Sex Differences in Developmental Reading Disability
New Findings From 4 Epidemiological Studies

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Context An influential article published in 1990 claimed that the increased rate of reading disability in boys was a consequence of referral bias.

Objectives To summarize the history of research on sex differences in reading disability and to provide new evidence from 4 independent epidemiological studies about the nature, extent, and significance of sex differences in reading disability.

Design, Setting, and Participants The Dunedin Multidisciplinary Health and Development Study comprised 989 individuals (52.1% male) in a cohort born between April 1972 and March 1973 in Dunedin, New Zealand, and followed up from age 3 years; reading performance and IQ were assessed at ages 7, 9, and 11 years using the Burt Word Reading Test and the Wechsler Intelligence Scale for Children–Revised (WISC-R), respectively. The Christchurch Health and Development Study comprised 895 individuals (50% male) in a prospectively studied cohort born in the Christchurch, New Zealand, region during a 4-month period in 1977; reading performance and IQ were assessed at ages 8 to 10 years using the Burt Word Reading Test and the WISC-R. The Office for National Statistics (ONS) Study comprised a UK nationally representative sample of 5752 children (50.1% male) aged 9 to 15 years in 1999; reading was assessed on the British Ability Scales II and IQ on the British Picture Vocabulary Scales II. The Environmental Risk Longitudinal Twin Study (E-Risk) comprised 2113 twin children from England and Wales (49.1% male) identified at birth in 1994 and 1995 and included administration of the Test of Word Reading Efficiency at age 7 years and the Wechsler Preschool and Primary Scale of Intelligence–Revised as a test of IQ at age 5 years.

Main Outcome Measure Reading performance by sex in the lowest 15% of the distribution for all 4 studies, with and without taking IQ into account.

Results In all 4 studies, the rates of reading disability were significantly higher in boys. For non–IQ-referenced reading disability: Dunedin study, 21.6% in boys vs 7.9% in girls (odds ratio [OR], 3.19; 95% confidence interval [CI], 2.15-4.17); Christchurch study, 20.6% in boys vs 9.8% in girls (OR, 2.38; 95% CI, 1.62-3.50); ONS study, 17.6% in boys vs 13.0% in girls (OR, 1.43; 95% CI, 1.23-1.65); and E-Risk, 18.0% in boys vs 13.0% in girls (OR, 1.39; 95% CI, 1.04-1.86). The rates for IQ-referenced reading disabilities were similar.

Conclusion Reading disabilities are clearly more frequent in boys than in girls.


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SEX DIFFERENCES IN READING DISABILITY

this disability should constitute a high priority.

The purposes of this article are (1) to summarize briefly the history of research on sex differences in reading disability to identify the source of claims and counterclaims on whether such differences are valid and (2) to provide new empirical evidence from 4 general population–based epidemiological studies with a total of almost 10000 participants about the nature, extent, and significance of sex differences in reading disability.

Thirty years ago, epidemiological studies drew attention to the preponderance of male children with reading disability. Surveys both on the Isle of Wight and in an inner London borough were consistent in showing that reading disability, whether assessed through group or individual tests, was substantially more frequent in boys than in girls. Moreover, the sex difference was evident whether reading disability was considered in terms of IQ-referenced (adjusted) specific reading retardation (in which reading was markedly lower than that predicted on the basis of age and IQ) or non–IQ-referenced general low achievement in reading. Thus, in the inner London sample of 10-year-olds, the rates of specific reading retardation on group tests were 16.9% in boys compared with 7.2% in girls. Using individual testing in those with positive screens on the group reading test, the rates were 4.6% vs 2.0%. The comparable data for Isle of Wight 10-year-olds and girls were 8.6% vs 3.7% on group tests and 5.6% vs 2.9% on individual tests.

When non–IQ-referenced reading disability was defined as performance at least 28 months behind population norms on either reading accuracy or reading comprehension, the male-female difference on group tests was 15.9% vs 7.2% in inner London, with 22.2% vs 15.6% on the basis of individual testing of those who had positive screens. The comparable Isle of Wight data were 8.6% vs 3.7% on group testing and 10.5% vs 6.1% on individual testing. The sample sizes in both cases were large: 1689 for the inner London 10-year-olds and 1142 for the Isle of Wight 10-year-olds.

Some 15 years later, in 1990, Shaywitz et al, reporting on a sample of 414 children aged 7 to 8 years, drew attention to their finding that the sex ratio in their epidemiological study was very much less than that in their sample of children identified on the basis of school records. Among the children in second grade, the rates were 8.7% in boys vs 6.9% in girls, and 1 year later (at a mean age of 8.7 years), the comparison was 9.0% vs 6.0%. Their findings were important in drawing attention to possible biasing effects of sampling on the basis of school records, but their findings have been widely used to infer that the sex difference was artifactual because the difference fell short of statistical significance. The latter conclusion was ill advised because the article made no mention of contrary findings from the earlier epidemiological studies based on much larger samples.

Since 1990, 2 large-scale epidemiological studies have reported findings on the sex ratio for reading disability. Flannery et al used data from the American National Collaborative Perinatal Project, involving some 32223 women and their offspring followed up from pregnancy to children’s age of 7 years. The regression method of Yule et al was used to identify children with an IQ-referenced reading disability (after exclusion of those who were blind or deaf or who had major behavior problems or an IQ ≤80). A male-female ratio of about 2:1 was found in both the white and black subsamples, with the excess of boys being more marked in the case of severe reading disability. The researchers showed that this was not an artifact of taking IQ into account. In addition, they found that the sex difference was not explicable on the basis of inattention or overactivity.

The second large-scale study was undertaken by Katusic et al in Rochester, Minn, and was based on 5718 children born between 1976 and 1982 who remained in the area after age 5 years. Data were available from medical, school, and tutoring sources, including individual psychological test findings as part of the records. Reading disability was defined through 2 formulas, 1 IQ-referenced and 1 non–IQ-referenced (ie, based solely on low achievement). Regardless of the method used, boys were 2 to 3 times more likely to be affected. The methods used were thorough, but the findings are limited by the outmigration of one fifth of the birth cohort before they began school and lack of detail on psychological testing.

As far as we can determine, these are the only unselected total population epidemiological studies in the English-speaking world with a sample size of 600 or greater (selecting this cutoff on the basis of power calculations).

In summary, despite continuing claims that reading disability affects boys and girls equally, the available evidence suggests that this is not the case. The goal of this report is to consider new findings from 4 recent major general population epidemiological studies to determine whether, across a range of different general populations, there is a significant excess of boys with reading disability.

To adequately test the hypothesis of a higher rate of reading disability in boys, it was essential to use representative total population samples that were not reliant on any kind of service referral and that did not involve exclusions on the basis of putative causal factors. That is what the 4 samples in this report provided.

METHODS
Dunedin Multidisciplinary Health and Development Study

This cohort of 1037 children (52.1% male) was formed at the participants’ age of 3 years, when the investigators successfully enrolled 91% of the consecutive births between April 1972 and March 1973 in Dunedin, New Zealand. The participants have been followed up through age 26 years. Cohort families represent the full range of socioeconomic status in the general population of New Zealand’s South Island. The study participants are pri-
arily European in origin, with 7% self-
identified at age 18 years as Maori or
Pacific Islander ethnicity.

Reading performance was individu-
ally assessed at ages 7, 9, and 11 years
using the Burt Word Reading Test,9 a
word recognition reading test that re-
sembles the American Wide Range
Achievement Test of reading. Assess-
ments were made within 2 months of
the children’s birthdays. We com-
bined the age-standardized measures of
reading scores from the 3 age periods
to form an overall score (to obtain a
more valid assessment).10 At ages 7, 9,
and 11 years, each child’s intelligence
was assessed with the Wechsler Intel-
ligence Scale for Children–Revised
(WISC-R).11 We combined the WISC-R
performance IQ scores from the 3 age
periods to form an overall perfor-
man ce IQ score. The reported reliabil-
ties of both the Burt Word Reading Test
and the WISC-R exceeded 0.90.

We used 2 methods to identify read-
ing-disabled children. First, all of the
children with reading scores that placed
them in the lowest 15% of the reading
test distribution were classified as hav-
ing a reading disability. We refer to this
as a non–IQ-referenced reading dis-
ability. The 15% cutoff was used to en-
sure adequate statistical power to test
for sex differences. Second, we mea-
sured reading disability in reference to
performance IQ. This was achieved by
fitting a regression model relating read-
ing scores to the children’s WISC-R per-
formance IQ scores and computing for
each child an expected reading score
conditional on IQ and then classifying
children whose observed reading score
was more than 1 SD below their read-
ing score predicted on the basis of
WISC-R performance IQ score. This
method follows that recommended by
Yule et al9 with the exception that Yule
et al recommended a cutoff criterion of
1.5 SDs below the predicted scores. We
used a 1-SD cutoff to ensure sufficient
base rates for what was needed in sta-
tistical analysis. Sex differences were as-
sessed by comparing the percentage of
boys vs girls with reading disability in
each study. The study had 80% power
(α = .05) to detect an odds ratio (OR)
of 1.6 or greater between sex and read-
ing disability.

Christchurch Health
and Development Study

Participants were part of a longitudinal
study of an unselected birth cohort of
1265 children who were born in the
Christchurch, New Zealand, urban re-

di on during a 4-month period in mid-
1977.12,13 These children were studied
at birth, 4 months, 1 year, and annual
intervals to age 16 years, and again at
ages 18 and 21 years. The sample was
predominantly European, with 15% indi-

tifying themselves as New Zealand
Maori or Pacific Islander ethnicity.

The present analysis is based on a
sample of 895 children (50% male) for
whom data on reading and IQ test
scores were available for ages 8 to 10
years. This sample is substantially
smaller than the original sample size of
1265 for 2 reasons. First, over the pe-
or of the study, there was attrition in
the sample owing to the combined ef-
ects of refusal, outmigration, and death.
The effect of this attrition was to re-
duce the cohort to 1067 participants by
age 10 years, with these children repre-
senting 92% of the cohort who were
still resident in New Zealand at that age.
Second, for administrative reasons, psy-
chometric testing was conducted only
among cohort members who resided
in Canterbury Province, of which
Christchurch is the major urban cen-
ter. The reduction in sample size was
not correlated with sex, nor did it in-
volve good readers in one sex and poor
readers in the other, suggesting that se-
lective factors did not influence the va-

idity of the findings reported here.

Reading performance was individu-
ally assessed at ages 8, 9, and 10 years
using the New Zealand revision of the
Burt Word Reading Test.14 To provide
an overall measure of reading ability,
the reading test scores at each age were
standardized and then averaged over the
3 age periods. At ages 8 and 9 years, par-
ticipants were also assessed using the
WISC-R.13 The WISC-R performance IQ
scores were averaged over the 2 peri-
ods to provide an overall measure of
performance IQ. All assessments were
completed within 2 months of the chil-
dren’s birthdays. The reliability of the
Burt Word Reading Test was in excess of
0.97 at each age. The reliabilities of the
WISC-R performance IQ scores ranged
from 0.87 to 0.90.

Reading disability was assessed in a
way similar to that used in the Dunedin
cohort.10 That is, non–IQ-referenced
reading disability was defined to in-
clude all children whose reading test
scores placed them in the lowest 15% of
the reading test score distribution; IQ-
referenced disability was defined to in-
clude all whose observed reading scores
were more than 1 SD below the score
predicted on the basis of performance IQ.
The study had 80% power (α = .05) to de-
tect an OR of 1.7 or greater between sex
and reading disability.

Office for National Statistics Study

Participants were children involved in
a national survey of child mental health

carried out by the UK Office for Na-
tional Statistics (ONS) in 1999.17 The full
cohort of 10 438 children was formed as
a representative sample of children in
private households between the ages of
5 and 15 years identified via the Child
Benefit Register. Child benefit is a fi-
nancial allowance available to all fami-
lies with children in the United King-
dom; the register should thus provide
a relatively complete basis for sam-
pling the child population. For the pre-

cent analyses, children aged 9 to 15 years
were included, resulting in a sample of
6524 children (50.1% male), of whom
90.6% were white.

The children were given individual
assessments of their single-word read-
ing ability using the British Ability
Scales II16 and their global cognitive
ability/receptive vocabulary using the
British Picture Vocabulary Scales II.17
Both tests are widely used in UK re-
s
c
and clinical practice and show
high reliability (0.89-0.97 and 0.86-
0.95, respectively). Standardized scores
for all measures were used to identify
the groups. Complete IQ and reading
test data were available for 5752 chil-

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The comparable data for IQ-referenced reading disability were 19.9% vs 8.3%, for an OR of 2.76 (95% CI, 1.84-4.16; P<.001).

ONS Study
In the overall sample of 5752, 17.6% of boys and 13.0% of girls fell below the 15% cutoff point for reading disability, with an OR of 1.43 (95% CI, 1.23-1.65; P<.001). Boys were also overrepresented on the more stringent 5% cutoff (6.7% boys vs 3.3% girls; OR, 2.05; 95% CI, 1.59-2.6; P<.001). In terms of IQ-referenced reading disability, 18.5% of boys and 11.6% of girls were in the lowest 15% of the IQ-reading discrepancy distribution (OR, 1.74; 95% CI, 1.49-2.02; P<.001), and 7.3% of boys but only 2.8% of girls were in the lowest 5% (OR, 2.72; 95% CI, 2.09-3.55; P<.001).

E-Risk Study
In the overall sample of 2163 children, the rate of non–IQ-referenced reading disability was 18% in boys vs 13% in girls, for an OR of 1.39 (95% CI, 1.04-1.86; P=.03). The comparable data for IQ-referenced reading disability were 19% in boys vs 11% in girls, for an OR of 1.93 (95% CI, 1.42-2.62; P<.001).

Overall
The FIGURE, A, summarizes the findings of the 4 large-scale previously published studies and Figure, B, does the same for the new data from our 4 large-scale studies, in all 8 instances using IQ-referenced reading disability. The overall rates are higher in the 4 newly reported studies because a 1-SD cutoff was used rather than the more ex-
Sex Differences in IQ-Referenced Reading Disability

The new findings from these 4 large-scale epidemiological studies are clearly in showing that reading disability is substantially more common in boys than in girls. This was true of both more stringent and less stringent definitions and also with respect to both IQ-referenced and non–IQ-referenced reading disability. The studies included in this report had 3 methodological strengths. First, the sample sizes were large. Second, the participation rates were high and the samples were representative of the general populations from which they were selected. Third, the findings were based on standardized testing that was in no way reliant on clinic referral or special educational services. The much earlier findings of the general population epidemiological samples in inner London and on the Isle of Wight and the more recent findings from 2 large American studies also showed that reading disability was more frequent in boys than girls. In short, all 8 studies found that reading disability is much more common in boys than girls.

Although there was general agreement among studies that the rate of reading disability was greater in boys than girls, the size of the difference varied across studies. In particular, the 2 New Zealand studies suggested ORs of well over 2.0, whereas those in the 2 UK studies were somewhat lower. This may reflect the fact that the New Zealand studies were able to combine measures across ages (thereby probably increasing the reliability and validity of measurement) whereas both of the UK studies had to rely on a single measurement point. Insofar as this explains the difference, it is probable that the true OR is at least 2.0.

However, that may not be the full explanation. The Programme for International Student Assessment (PISA) has recently reported the findings of its survey of reading skills in 15-year-olds in 32 different countries. In all 32 countries, the literacy levels of girls exceeded that of boys. However, to some extent the sex difference varied considerably. New Zealand had the third highest difference, whereas the United Kingdom was seventh lowest (the ratio between the 2 was 1.8). Despite these national differences, it appears that throughout the English-speaking world (as represented by the United States, the United Kingdom, and New Zealand) boys are more likely than girls to have reading disability.

In conclusion, the epidemiological findings should now be sufficient for a firm statement that reading disability is truly more frequent in boys than girls. There now needs to be research to determine the causal influences that underlie the sex difference, because their elucidation could throw light on the processes leading to reading disability in both sexes.

Author Contributions: Dr Rutter had full access to all of the data in the studies and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Rutter. Acquisition of data: Caspi, Fergusson, Horwood, Goodman, Moffitt, Meltzer. Analysis and interpretation of data: Caspi, Fergusson, Horwood, Goodman, Maughan, Moffitt, Meltzer, Carroll. Drafting of the manuscript: Rutter, Caspi, Fergusson, Goodman, Maughan, Meltzer. Critical revision of the manuscript for important intellectual content: Rutter, Caspi, Fergusson, Goodman, Moffitt.
SEX DIFFERENCES IN READING DISABILITY

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Philosophy is the battle against the bewitchment of our intelligence by means of language.
—Ludwig Wittgenstein (1889-1951)