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The prevalence and correlates of adult ADHD in the United States: Results from the National Comorbidity Survey Replication

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Abstract

OBJECTIVE—Despite growing interest in adult attention-deficit/hyperactivity disorder (ADHD), little is known about prevalence or correlates.

METHODS—A screen for adult ADHD was included in a probability sub-sample (n = 3199) of 18–44 year old respondents in the National Comorbidity Survey Replication (NCS-R), a nationally representative household survey that used a lay-administered diagnostic interview to assess a wide range of DSM-IV disorders. Blinded clinical follow-up interviews of adult ADHD were carried out with 154 NCS-R respondents, over-sampling those with a positive screen. Multiple imputation (MI) was used to estimate prevalence and correlates of clinician-assessed adult ADHD.

RESULTS—Estimated prevalence of current adult ADHD is 4.4%. Significant correlates include being male, previously married, unemployed, and Non-Hispanic White. Adult ADHD is highly comorbid with many other NCS-R/DSM-IV disorders and is associated with substantial role impairment. The majority of cases are untreated, although many obtain treatment for other comorbid mental and substance disorders.

CONCLUSIONS—Efforts are needed to increase the detection and treatment of adult ADHD. Research is needed to determine whether effective treatment would reduce the onset, persistence, and severity of disorders that co-occur with adult ADHD.

Keywords

Attention Deficit Hyperactivity Disorder - AJP0005; Diagnosis And Classification - AJP0086; Epidemiology - AJP0087

Although it has long been known that attention-deficit/hyperactivity disorder (ADHD) often persists into adulthood (1,2), adult ADHD has only recently become the focus of widespread clinical attention (3–5). As an indication of this neglect, adult ADHD was not included in either major US psychiatric epidemiological survey of the past two decades, the Epidemiologic Catchment Area Study (6) and the National Comorbidity Survey (7). Attempts to estimate adult ADHD prevalence by extrapolating from childhood prevalence estimates linked with adult persistence estimates (8–11) and direct estimation in small samples (12,13) yield estimates in the range 1–6%. In order to obtain more accurate estimates of prevalence and correlates, an adult ADHD screen was included in the National Comorbidity Survey Replication (NCS-R) (14) and clinical reappraisal interviews were carried out with screened positives. These data are used here to estimate the prevalence, comorbidity, and impairment of adult ADHD in the US.

METHODS

Sample

As detailed elsewhere (15) the NCS-R is a nationally representative survey of 9282 English-speaking household residents ages 18+. The response rate was 70.9%. Recruitment featured an advance letter and Study Fact Brochure followed by in-person interviewer visit to answer questions before obtaining verbal informed consent. Consent was verbal rather than written to parallel the baseline NCS procedures (7) for trend comparison. The Human Subjects Committees of Harvard Medical School and the University of Michigan both approved these procedures.

The NCS-R interview was in two parts. Part I included a diagnostic assessment administered to all 9282 respondents. Part II included additional questions administered to 5692 Part I respondents that included all who met criteria for at least one Part I disorder and a probability sub-sample of others. Based on concern about recall failure among older adults, ADHD was assessed in Part II only among the 3199 respondents aged 18–44. This sample was weighted to be nationally representative. More details about NCS-R weighting are reported elsewhere (15).

Respondents were divided into four strata to select cases for adult ADHD clinical reappraisal interviews: those who denied ever having symptoms of childhood ADHD; those who reported symptoms but did not meet full criteria for childhood ADHD; childhood cases who denied adult symptoms; and childhood cases who reported adult symptoms. An attempt was made to contact by telephone and administer a semi-structured adult ADHD clinical interview to 30 respondents in each of the first three strata and 60 in the fourth. The final quota sample included 154 respondents (slightly more than the target because more pre-designated respondents kept their appointments to be interviewed than expected). These cases were weighted to be representative of the US population in the age range of the sample. Details on the ADHD clinical reappraisal sample design are reported elsewhere (16).

Adult ADHD

The retrospective assessment of childhood ADHD in the NCS-R was based on the Diagnostic Interview Schedule for DSM-IV (17). Respondents classified retrospectively as having had ADHD symptoms in childhood were then asked a single question about whether they continued

to have any current problems with attention or hyperactivity-impulsivity. The clinical reappraisal interview used the Adult ADHD Clinical Diagnostic Scale (ACDS) V 1.2 (18, 19), a semi-structured interview that includes the ADHD Rating Scale (ADHD-RS) (20) for childhood ADHD and an adaptation of the ADHD-RS to assess current adult ADHD. The ACDS has been used in clinical trials of adult ADHD (21,22).

Four experienced clinical interviewers (all Ph.D. clinical psychologists) carried out the clinical reappraisal interviews. Each interviewer received 40 hours of training from two board certified psychiatrist specialists in adult ADHD (LA, TS) and successfully completed five practice interviews. All clinical interviews were tape recorded and reviewed by a supervisor. Weekly calibration meetings were used to prevent drift. A clinical diagnosis of adult ADHD required six symptoms of either inattention or hyperactivity-impulsivity during the six months before the interview (DSM-IV Criterion A), at least two Criterion A symptoms before age seven (Criterion B), some impairment in at least two areas of living during the past six months (Criterion C), and clinically significant impairment in at least one of these areas (Criterion D). No attempt was made to operationalize DSM-IV diagnostic hierarchy rules (Criterion E).

Comorbid DSM-IV disorders

Other DSM-IV disorders were assessed in the NCS-R using the World Health Organization's (WHO) Composite International Diagnostic Interview (CIDI) Version 3.0 (23), a fully structured lay-administered diagnostic interview. The disorders include anxiety disorders, mood disorders, substance use disorders, and intermittent explosive disorder. Organic exclusion rules and diagnostic hierarchy rules were used in making diagnoses. As detailed elsewhere (15), blinded clinical reappraisal interviews using the Structured Clinical Interview for DSM-IV (SCID) (24) with a probability sub-sample of NCS-R respondents found generally good concordance of DSM-IV diagnoses based on the CIDI and SCID, with AUC .65-.81 for anxiety disorders, .75 for major depression, and .62-.88 for substance disorders. No validation was made of intermittent explosive disorder, as no gold standard clinical assessment exists for this disorder.

Other correlates of adult ADHD

We examined associations of adult ADHD with socio-demographics and functional disability assessed in the WHO Disability Assessment Schedule (WHO-DAS) (25). The WHO-DAS assesses frequency and intensity of difficulties experienced over the past 30 days in each of three areas of basic functioning: mobility (e.g., walking a mile), self-care (e.g., getting dressed) and cognition (e.g., remembering to do important things); and three areas of instrumental functioning: time out of role (i.e., number of days totally unable to carry out normal daily activities; number of days of cutting back on amount done or time spent on daily activities), productive role performance (e.g., cutting back on the quality of work) and social role performance (e.g., controlling emotions when around other people). Dichotomous measures of disability were defined for each domain by giving equal weights to frequency and intensity of impairments and defining the top ten percentile of the composite as being disabled. Treatment was assessed in each diagnostic section and in a separate treatment section where we asked about treatment for any emotional or substance problem. Comparison of responses to the more and less inclusive questions pinpointed people in treatment for comorbid mental or substance problems but not for ADHD.

Analysis methods

The multiple imputation (MI) method (26) was used to assign predicted diagnoses of clinician-assessed adult ADHD to respondents who did not participate in the reappraisal interviews. As detailed below, a strong monotonic relationship was found between sampling strata and blinded adult ADHD clinical diagnoses, justifying this use of MI. We began by selecting ten pseudo-

samples of size 154 with replacement from the 154 cases in the clinical calibration sample, estimating predicted probabilities of adult ADHD in each sampling stratum of each pseudo-sample, and transforming probabilities to case classifications separately for each case by random selection from the binomial distribution for the predicted probability. These imputations were then used to create ten separate “datasets” in which substantive analyses were replicated. The parameter estimates in these replications were averaged to obtain MI parameter estimates, while MI parameter variance was estimated by combining the mean within-replication variance with the variance of the parameter estimates across the replications using standard MI averaging (26). The increase in variance due to between-replication variance adjusted for the variance introduced by using imputation rather than direct clinical evaluation of all respondents.

Socio-demographic correlates were estimated using logistic regression analysis, again separately in the ten MI replications. Comorbidity was assessed by obtaining MI estimates of odds-ratios (OR's) between adult ADHD and other DSM-IV disorders in logistic regression equations that controlled for age in five-year age groups. Functional disabilities were also estimated using MI logistic regression. Twelve-month treatment was estimated using MI cross-tabulations. Because the sample design used weighting and clustering, all parameters were estimated using the Taylor series linearization method (27), a design-based method implemented in the SUDAAN software system (28). Significance tests of set of coefficients used Wald χ^2 tests based on design-corrected MI coefficient variance-covariance matrices. Statistical significance was evaluated using two-sided design-based .05 level tests.

RESULTS

Prevalence

85.8% of respondents (Table 1) reported no clinically significant problems with inattention, hyperactivity, or impulsivity during their childhoods. Smaller percentages reported sub-threshold childhood symptoms (7.5%), full childhood criteria without current symptoms (4.0%), and full childhood criteria with current symptoms (2.6%). A strong monotonic relationship was found between this four-category classification and blinded clinical diagnoses of adult ADHD in the reappraisal interviews, with an area under the receiver operator characteristic curve (AUC) in the weighted clinical calibration sample of .86. No false negatives were found among the 85.6% of respondents who reported no childhood symptoms of ADHD, although false negatives were found among respondents who reported sub-threshold symptoms. The estimated prevalence of clinician-assessed adult ADHD (standard error in parentheses) in the total sample based on MI, using a combination of directly interviewed cases from the clinical reappraisal sample and multiply imputed cases in the remainder of the sample, is 4.4% (0.6). It is noteworthy that exactly the same estimated prevalence and standard error are obtained by using a more conventional two-stage sampling adjustment (29).

Socio-demographic correlates

MI estimates of clinician-assessed adult ADHD are estimated to be significantly elevated among men, Non-Hispanic Whites compared to Non-Hispanic Blacks and Hispanics (i.e., the latter have significantly lower odds than Non-Hispanic Whites), the previously married, and people in the “other” (mostly unemployed and disabled) employment category. (Table 2) The OR's of these predictors are all modest in substantive terms (1.6–3.3).

Comorbidity with other DSM-IV disorders

Adult ADHD is significantly comorbid with a wide range of other 12-month DSM-IV disorders. (Table 3) Strength of comorbidity does not vary greatly across classes of disorder,

with OR's of 2.7–7.5 for mood disorders, 1.5–5.5 for anxiety disorders, 1.5–7.9 for substance disorders, and 3.7 for intermittent explosive disorder.

Basic and instrumental functioning

Adult ADHD is associated with significantly elevated OR's of disability in all three WHO-DAS dimensions of basic functioning -- self-care (2.2), mobility (3.9), and cognition (2.6) -- as well as all three dimensions of instrumental functioning -- days out of role (2.7), productive role functioning (2.1), and social role functioning (3.5).

Twelve-month treatment

A significantly higher proportion of females than males with adult ADHD received treatment for mental or substance problems in the 12 months before interview (53.1% vs. 36.5%, $z = 2.6$, $p = .014$). However, only 25.2% of treated cases received treatment for ADHD (22.8% of females vs. 27.7% of males, $z = 0.5$, $p = .598$). Because of this low proportion, only 10.9% of respondents with adult ADHD received treatment for ADHD in the 12 months before interview (12.1% of females vs. 10.1% of males, $z = 0.4$, $p = .657$).

DISCUSSION

An important limitation is that the DSM-IV criteria for ADHD were developed with children in mind and offer only limited guidance regarding diagnosis among adulthood. Clinical studies make it clear that symptoms of ADHD are more heterogeneous and subtle in adults than children (32,33), leading some clinical researchers to suggest that assessment of adult ADHD might require an increase in the variety of symptoms assessed (34), a reduction in the severity threshold (35), or a reduction in the DSM-IV six-of-nine symptom requirement (36). To the extent that such changes would lead to a more valid assessment than in the current study, our prevalence estimate is conservative.

Three additional limitations are also noteworthy. First, adult ADHD was assessed comprehensively only in the clinical reappraisal sub-sample. Although the imputation equation was strong, the need to impute entire diagnoses made it impossible to carry out symptom-level investigations of such things as the notion that inattentive symptoms are more prominent than hyperactive/impulsive symptoms among adults than children.

Second, both the CIDI and clinical reappraisal interviews were based on self-reports. Childhood ADHD is diagnosed based on parent and teacher reports (37). Informant assessment is much more difficult for adults, making it necessary to base assessment largely on self-report (38). Methodological studies comparing adult self-reports versus informant reports of ADHD symptoms document the same general pattern of under-estimation in self-reports in adults as children (39,40), suggesting that our prevalence estimates is probably conservative, although the only study of self versus informant assessment of adult ADHD in a non-clinical sample found fairly strong associations between the two reports (41).

Third, even though the semi-structured interview used in the clinical reappraisal interviews, the ACDS, had been used in clinical studies of adult ADHD, no standard method of clinical validation of adult ADHD exists with the same level of acceptance as the SCID has for anxiety, mood, or substance disorders, limiting the interpretability of results.

Within the context of these limitations, the results reported document that adult ADHD is a commonly occurring and often seriously impairing disorder. The 4.4 % estimated prevalence is in the middle of previous estimates. This estimate is likely to be conservative for reasons described above. The findings that adult ADHD is associated with unemployment and being previously married are broadly consistent with studies that have documented adverse effects

of adult ADHD (8,42). The WHO-DAS analyses are also consistent with this broad pattern. However, the WHO-DAS might under-represent ADHD impairments because some WHO-DAS dimensions tap areas where ADHD is not highly impairing (e.g., people with ADHD are often very mobile and overwork) and because the WHO-DAS does not assess many dimensions where people with ADHD are thought to function least adequately (e.g., poor sleep and nutrition, high rates of accidents, high smoking). In addition, as noted in the last paragraph, people with ADHD might have poor insight into their impairments, leading to underestimation of WHO-DAS scores.

The finding of low prevalence among Hispanics and Non-Hispanic Blacks was unexpected. As the DSM-IV ADHD field trials found no effects of race-ethnicity (43), the NCS-R result could reflect a race-ethnic difference either in adult persistence, in accuracy of adult self-report, in cultural perceptions of the acceptability of ADHD symptoms, or some combination. The finding that adult ADHD is significantly more prevalent among men than women, in comparison, is consistent with much previous research (44). The 1.6 male:female OR is comparable to the OR's found in studies of children and adolescents, suggesting that childhood-adolescent ADHD is no more likely to persist into adulthood among girls than boys (45). This indirectly suggests that the high proportion of adult women in adult ADHD patient samples is due to help-seeking or recognition bias (46). The finding that adult ADHD is highly comorbid is consistent with clinical evidence (42). Methodological analysis shows that these comorbidities are not due to overlap of symptoms, imprecision of diagnostic criteria, or other methodological confounds (47).

The average magnitude of OR's between adult ADHD and other comorbid disorders is comparable to most NCS DSM-IV anxiety and mood disorders (48). The absence of strong variation in comorbidity OR's was surprising, as family studies would lead us prediction of high comorbidities with major depression (49), bipolar disorder (50,51), and conduct disorder (52,53), and lower comorbidities with anxiety disorders (54). One striking implication of the high overall comorbidity is that many people with adult ADHD are in treatment for other mental or substance disorders, but not ADHD. The 10% of cases who receive treatment for adult ADHD is much lower than for anxiety, mood, or substance disorders (55). Direct-to-consumer outreach and physician education are needed to address this problem.

The comorbidity findings raise the question whether early successful treatment of childhood ADHD would influence secondary adult disorders. The fact that a diagnosis of adult ADHD requires at least some symptoms to begin before age 7, means that the vast majority of comorbid conditions are temporally secondary to adult ADHD. We know from the MTA study that successful treatment of childhood ADHD also reduces childhood symptoms of comorbid disorders (56). Indirect evidence suggests that stimulant treatment of childhood ADHD might reduce subsequent risk of substance use disorders (57), although this is not definitive because of possible sample selection bias. Long-term prospective research using quasi-experimental methods is needed to resolve this uncertainty.

A related question is whether adult treatment of ADHD would have any effects on severity or persistence of comorbid disorders. A question could also be raised whether ADHD explains part of the adverse effects found in studies of comorbid DSM disorders. A number of studies, for example, have documented high societal costs of anxiety (58,59), mood (60,61), and substance (62,63) disorder, but these all ignored the role of comorbid ADHD. Reanalysis might find that comorbid ADHD accounts for part, possibly a substantial part, of the effects previously attributed to these other disorders.

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Table 1

Distribution of Adult ADHD imputation classes in the NCS-R¹ and conditional prevalence of clinician-rated Adult ADHD in the clinical reappraisal sub-sample

ADHD Risk	Total Sample Distribution		Conditional Prevalence of Adult ADHD in the Clinical Reappraisal Sub-sample	
	%	(se)	%	(se)
None	85.8	(0.8)	0.0	--
Low	7.5	(0.5)	7.3	(6.4)
Medium	4.0	(0.4)	36.6	(8.9)
High	2.6	(0.4)	84.8	(7.7)
(n)	(3199)		(154)	

¹Part II respondents ages 18–44

Table 2

Socio-demographic correlates of Adult ADHD (n=3199)¹

	% ²	(se) ²	% ³	(se) ³	OR ⁴	(95% CI) ⁴
Sex						
Female	38.4	(4.7)	3.2	(0.6)	1.0	--
Male	61.6	(4.7)	5.4	(0.9)	1.6*	(1.0-2.5)
Age						
18-24	30.3	(5.5)	4.5	(1.0)	1.0	--
25-34	27.5	(4.1)	3.8	(0.8)	0.9	(0.6-1.5)
35-44	42.2	(5.5)	4.6	(0.9)	1.1	(0.6-1.9)
Race-Ethnicity						
Non-Hispanic White	81.8	(3.8)	5.4	(0.8)	1.0	--
Non-Hispanic Black	6.2	(1.9)	1.9	(0.6)	0.3*	(0.2-0.6)
Hispanic	7.5	(2.3)	2.1	(0.8)	0.3*	(0.2-0.6)
Other	4.5	(2.1)	3.6	(1.8)	0.6	(0.2-1.8)
Education						
0-11	15.7	(3.3)	4.8	(1.1)	1.4	(0.7-2.6)
12	32.7	(5.2)	4.4	(1.0)	1.4	(0.7-2.6)
13-15	35.8	(3.9)	5.0	(0.9)	1.6	(0.8-3.2)
16+	15.8	(5.0)	2.9	(0.8)	1.0	--
Marital Status						
Married cohabitating	45.0	(4.3)	3.9	(0.7)	1.0	--
Previously married	17.7	(4.0)	6.9	(1.9)	1.9*	(1.1-3.3)
Never married	37.3	(4.7)	4.1	(0.8)	1.0	(0.7-1.5)
Employment						
Working	72.0	(4.3)	3.9	(0.7)	1.0	--
Student	5.6	(2.5)	4.4	(1.8)	1.1	(0.4-2.6)
Homemaker	4.9	(1.9)	3.7	(1.6)	1.2	(0.5-2.8)
Other	16.8	(4.0)	7.1	(1.9)	2.0*	(1.0-4.0)
Income⁵						
Low	22.1	(4.2)	4.0	(0.8)	1.2	(0.7-2.0)

	% ²	(se) ²	% ³	(se) ³	OR ⁴	(95% CI) ⁴
Low-average	28.8	(4.8)	5.5	(1.3)	1.4	(0.8–2.6)
High-average	31.2	(4.9)	4.1	(0.7)	1.1	(0.6–2.0)
High	17.9	(3.6)	3.7	(1.0)	1.0	--
Urbanicity⁶						
Central city large MSA	10.2	(3.5)	3.0	(1.1)	0.8	(0.4–1.6)
Central city small MSA	15.2	(5.3)	4.6	(1.8)	1.1	(0.5–2.4)
Suburbs large MSA	14.0	(4.0)	3.3	(1.0)	0.8	(0.4–1.3)
Suburbs small MSA	23.8	(4.6)	5.8	(1.3)	1.4	(0.7–2.9)
Non-MSA	37.0	(6.4)	4.4	(0.7)	1.0	--

* Significant at the .05 level, two-sided design-based MI tests.

¹ Part II respondents ages 18–44

² Percent (standard error) of respondents with adult ADHD who have the socio-demographic characteristic

³ Percent (standard error) of respondents with the socio-demographic characteristic who have adult ADHD.

⁴ Based on multivariate logistic regression analysis using MI to estimate odds-ratios (OR) and 95% Confidence Intervals (95% CI)

⁵ Defined in relation to the official federal poverty line for families of the size and composition of the respondent's family (30). Low = less than or equal to 1.5 times the poverty line. Low-average = 1.5+ to 3 times the poverty line. High-average = 3+ to 6 times the poverty line. High = greater than 6 times the poverty line.

⁶ Coded according to the 2000 census definitions (31) to distinguish between large (at least 2 million residents) and smaller Metropolitan Statistical Areas (MSA's) and, within MSA's, to distinguish between central cities and suburbs. Non-MSA's include both adjacent areas (areas outside the suburban belt, but within 50 miles of the central business district of a central city of an MSA) and rural areas (more than 50 miles from the central business district of a central city of an MSA).

Table 3

Twelve-month comorbidities of Adult ADHD with other DSM-IV disorders (n=3199)^a

	Conditional prevalence of...								OR ²	(95%CI) ²				
	ADHD among respondents...				other disorders among Respondents...									
	with other disorders	%	(se)		without other disorders	%	(se)				with ADHD	%	(se)	without ADHD
I. Mood Disorders														
Major depressive disorder	9.4	2.3	3.7	0.5	18.6	4.2	7.8	0.4	2.7*	(1.5–4.9)				
Dysthymia	22.6	5.8	3.7	0.5	12.8	3.4	1.9	0.2	7.5*	(3.8–15.0)				
Bipolar disorder	21.2	3.9	3.5	0.5	19.4	3.8	3.1	0.3	7.4*	(4.6–12.0)				
Any mood disorder	13.1	2.3	2.9	0.5	38.3	5.5	11.1	0.6	5.0*	(3.0–8.2)				
II. Anxiety Disorders														
Generalized anxiety disorder	11.9	3.9	4.0	0.5	8.0	2.5	2.6	0.3	3.2*	(1.5–6.9)				
Post-traumatic stress disorder	13.4	3.4	3.8	0.5	11.9	3.0	3.3	0.4	3.9*	(2.1–7.3)				
Panic disorder	11.1	3.0	3.9	0.5	8.9	2.5	3.1	0.3	3.0*	(1.6–5.9)				
Agoraphobia	19.1	9.0	4.0	0.5	4.0	2.0	0.7	0.1	5.5*	(1.6–18.5)				
Specific phobia	9.4	1.9	3.6	0.5	22.7	4.2	9.5	0.6	2.8*	(1.7–4.6)				
Social phobia	14.0	2.5	3.2	0.5	29.3	4.3	7.8	0.5	4.9*	(3.1–7.6)				
Obsessive-compulsive disorder	6.5	5.2	4.2	0.5	2.7	2.0	1.3	0.4	1.5	(0.2–9.4)				
Any anxiety disorder	9.5	1.4	2.8	0.5	47.1	5.0	19.5	0.7	3.7*	(2.4–5.5)				
III. Substance Disorders														
Alcohol abuse	9.5	4.2	4.0	0.5	5.9	2.5	2.4	0.2	2.5	(0.9–6.6)				
Alcohol dependence	11.1	5.9	4.0	0.5	5.8	2.9	2.0	0.4	2.8	(0.8–9.8)				
Drug abuse	7.2	6.6	4.1	0.5	2.4	2.3	1.4	0.2	1.5	(0.2–10.5)				
Drug dependence	25.4	11.7	4.0	0.5	4.4	2.3	0.6	0.1	7.9*	(2.3–27.3)				
Any substance disorder	10.8	3.6	3.8	0.5	15.2	4.8	5.6	0.6	3.0*	(1.4–6.5)				
IV. Impulse-Control Disorders														
Intermittent explosive disorder	12.3	2.5	3.6	0.5	19.6	3.8	6.1	0.5	3.7*	(2.2–6.2)				

Conditional prevalence of...					
ADHD among respondents...			other disorders among Respondents...		
with other disorders	without other disorders		with ADHD	without ADHD	
%	%	(se)	%	%	(se)
					OR ² (95%CI) ²

* Significant at the .05 level, two-sided design-based MI tests.

¹ Part II respondents ages 18–44

² Based on multivariate logistic regression analysis controlling for age using MI to estimate odds-ratios (OR) and 95% Confidence Intervals (95% CI)