deficits are in all of learning disability subgroups (7). Neverthless, Willburger et al. demonstrated that cognitive bases of subgroups learning disabilities are independent from each other and they stated that the children with dyscalculia have deficits in speed learning and quantity (8). They assumed dyscalculia and deficit in numerical processing is associated with neurobiological deficit (8). Andersson reported that weakness of children with math disorder is related to visual-spatial working memory and these children don't have achievement as other peers (9).

Some of studies have reported that dyscalculia is related to genetic factors and other factors such as gender, socioeconomic status and education interventions have no effect on dyscalculia (10). Although poor teaching, environmental deprivation and low intelligence cause disability, some recent findings have indicated that learning disabilities are caused by brain-based disorders with familial-genetic background. Moreover neurologic substrates of dyscalculia include both hemispheres, specially the left parietotemporal regions (11). The functional MRI in 8- to 10-year-old children with dyscalculia shows weaker neural activities compared with normal control group during their spatial working memory task in the right intraparietal sulcus (12).

According to the report of NACHC, the prevalence of learning disability is from 1% to 3% of school age children but the estimation of LDs prevalence is different, the rate has been reported from 1% to 30% in different researches (4). In Western researches, the life time prevalence of LD in American children was reported 9.7% that this prevalence rate increased with increasing age (13). Also, MD prevalence was reported about 6% (14-15). Recently, Shalve and Gross-Tsur reported MD prevalence about 5-6% in the school population (11). In Iran, different researches have reported the rate of LD prevalence from 8.9% to 12.5% .For example, Behrangi, Hosseinian and Sharifi reported 8.9% learning disability prevalence (16), and Erfani reported 12.5%. Mathematic disability prevalence was reported from 1.63% to 9.4% in Iran (17). For instance: Behrangi et al., Erfani and Ramezani have reported mathematic disability prevalence 5.2%, 9.4% and 1.63%, respectively (16-18).

The reports of clinical services centers and schools have reveal that the number of boys with learning disability is four times more than the number of girls, but recent epidemiological longitudinal studies have demonstrated that the number of girls with LD might be equal with number of boys (4). The demographic information of epidemiological studies demonstrates that the boys have this disability more than the girls (19). Sex has a role as a moderate or variable contradicts in MD prevalence. In some researches, MD ratio in girls was reported more than boys. In these researches the ratio of MD in girls compared to boys was reported from 1.1:1 to 1.6:1.For example, Erfani reported the mathematic disability in boys 9% and in girls 9.8% and Ramezani reported 2.01% in girls and 1.24% in boys (17-18). In a meta-analysis study learning disability prevalence was reported 4.56% in girls and 6% in boys (1).

These contradictions were observed in western studies as well. While in some studies there is no difference between two sexes (20-22), in a study the rate of boys' superiority in MD was from 1.6% to 2.2% (23). Therefore, sex moderator role was indicated in most researches, but there is discrepancy in superiority (MD) prevalence in boys compared with girls.

In the researches that have been done in Iran, more attention has been paid to spoken and written language difficulties. One of the most serious deficits of former researches is that they do no have precise screening about co morbidity disorders with learning difficulties. For instance, in Erfani, Behrangi and Ramezanis' researches, co morbidity disorders were not screened and visual, auditory and behavioral problems were not considered, and math disorder were labeled by a standard or nonstandard math test .However, still there is a risk that some students have been classified in category of LD wrongly just because of visual, auditory or behavioral problems.

The main objective of this research is estimating MD prevalence in conditions that auditory and visual deficits, mental retardation, behavioral problems have been screened from MD. Therefore, considering the significance of learning and its role in human's life, it seems that the research on learning disability prevalence rate especially MD has specific significance. Additionally, having precise statistic gives assistance to prevention and solving students learning problems.

Method

Participants

In this study, 432 students (216 girls, 216 boys) were recruited by multi-stage sampling method. Karaj city have four educational regions. In the first stage, four schools were recruited from every four regions of Karaj city randomly, i.e. two male schools and two female schools were recruited (totally 16 schools). In the second stage, in every school, nine students were recruited from third, fourth and fifth grades.

Tools

In this study five instruments were used that consists of:

Raven Test: Raven test was made by Penrose and Raven in order to measure intelligence (24). The test has two forms that the children form was used to measure intelligence. The form has 36 pictures and administered time is about 30 minutes.

Reliability and Validity

Raven test was validated for Tehran's children by Barahani . Test-retest reliability coefficient range was from 0.69 to 0.91 (25). In present study test-retest coefficient was estimated 0.58 after one month.

Development Test of Visual Perception (DTVP): This test was provided by Frostig, Lefever and Whittlesey (26). It consists of five subtests: eye-motor coordination, figure-ground, shape constancy, position in space and spatial relations. The test was administered in group form and also the scoring procedure was accordance with guideline of test. Total score was obtained from sum of the subtests scores, and then the perceptual quotient was calculated. The maximum score in the eye-motor coordination, figure-ground, shape constancy, position in space and spatial relations is 30, 20, 17, 8 and 8, respectively. The maximum of total score is 83.

Reliability and Validity: the reliability of this test in each subtest was reported from 0.42 to 0.80. The reliability of this test was reported via test-retest and Cronbach's Alpha coefficient 0.79 and 0.81 respectively (27). In this study the coefficient test-retest was calculated in eye-motor coordination, figure-ground, shape constancy, position in space and spatial relations after one month 0.23, 0.73, 0.75, 0.53, 0.33, respectively.

The scoring reliability: The test was scored by two judges independently. Agreement coefficient of scoring was calculated in total 0.93 and for eye-motor coordination, figure-ground, shape constancy, position in space and spatial relations was 0.83, 0.9, 0.91,1 and 0.93, respectively.

Wepman Auditory Discrimination Test (ADT): This test was designed by Wepman and validated for Iranian children by Seifnaraghi and Naderi (2, 28). This test measures the auditory discrimination that is child's ability in distinguishing the existent differences between contrasting or similar syllables. The Wepman test consists of 30 pairs of contrasting words and 10 pairs of similar words. Two scores were calculated on basis of distinguishing contrasting and similar words.

Reliability and Validity

Taylor has reported the test-retest coefficient from 0.91 to 0.95 and validity of this test was reported 0.79 (25, 29).

Rutter Behavioral Evaluation Test (Teacher Form): This test was designed by Rutter for 7-13-year-old children and has two forms of A and B, that the form A and B is completed by parents and teachers, respectively (30). In this study, form B was used. The form has 30 items, 24 items out of 30 items came from Rutter's questionnaire and 6 items were added by Mahriyar (31). Yousefi has validated it in Iran. Teachers have graded items on one likert spectrum (0 = it does not apply at all, 2 = it completely applies). There are (0), (1) and (2) numbers in front of each item in this questionnaire and teachers were asked to read each item and recognize how much of them apply for the selected students. Therefore one total score was found from some of scores which is given to each question.

Reliability and Validity

The reliability of this test has been reported via split-half method 0.89. Agreement percent between questionnaire and psychiatry diagnosis have been reported 76.7%. Test-retest reliability has been reported 0.91 (32). In this study, Cronbach's Alpha coefficient was estimated 0.91, and after a month test-retest, coefficient was estimated 0.78.

Iran Key-math Test: This test is consists of three parts: Basic concepts, operation and application and all have the same educational importance. These parts are totally divided by 13 subtests. The person function is divided by three areas in this test that consists of: 1) the basic concept area which consists is of counting, rational number, geometry. 2) The

operation area which includes addition, subtraction, multiplication, division and mental calculation. 3) The application area which consists of items to measure time and money, estimation, data analysis and problem solving.

Reliability and Validity

This test norm has been done for students from 6.6 to 11.8-year-old in Iran. The correlation coefficient in this test norm was calculated by teacher-made test in primary school with 0.57, 0.62, 0.67, 0.56 and 0.55 measures. The reliability of the test was estimated via Cronbach's Alpha method and its measure was reported from 0.80 to 0.84 in five grades (33). In this research test-retest coefficient in an interval of one month was estimated on each three dimensions 0.84, 0.71, and 0.98, respectively and for the total standard score was found to be 0.92.

Results

Screening Stages

Screening was made in several stages in order to segregate of the probable co morbid problems with MD and these stages include:

Intelligence: the Raven test was administered and the students who were selected for next step that had higher or natural range in intelligence(x>85). 57 students of total 432 participants who had lower intelligence quotient of 85 were refused (432 – 57= 375).

Visuo-motor Problems: the visuo-motor perception test was used. As a result of administering this test, 58 children were distinguished as having visual problem (375 – 58 = 317).

Auditory Problems: Wepman diagnostic auditory test was administered in order to assure students hearing problems. 28 children were recognized with hearing problems. 9 children out of these had both hearing and auditory problems.

Behavioral Problems: Rutter behavioral assessment form was simultaneously completed by the teacher of every child and students who had behavioral problems were discriminated from others. 45 children had behavioral problems among 375 children. 13 children out of these, had visuo problem. 2 participants had auditory problem that were recognized in the previous stages and also there was 2 participants had all behavioral, visuo and auditory problems. Finally, only students who had not behavioral, visuo and auditory problems and had not lower IQ were selected for next stage (n = 281).

Mathematic Disability: in the last stage, Iranian key-math achievement test was administered and children, whose total standard scores were a standard deviation below the mean in Iran key-math test, were recognized as students with mathematic disability.

Table 1 shows how many students were omitted in different stages of screening. For instance, when Raven test was administered, 57 students (13%) with lower IQ than 85 were omitted from the next stage. After to administer the of Frostig visuo-motor test, 58 persons or (about 15%) had visuo-motor problem in second stage. In third stage, Wepman auditory test were administered that 28 persons or (about 7%) had auditory problem. In last stage, Rutter behavioral assessment form was administered. The results showed that 45 persons (12%) had behavioral problem.

After screening stage, the students who scores were lower one standard deviation were counted in mathematic Iran key-math test. Next, prevalence of math disability was calculated (2 / 432 = .0046 * 100 = 0.46%). Mathematic disability prevalence with 95% probability was estimated from 0.13 to 0.78 ranges (SE = 0.003).

Table 1. Frequency-percent distribution with problems and without problems children

	With problem		Without problem	
	F	P	F	P
57	IQ	13.19	375	86.60
58	Visual	15.46	317	84.50
28	Auditory	07.46	347	92.53
45	Behavioral	12.00	330	88.00

*Percentages in visual and auditory perceptions and behavioral disorder have been computed after omitting children with IQ lower than 85

Also in this study, moderator roles of gender and educational grade were examined (table.2).

Table2. MD Prevalence by sex and grade

		n	Prevalence F	Prevalence P	CI %95
Sex	Boy	216	2.00	0.92	0-0.02
	Girl	216	0.00	0.00	-
Grade	3rd	144	0.00	0.00	-
	4th	144	0.00	0.00	-
	5th	144	2.00	1.39	0-0.03

MD prevalence was estimated for boys (0.92%) and girls (0.00%). MD prevalence in boys was estimated from 0 to 0.02 ranges with 95% of confidence interval that included the prevalence of MD in girls. Thus, findings demonstrated that MD prevalence did not differ significantly by sex.

Also, moderator role of educational grade was examined. MD prevalence was 1.38% in 5th grade. The rate of prevalence with a 95% of confidence interval was estimated from 0 to 0.03 (table 2). Thus, MD prevalence did not differ significantly by grade.

The rate of mathematic disability prevalence was examined by gender and grade (table 3).

Table3. MD Prevalence by sex grade

Grade	Sex	n	Prevalence F	Prevalence P	CI %95
3rd	Girl	72	0	0	-
	Boy	72	0	0	-
4th	Girl	72	0	0	-
	Boy	72	0	0	-
5th	Girl	72	0	0	-
	Boy	72	2	2.7	0 – 6.5

Findings indicated that the rate of prevalence in boys of 5th grade was 2.7%. The minimum and maximum of mathematic disability prevalence with 95% confidence interval was from 0% to 6.5%. The rate of mathematic disability prevalence had no significance statistically by grade * sex (table3).

The Co-morbid Problems: in this study the co morbid problems prevalence was estimated as well (table 4). Findings showed that 2.4% of students simultaneously had auditory and visual problems. A 95 confidence interval showed that the co morbid prevalence of them was between 0.8 - 3.9 percent. The prevalence of the co morbid problems of visual and behavioral, auditory and behavioral, and auditory, visual and behavioral was 3.5, 0.5 and 0.5, respectively. Confidence intervals were reported for them (table 4).

Table 4. Comorbidity of visual, auditory and behavioral problems (n=375)

	Abnormal cases F	Abnormal cases P	*CI* %95
Auditory and Visual	9	2.4	0.80-3.90
Visual and Behavioral	13	3.5	1.60-5.30
Auditory and behavioral	2	0.5	0.00 -1.26
Auditory, visual and behavioral	2	0.5	0.00-1.26

In table 5 visuo-motor perception, hearing, behavioral and IQ problems were estimated. For example, there were 144 participants in Raven test and 3rd grade that 22 participants had lower IQ than 85 (22/144 = 15.3). In the other word, 15.3 percent of 3rd grade students had IQ lower than 85. In this grade, mild mental retardation proportion was for male and female, 18 and 12 percent, respectively. The intelligence problems intensified between boys and girls in 4th and 5th grades. The proportion of girl's intelligence problems to boys in 4th grade was 2.3:1 and in 5th grade was 4:1. Findings demonstrated that boy's intelligence problems decreased with more intensity as educational grade increased but this trend was too much slower in girls.

Table 5. Prevalence of IQ, Visuo- motor, Auditory and Behavioral problems and confidence interval by gender and grade

		Girl			Boy			Total		
		F	P	CI 95%	F	P	CI 95%	F	P	CI 95%
Raven	3rd	13	18	0.09 – 0.27	9	12.5	0.05 – 0.20	22	15.3	0.06 – 0.21
	4th	14	19.4	0.10 – 0.28	6	8.3	0.02 – 0.15	20	13.9	0.08 – 0.19
	5th	12	16.7	0.08 – 0.25	3	4.2	0.00 - 0.09	15	10.5	0.05 – 0.16
	total	39	18	0.13 – 0.23	18	8.3	0.05 – 0.12	57	13.1	0.10 – 0.16
Frostig	3rd	10	13.8	0.06 – 0.22	11	15.2	0.07 – 0.23	21	14.6	0.09 – 0.20
	4th	5	6.9	0.01 – 0.13	15	20.8	0.11 – 0.30	20	13.9	0.08 – 0.19
	5th	8	11.1	0.04 – 0.18	9	12.5	0.05 – 0.20	17	11.8	0.06 – 0.17
	total	23	10.7	0.06 – 0.15	35	16.2	0.11 – 0.21	58	15.4	0.12 – 0.19
Wepman	3rd	17	23.6	0.14 – 0.33	9	12.5	0.05 – 0.20	26	18	0.12 – 0.24
	4th	0	0	-	9	2.7	0.00 – 0.06	2	1.4	0.00 – 0.03
	5th	0	0	-	0	0	-	0	0	-
	total	17	7.8	0.04 – 0.11	11	5	0.02 – 0.08	28	7.4	0.05 – 0.10
Rutter	3rd	7	9.8	0.03 – 0.17	5	6.9	0.01 – 0.13	12	8.4	0.04 – 0.13
	4th	1	1.4	0.00 – 0.04	10	13.9	0.06 – 0.22	11	7.7	0.03 – 0.12
	5th	12	16.6	0.08 – 0.25	10	13.9	0.06 – 0.22	22	15.3	0.09 – 0.21
	total	20	9.3	0.05 – 0.13	25	11.6	0.07 – 0.16	45	12	0.09 – 0.15

In addition, findings showed that about 14% of students in 4th grade had visuo-motor problems which were 21% in boys and 7% in girls. Although the increase of grade was consistent with the decrease of visuo-motor problems, visuo-motor problems increase for boys in 4th grade and decreases in girls in the same grade. Also 3rd grade was the most major grade that hearing problem was

detected on. These problems were observed mostly in girls compared with boys.

In addition, findings showed that behavioral problems were fixed or increased as educational grade increased. The behavioral problems prevalence was about 7% for boys in 3rd grade. In 4th grade, the behavioral problems prevalence increased to (14 %) for boys. The behavioral problems prevalence had a curve trend in girls. It was equal with boys in 3rd grade. A dramatic drop of 4th grade was observed in these problems but in 5th grade it reached to 17% approximately (see table 5).

Discussion

The main findings of this study are as follows: the prevalence of probable MD is 0.46%. This prevalence rate is much less than previously reported researches results (17-18). Also, Badian and Ghublikian, Norman and Zigmond have reported about 6% of primary students have different kinds of learning disabilities (14-15). There are different explanations for this difference. First, other researchers have reported the rate of MD prevalence without considering the above mentioned problems in children and only with administering intelligence and standard mathematic tests. It seems in these studies co morbid disorders such as behavioral, visual and auditory problems were overlapped with mathematic disorder. Another probably explanation is the usage of different measurement instruments that is all the researchers did not use single instrument to estimate mathematic disorder.

In this study it has been revealed that the mathematic disability prevalence is not function of gender. The findings showed that MD in boys is 0.92% and 0% in girls. There was no significant difference between observed proportions in both sexes. This result is consistent with the result of some researches that have reported MD is not function of sex (20-22), and is not consistent with some researches that have reported MD in boys is more than girls (1, 16, 23, 34). In addition, it is not consistent with some researches that have reported MD in girls is more than boys (17-18).

The other finding of this study is that MD prevalence is not function of educational grade. Findings showed that MD prevalence is 1.38% in 5th grade and 0% in 3rd and 4th grade. There is no significant difference between observed proportion in in 3rd, 4th and 5th grades. These findings are not consistent with Ramezani's finding that has reported that MD prevalence is that function of educational grade.

In this study, the moderator role of gender and educational grade was examined. Findings demonstrated that the rate of MD prevalence in both sexes is 0 in 3rd and 4th grades and also is 0 in girls in 5th grade but it is 2.7% in boys of 5th grade. There is no significant difference between observed proportion by sex*grade. This finding is the unique contribution of this study.

Another finding of this study is that the intelligence problems in boys decreases with more intensity as educational grade increases but this trend has less intensity in girls. Also, it was revealed that visuo - motor problems increases in boys of 4th grade but it decreases in girls. The most major grade that auditory problems were observed on is the 3rd grade. Girls have auditory problem more than boys. In addition, findings showed that as educational grade increases, the behavioral problems increases accordingly or remain fixed. The behavioral problem prevalence is higher in boys of 4th and 5th grades, and girls of 5th grade. The difference of girls' behavioral problems prevalence with boys in 4th grade is quite evident.

The first limitation of the study is co morbidity math disability and reading problem. Thus recognizing students that reading and mathematics disabilities is co morbid them was not possible. For instance, when a student cannot multiply two numbers, does not he/she really know the numbers or does not he/she know what is the function of addition operator? The second limitation of the current study is the role of cultural, social and economic factors of students in mathematic disability that were not examined. The third limitation of this study is the cutoff scores of the tools. The classification errors were not examined in Wepman and Frostig tests. In addition, since this study was only conducted in Karaj city; conceivably, findings may not be generalized to other regions of Iran.

It is suggested that the rate of co morbidity in reading and mathematics disabilities be estimated since the cultural, economic and educational factors might influence specific learning disabilities, it is recommended that the role of economic, cultural and social factors be taken into considered. Based on results of Iran key-math scores of three subscales, it is suggested that each kind of mathematics education for MD focus on mathematic conceptions and applications instead of mathematic operations.

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