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WHO World Mental Health Survey Collaborators; McGrath, John J.; Al-Hamzawi, Ali; Alonso, Jordi; Altwaijri, Yasmin; Andrade, Laura H.; Bromet, Evelyn J.; Bruffaerts, Ronny; de Almeida, José Miguel Caldas; Chardoul, Stephanie

Published in:
The Lancet Psychiatry

DOI:
10.1016/S2215-0366(23)00193-1

Publication date:
2023

Age of onset and cumulative risk of mental disorders: a cross-national analysis of population surveys from 29 countries

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Lancet Psychiatry 2023; 10: 668–81

Published **Online** July 30, 2023 https://doi.org/10.1016/S2215-0366(23)00193-1

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Summary

Background Information on the frequency and timing of mental disorder onsets across the lifespan is of fundamental importance for public health planning. Broad, cross-national estimates of this information from coordinated general population surveys were last updated in 2007. We aimed to provide updated and improved estimates of age-of-onset distributions, lifetime prevalence, and morbid risk.

Methods In this cross-national analysis, we analysed data from respondents aged 18 years or older to the World Mental Health surveys, a coordinated series of cross-sectional, face-to-face community epidemiological surveys administered between 2001 and 2022. In the surveys, the WHO Composite International Diagnostic Interview, a fully structured psychiatric diagnostic interview, was used to assess age of onset, lifetime prevalence, and morbid risk of 13 DSM-IV mental disorders until age 75 years across surveys by sex. We did not assess ethnicity. The surveys were geographically clustered and weighted to adjust for selection probability, and standard errors of incidence rates and cumulative incidence curves were calculated using the jackknife repeated replications simulation method, taking weighting and geographical clustering of data into account.

Findings We included 156 331 respondents from 32 surveys in 29 countries, including 12 low-income and middle-income countries and 17 high-income countries, and including 85 308 (54·5%) female respondents and 71 023 (45·4%) male respondents. The lifetime prevalence of any mental disorder was 28·6% (95% CI 27·9–29·2) for male respondents and 29·8% (29·2–30·3) for female respondents. Morbid risk of any mental disorder by age 75 years was 46·4% (44·9–47·8) for male respondents and 53·1% (51·9–54·3) for female respondents. Conditional probabilities of first onset peaked at approximately age 15 years, with a median age of onset of 19 years (IQR 14–32) for male respondents and 20 years (12–36) for female respondents. The two most prevalent disorders were alcohol use disorder and major depressive disorder for male respondents and major depressive disorder and specific phobia for female respondents.

Interpretation By age 75 years, approximately half the population can expect to develop one or more of the 13 mental disorders considered in this Article. These disorders typically first emerge in childhood, adolescence, or young adulthood. Services should have the capacity to detect and treat common mental disorders promptly and to optimise care that suits people at these crucial parts of the life course.

Funding None.

Introduction

Age of onset, lifetime prevalence (ie, the proportion of survey respondents with a history of disorder at the time of assessment), and lifetime morbid risk (ie, the projected lifetime prevalence in the sample as of a fixed age) are essential features of epidemiology. Many mental disorders have an onset in the first and second decades of life,[1,2] unlike most other non-communicable disorders (eg, respiratory and cardiovascular disorders or cancer), which typically have onsets in late adulthood. Understanding onset patterns is important for several reasons. First, this understanding helps to ensure that the correct mix of services is available to provide prompt treatments to the right groups (eg, early intervention for teenagers with mental disorders). Second, research efforts should focus on understanding risk factors for different types of mental disorders during crucial parts of the lifespan. Third, register-based family pedigree studies[3] and genome-wide association studies based on case-control or case-cohort studies[4] increasingly use age-of-onset distributions to weight non-cases at the time of sample ascertainment, according to the estimated future

Research in context

Evidence before this study

Age of onset, lifetime prevalence, and lifetime morbid risk of mental disorders are key estimates for service planning as they provide valuable insight into when in the life course disorders first emerge. Previous studies of these estimates often used suboptimal samples (eg, case-only samples or registers of patients who were treated). Few studies present both age of onset and lifetime prevalence for diverse mental disorders based on population-based data from multiple countries. We searched PubMed with the search terms ([“age of onset”[TIAB] OR “lifetime prevalence”[TIAB] OR “morbid risk”[TIAB] OR “cumulative incidence” [TIAB]) AND (“mental”[TIAB] OR “psychiatri*”[TIAB]) for articles in any language published between Jan 1, 1966, and June 30, 2022. We identified 4050 articles, including 93 systematic reviews. Most studies focused on one type of mental disorder in one country. A systematic review of age of onset summarised data from 192 studies but did not examine lifetime prevalence. Regarding cross-national studies, one 2007 study reported country-specific age of onset, lifetime prevalence, and morbid risk for 17 countries, but cross-national and sex-specific estimates were not presented.

Added value of this study

Using data from community epidemiological surveys in 29 countries, including 16 surveys from the 2007 study and 16 more recent surveys with 13 additional countries, we found a lifetime prevalence for any mental disorder of 28·6% for male respondents and 29·8% for female respondents. The risk for any mental disorder by age 75 years was around one in two people. The peak incidence was at around age 15 years, and the median age of onset was 19 years for male respondents and 20 years for female respondents. In this Article, we provide updated and detailed estimates related to the age of onset, lifetime prevalence, and morbid risk of mental disorders.

Implications of all the available evidence

Mental disorders are common by age 75 years. The updated estimates substantiate that many mental disorders have first onsets during childhood and young adulthood. Health planners should ensure sufficient services to reach out and treat mental disorders among young people. Future research related to causes and prevention can be informed by the distinct age-of-onset curves and sex differences associated with different types of mental disorders.

morbid risk of the disorder of interest, which means having accurate onset information is important, although other factors are also important in controlling for bias in these types of studies. Finally, disease-specific age-of-onset distributions are important inputs for models that are used to estimate the non-fatal burden of disorders.[5]

The most comprehensive data on age of onset, lifetime prevalence, and morbid risk of common mental disorders to date were reported in 2007 by the World Mental Health (WMH) survey collaborators[1] on the basis of data obtained from coordinated community epidemiological surveys in 17 countries. Key features (eg, median and other quantiles) were reported, providing evidence that many mental disorders first emerge between childhood and early adulthood. In 2022, Solmi and colleagues[2] presented a systematic review and meta-analysis of published literature on age of onset including 192 studies. The authors noted that the studies were heterogeneous, which made pooling the data difficult, but they presented key properties of age-of-onset distributions (eg, peak age of onset and proportion of people with mental disorders with onset by age 25 years) by disorder type and sex.

Epidemiological studies commonly show sex-specific incidence rates by age; the rate of first onset at a specific age is defined as a ratio of the number of disorder onsets divided by the number of people who never had the disorder up to that age and lived through that age. These estimates allow the calculation of cumulative lifetime risk by sex. Whereas incidence rates can either increase or decrease with increasing age, cumulative risk curves are always non-decreasing. Univariate statistics can be derived from these cumulative risk curves (eg, median and IQR of the age-of-onset distributions) to estimate lifetime morbid risk. However, the morbid risk does not indicate how many people had the disorder as of their current age, which is known as lifetime prevalence. By comparing the ratio of morbid risk as of some fixed age to lifetime prevalence, we can appreciate how age-related incidence interacts with background population age structure. Disorders with peak incidence in early life will have a lower ratio of morbid risk to lifetime prevalence than will disorders with peak hazard rates later in life.

Existing data on age of onset and morbid risk are prone to under-reporting[6] because survey data rely on memory. Recall bias might result in a systematic bias against recalling events in the distant past or telescoping the recalled age (eg, temporally distant events might be incorrectly recalled as having occurred more recently). Although the structured interview used in WMH surveys is designed to reduce recall bias,[7] accuracy can also be improved by focusing on respondents who reported more recent onsets (eg, in the past 10 years).[8] In this Article, we used this method to update estimates of age of onset and morbid risk for 13 defined mental disorders. Since the 2007 publication,[1] WMH surveys have been completed with 74 989 respondents, including people in 13 additional countries. We combined these new data with data from the earlier WMH surveys with the aim of providing updated and improved estimates of age-of-onset distributions, lifetime prevalence, and morbid risk.

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	Survey	Sample characteristics	Survey dates	Age range of participants, years	Sample size			Sex of participants, n/N (%)		Response rate*
					Part 1	Part 2	Part 2 and participants aged ≤44 years†	Male	Female	
Low-income and middle-income countries										
Brazil-São Paulo	São Paulo Megacity	São Paulo metropolitan area	2005–08	18–93	5037	2942	NA	2187/5037 (43·4%)	2850/5037 (56·6%)	81·3%
Bulgaria	NSHS	Nationally representative	2002–06	18–98	5318	2233	741	2430/5318 (45·7%)	2888/5318 (54·3%)	72·0%
Bulgaria 2	NSHS-2	Nationally representative	2016–17	18–91	1508	578	NA	670/1508 (44·4%)	838/1508 (55·6%)	61·0%
Colombia‡	NSMH	All urban areas of the country (approximately 73% of the total national population)	2003	18–65	4426	2381	1731	1700/4426 (38·4%)	2726/4426 (61·6%)	87·7%
Colombia-Medellín	MMHHS	Medellín metropolitan area	2011–12	19–65	3261	1673	NA	1120/3261 (34·3%)	2141/3261 (65·7%)	97·2%
Iraq	IMHS	Nationally representative	2006–07	18–96	4332	4332	NA	2091/4332 (48·3%)	2241/4332 (51·7%)	95·2%
Lebanon‡	LEBANON	Nationally representative	2002–03	18–94	2857	1031	595	1297/2857 (45·4%)	1560/2857 (54·6%)	70·0%
Mexico‡	M-NCS	All urban areas of the country (approximately 75% of the total national population)	2001–02	18–65	5782	2362	1736	2285/5782 (39·5%)	3497/5782 (60·5%)	76·6%
Nigeria‡	NSMHW	21 (58%) of 36 states in the country, representing 57% of the national population; surveys were conducted in Yoruba, Igbo, Hausa, and Efik languages	2002–04	18–100	6752	2143	1203	3315/6752 (49·1%)	3437/6752 (50·9%)	79·3%
Peru	EMSMP	Five urban areas of the country (approximately 38% of the total national population)	2004–05	18–65	3930	1801	1287	1759/3930 (44·8%)	2171/3930 (55·2%)	90·2%
China-Shenzhen§	Shenzhen	Shenzhen metropolitan area; included temporary residents and household residents	2005–07	18–88	7132	2475	NA	3614/7132 (50·7%)	3518/7132 (49·3%)	80·0%
Romania	RMHS	Nationally representative	2005–06	18–96	2357	2357	NA	1092/2357 (46·3%)	1265/2357 (53·7%)	70·9%
South Africa‡§	SASH	Nationally representative	2002–04	18–92	4315	4315	NA	1718/4315 (39·8%)	2597/4315 (60·2%)	87·1%
Ukraine‡	CMDPSD	Nationally representative	2002	18–91	4725	1720	541	1793/4725 (37·9%)	2932/4725 (62·1%)	78·3%
Total	..	..	..	..	61732	32343	7834	27071/61732 (43·9%)	34661/61732 (56·1%)	80·4%
High-income countries										
Argentina	AMHES	Eight largest urban areas of the country (approximately 50% of the total national population)	2015	18–98	3927	2116	NA	1692/3927 (43·1%)	2235/3927 (56·9%)	77·3%
Australia§	NSMHWB	Nationally representative	2007	18–85	8463	8463	NA	3843/8463 (45·4%)	4620/8463 (54·6%)	60·0%
Belgium‡	ESEMeD	Nationally representative; sample was selected from a national register of residents of Belgium	2001–02	18–95	2419	1043	486	1190/2419 (49·2%)	1229/2419 (50·8%)	50·6%
France‡	ESEMeD	Nationally representative; sample was selected from a national list of households with listed telephone numbers	2001–02	18–97	2894	1436	727	1329/2894 (45·9%)	1565/2894 (54·1%)	45·9%
Germany‡	ESEMeD	Nationally representative	2002–03	19–95	3555	1323	621	1660/3555 (46·7%)	1895/3555 (53·3%)	57·8%
Israel‡	NHS	Nationally representative	2003–04	21–98	4859	4859	NA	2380/4859 (49·0%)	2479/4859 (50·9%)	72·6%
Italy‡	ESEMeD	Nationally representative; sample was selected from municipality resident registries	2001–02	18–100	4712	1779	853	2321/4712 (49·3%)	2391/4712 (50·7%)	71·3%
Japan‡	WMHJ 2002–2006	11 metropolitan areas	2002–06	20–98	4129	1682	NA	1868/4129 (45·2%)	2261/4129 (54·8%)	55·1%

(Table 1 continues on next page)

	Survey	Sample characteristics	Survey dates	Age range of participants, years	Sample size			Sex of participants, n (%)		Response rate*
					Part 1	Part 2	Part 2 and participants aged ≤44 years†	Male	Female	
(Continued from previous page)										
Netherlands‡	ESEMeD	Nationally representative; sample was selected from municipal postal registries	2002–03	18–95	2372	1094	516	1032/2372 (43·5%)	1340/2372 (56·5%)	56·4%
New Zealand‡§	NZMHS	Nationally representative	2004–05	18–98	12 790	7312	NA	5537/12 790 (43·3%)	7253/12 790 (56·7%)	73·3%
Northern Ireland	NISHS	Nationally representative	2005–08	18–97	4340	1986	NA	1899/4340 (43·8%)	2441/4340 (56·2%)	68·4%
Poland	EZOP	Nationally representative	2010–11	18–65	10 081	4000	2276	4883/10 081 (48·4%)	5198/10 081 (51·6%)	50·4%
Portugal	NMHS	Nationally representative	2008–09	18–81	3849	2060	1070	1632/3849 (42·4%)	2217/3849 (57·6%)	57·3%
Qatar	WMHQ	Nationally representative; sample was selected from a national list of mobile telephone numbers and restricted to Qatari nationals and Arab expatriates¶	2019–22	18–90	5195	2583	NA	3215/5195 (61·9%)	1980/5195 (38·1%)	19·2%
Saudi Arabia§	SNMHS	Nationally representative	2013–16	18–65	3638	1793	NA	1719/3638 (47·3%)	1919/3638 (52·7%)	61·0%
Spain‡	ESEMeD	Nationally representative	2001–02	18–98	5473	2121	960	2421/5473 (44·2%)	3052/5473 (55·8%)	78·6%
Spain-Murcia	PEGASUS-Murcia	Murcia region; regionally representative	2010–12	18–96	2621	1459	NA	1192/2621 (45·5%)	1429/2621 (54·5%)	67·4%
USA‡	NCS-R	Nationally representative	2001–03	18–99	9282	5692	3197	4139/9282 (44·6%)	5143/9282 (55·4%)	70·9%
Total	..	..	..	..	94 599	52 801	10 706	43 952/94 599 (46·5%)	50 647/94 599 (53·5%)	56·0%
Overall total	..	..	..	..	156 331	85 144	18 540	71 023/156 331 (45·4%)	85 308/156 331 (54·6%)	63·6%

Data on income categories are from 2012 World Bank data. Some WMH survey countries have moved into new income categories since the surveys were done; we used income groups at the time of data collection. AMHES=Argentina Mental Health Epidemiologic Survey. CMDPSD=Comorbid Mental Disorders during Periods of Social Disruption. EMSMP=La Encuesta Mundial de Salud Mental en el Peru. ESEMeD=The European Study of The Epidemiology of Mental Disorders. EZOP=Epidemiology of Mental Disorders and Access to Care Survey. IMHS=Iraq Mental Health Survey. LEBANON=Lebanese Evaluation of the Burden of Ailments and Needs of the Nation. M-NCS=The Mexico National Comorbidity Survey. MMHHS=Medellín Mental Health Household Study. NA=not applicable. NCS-R=The US National Comorbidity Survey Replication. NHS=Israel National Health Survey. NISHS=Northern Ireland Study of Health and Stress. NMHS=Portugal National Mental Health Survey. NSHS=Bulgaria National Survey of Health and Stress. NSMH=The Colombian National Study of Mental Health. NSMHW=The Nigerian Survey of Mental Health and Wellbeing. NSMHWB=National Survey of Mental Health and Wellbeing. NZMHS=New Zealand Mental Health Survey. PEGASUS-Murcia=Psychiatric Enquiry to General Population in Southeast Spain-Murcia. RMHS=Romania Mental Health Survey. SASH=South Africa Health Survey. SNMHS=Saudi National Mental Health Survey. WMH=World Mental Health. WMHJ2002–2006=World Mental Health Japan Survey. WMHQ=World Mental Health Qatar Study. *Response rate is the ratio of the number of households in which an interview was completed to the number of households originally sampled, excluding from the denominator households known not to be eligible either because of being vacant at the time of initial contact or because the residents were unable to speak the designated survey languages. †Argentina, Australia, Brazil, Bulgaria 2, Colombia-Medellín, Iraq, Israel, Japan, New Zealand, Northern Ireland, China-Shenzhen, Qatar, Romania, Saudi Arabia, South Africa, and Spain-Murcia did not have an age-restricted part 2 sample. All other surveys, except for those in Nigeria and Ukraine (which were restricted to participants aged ≤39 years), were restricted to participants aged 44 years or younger. ‡Surveys included in the 2007 WMH report;[1] all other surveys were conducted after that report. §For cross-national comparisons, we limited the sample to participants aged 18 years or older. ¶Initially an in-person household survey, but changed to be telephone-based due to the COVID-19 pandemic.

Table 1: **WMH survey sample characteristics by World Bank income categories**

Methods

Study design and samples

In this cross-national analysis, we obtained data from 32 WMH surveys conducted in 29 countries. All surveys were based on rigorous, multistage, geographically clustered area probability household sampling designs and were conducted between 2001 and 2022. A detailed description of sample designs is presented in an earlier report.[9] A discussion of possible reasons for variation in WMH survey response rates is presented elsewhere.[10]

Most WMH surveys are based on stratified, multistage, clustered area probability samples of households in the participating countries. Areas equivalent to counties or municipalities in the USA were selected in the first stage, followed by one or more stages of geographical sampling (eg, towns within counties, blocks [typically 50–100 housing units] within towns, or households within blocks) to establish a nationally representative sample of households. In each household, an attempt was made to obtain a list of all adult (ie, aged ≥18 years) household members. Then one person (or in surveys conducted in Brazil-São Paulo, Belgium, Bulgaria, France, Germany, Italy, Lebanon, Nigeria, Saudi Arabia, Spain, and the USA, two people) was selected from this

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list at random to be interviewed. No substitution of households was made when the originally sampled household could not be contacted or listed, and no substitution was allowed when the originally sampled household resident could not be interviewed. These household samples were selected from census-area data in all countries other than France, where telephone directories were used to select households, and the Netherlands, where postal registries were used to select households. Several countries participating in WMH surveys (ie, Belgium, Germany, Italy, Poland, and Spain-Murcia) used municipal, country resident, or universal health-care registries to select respondents without listing households. The Japanese sample is the only totally unclustered sample, with households randomly selected in each of the 11 metropolitan areas and one random respondent selected in each sample household.

Procedures for obtaining informed consent and ethics approval were somewhat different across countries, but ethics approval was always obtained from the institutional review boards of the collaborating organisations in each country before beginning the WMH survey and written or oral informed consent, depending on the country, was obtained from respondents before beginning the interview. Data use agreements allowed only deidentified data to be deposited in the centralised WMH server and required all analyses to be conducted on that server by trained and approved WMH analysts.

Procedures

Interviews were conducted in two parts. Part 1 was administered to one randomly selected adult (or in surveys conducted in some countries, two randomly selected adults) in each sampled household. Part 1 contained assessments of core mental disorders (ie, depression, mania, panic disorder, social phobia, specific phobia, agoraphobia, generalised anxiety disorder, and substance use disorder). A part 1 weight adjusted for differential probabilities of selection within households (on the basis of number of eligible adults in the household) and between households (on the basis of discrepancies between census estimates of the number of households in a sample segment and the number of households found when the interviewers visited that segment). Part 2, which included questions about other mental disorders and correlates (which varied across surveys but were based on the US survey), was then administered to 100% of part 1 respondents who met lifetime criteria for any part 1 disorder and a random subsample, varying across surveys between 20% and

	Male sex			Female sex			χ^2 (p value)*
	Number of lifetime cases at time of interview†	Number of people in sample in whom disorder was assessed‡	Lifetime prevalence, % (95% CI)§	Number of lifetime cases at time of interview†	Number of people in sample in whom disorder was assessed‡	Lifetime prevalence, % (95% CI)§	
Anxiety disorders							
Panic disorder or agoraphobia	1309	67 808	1·9% (1·8–2·1)	3303	83 328	3·7% (3·6–3·9)	289·6 (<0·0001)
Generalised anxiety disorder	1955	71 023	2·7% (2·6–2·9)	4500	85 308	5·0% (4·8–5·1)	396·8 (<0·0001)
Post-traumatic stress disorder	1456	35 446	2·7% (2·5–2·9)	3721	47 223	5·4% (5·2–5·7)	279·8 (<0·0001)
Social phobia	2254	65 428	3·5% (3·3–3·7)	3770	80 849	4·6% (4·4–4·8)	69·5 (<0·0001)
Specific phobia	2825	56 355	5·0% (4·8–5·3)	6954	68 781	10·0% (9·7–10·2)	744·6 (<0·0001)
Any anxiety disorder	6559	39 060	11·3% (10·9–11·7)	13 830	50 741	18·8% (18·3–19·2)	669·8 (<0·0001)
Mood disorders							
Major depressive disorder	5324	71 023	7·5% (7·2–7·7)	12 144	85 308	13·6% (13·3–13·9)	1160·5 (<0·0001)
Bipolar disorder	1398	57 559	2·5% (2·4–2·7)	1593	68 307	2·3% (2·1–2·4)	7·2 (0·0074)
Any mood disorder	6674	71 023	9·5% (9·2–9·7)	13 675	85 308	15·4% (15·1–15·7)	880·6 (<0·0001)
Substance use disorders							
Alcohol abuse	7629	52 757	13·7% (13·3–14·1)	2602	67 650	3·3% (3·1–3·4)	2226·0 (<0·0001)
Alcohol dependence	2056	52 757	3·5% (3·3–3·7)	840	67 650	0·9% (0·9–1·0)	516·5 (<0·0001)
Drug abuse	2083	46 180	4·1% (3·9–4·3)	1204	59 642	1·7% (1·6–1·8)	337·4 (<0·0001)
Drug dependence	711	46 180	1·4% (1·3–1·6)	490	59 642	0·6% (0·6–0·7)	89·9 (<0·0001)
Any substance use disorder	7926	46 939	15·6% (15·2–16·1)	3181	60 943	4·5% (4·2–4·7)	1960·2 (<0·0001)
Externalising disorders							
ADHD	571	19 402	2·4% (2·1–2·7)	575	25 116	1·5% (1·3–1·7)	26·1 (<0·0001)
Intermittent explosive disorder	1326	40 529	3·5% (3·2–3·7)	1267	49 561	2·5% (2·4–2·7)	39·4 (<0·0001)
Any externalising disorder	1524	30 526	4·3% (3·9–4·6)	1563	39 231	3·1% (2·9–3·3)	43·0 (<0·0001)
Any mental disorder	14 662	36 700	28·6% (27·9–29·2)	21 485	48 444	29·8% (29·2–30·3)	9·2 (0·0024)

*Wald test for significance of difference between male sex and female sex values. †Observed (ie, unweighted) number of respondents classified as meeting criteria for the disorder. ‡Observed (ie, unweighted) number of respondents in the sample. §Calculated with weighted data.

Table 2: **Count and lifetime prevalence of disorders by sex**

33%, of other part 1 respondents. A part 2 weight equal to the inverse of the probability of selection into part 2 was used to restore the representativeness of the part 2 sample, resulting in the prevalence estimates of part 1 disorders in the doubly weighted part 2 sample having the same expected-values-weighted prevalence estimates as in the part 1 sample. A third weight was then applied to the doubly weighted part 2 sample to calibrate discrepancies between sample and population distributions on the cross-classification of census sociodemographic and geographical variables.

Measures

The WHO Composite International Diagnostic Interview (CIDI)[11] was used to assess DSM-IV disorders in the WMH surveys (except for the 2019–22 survey in Qatar, in which DSM-5 disorders were assessed). The CIDI is a fully structured diagnostic interview administered by trained interviewers who read questions word for word and record answers in prespecified categories. Sex data were recorded by interviewer observation or, when unsure, by asking respondents if they were male or female. No options were included for gender categories, but all responses other than male or female were coded as other. Consistent interviewer training and quality control monitoring procedures were used across surveys.[12] On the basis of DSM-IV or DSM-5 criteria, 13 specific diagnoses were identified: panic disorder or agoraphobia; generalised anxiety disorder; post-traumatic stress disorder (PTSD); social phobia; specific phobia; major depressive disorder; bipolar disorder; alcohol abuse disorder; alcohol dependence disorder; drug abuse disorder; drug dependence disorder; ADHD; and intermittent explosive disorder. Diagnoses were also pooled for any anxiety disorder, any mood disorder, any substance use disorder, any externalising disorder, and any disorder. We retained the DSM-IV distinction between alcohol and drug abuse and dependence although DSM-5 combines these into single alcohol and drug use disorders. Clinical reappraisal studies indicate that lifetime diagnoses based on the CIDI have good concordance with diagnoses based on masked, semi-structured (ie, allowing open-ended clinical probing), clinical research diagnostic interviews.[13]

Respondents who met lifetime criteria for a specific disorder were asked about their age of onset with a question series designed to review core symptoms and encourage accurate dating. For example, the CIDI question about onset of a major depressive episode was administered after the completion of a question series that focused on symptoms of the respondents' worst lifetime episode, establishing that lifetime criteria were met. The next CIDI question after completing that question series was "Think of the very first time in your life when you had an episode lasting two weeks or longer when most of the day nearly every day you felt (sad/or/discouraged/or/uninterested) and also had some of the other problems we just reviewed. Can you remember your exact age?". Respondents who could not remember their exact ages were then questioned about the earliest age they could clearly remember having the syndrome with the aim of obtaining upper-bound onset estimates. Symptom-level assessments were only obtained for worst lifetime episodes, not for first onsets, introducing the possibility that age-of-onset estimates were for subthreshold episodes. A more detailed description of the CIDI is presented elsewhere.[11]

Statistical analysis

We pooled results across surveys with sums of weights equal to numbers of respondents rather than country populations. We estimated lifetime prevalence in the doubly weighted and calibrated part 2 sample as the proportion of respondents who had ever had a specific disorder as of the time of interview. For each disorder, we then estimated the incidence by year of life, by estimating the conditional probability of the first onset in each year of life, t, in the subsample of respondents aged at least t years and who reported not having had the disorder at

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	Morbid risk per 100 participants at age 75 years (95% CI)		Ratio of morbid risk to lifetime prevalence (95% CI)	
	Male sex	Female sex	Male sex	Female sex
Anxiety disorders				
Panic disorder or agoraphobia	3·6 (3·2–3·9)	7·3 (6·8–7·8)	1·8 (1·7–2·0)	2·0 (1·9–2·0)
Generalised anxiety disorder	6·5 (5·9–7·0)	12·5 (11·8–13·2)	2·4 (2·2–2·5)	2·5 (2·4–2·6)
Post-traumatic stress disorder	5·7 (5·1–6·3)	12·6 (11·7–13·5)	2·1 (1·9–2·2)	2·3 (2·2–2·4)
Social phobia	4·2 (3·8–4·6)	6·0 (5·5–6·4)	1·2 (1·1–1·3)	1·3 (1·2–1·4)
Specific phobia	5·9 (5·3–6·5)	11·6 (10·9–12·2)	1·2 (1·1–1·2)	1·2 (1·1–1·2)
Any anxiety disorder	18·3 (17·3–19·4)	31·0 (29·9–32·2)	1·6 (1·6–1·7)	1·7 (1·6–1·7)
Mood disorders				
Major depressive disorder	20·1 (19·2–20·9)	34·0 (33·2–34·9)	2·7 (2·6–2·8)	2·5 (2·4–2·5)
Bipolar disorder	6·3 (5·7–6·8)	6·2 (5·7–6·7)	2·5 (2·3–2·6)	2·8 (2·6–2·9)
Any mood disorder	24·5 (23·5–25·4)	37·9 (37·0–38·8)	2·6 (2·5–2·7)	2·5 (2·4–2·5)
Substance use disorders				
Alcohol abuse	21·6 (20·6–22·7)	7·2 (6·7–7·7)	1·6 (1·5–1·6)	2·2 (2·1–2·3)
Alcohol dependence	6·1 (5·6–6·7)	2·3 (2·0–2·7)	1·8 (1·7–1·9)	2·4 (2·2–2·7)
Drug abuse	7·9 (7·2–8·7)	4·2 (3·8–4·7)	1·9 (1·8–2·1)	2·5 (2·3–2·7)
Drug dependence	3·0 (2·4–3·5)	1·6 (1·4–1·9)	2·1 (1·8–2·3)	2·5 (2·3–2·8)
Any substance use disorder	24·4 (23·3–25·6)	9·9 (9·2–10·5)	1·6 (1·5–1·6)	2·2 (2·1–2·3)
Externalising disorders				
ADHD	3·0% (2·4–3·6)	1·8% (1·4–2·2)	1·3% (1·1–1·4)	1·2% (1·1–1·4)
Intermittent explosive disorder	5·9% (5·2–6·5)	5·2% (4·7–5·8)	1·7% (1·6–1·8)	2·1% (1·9–2·2)
Any externalising disorder	6·8% (6·0–7·5)	5·6% (5·0–6·2)	1·6% (1·5–1·7)	1·8% (1·7–1·9)
Any mental disorder	46·4% (44·9–47·8)	53·1% (51·9–54·3)	1·6% (1·6–1·7)	1·8% (1·8–1·8)

Table 3: **Morbid risk per 100 participants at age 75 years and ratio of morbid risk to lifetime prevalence by sex**

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See **Online** for appendix

For **World Bank data** see http://data.worldbank.org/country

For the **interactive data-visualisation website** see https://csievert.shinyapps.io/mental-aoo/

age $t-1$ year. We used information only from respondents in the age range between $t\pm10$ years to minimise recall bias. We then calculated cumulative lifetime disorder risk up to age 75 years (ie, morbid risk) from these incidence data using the standard exponential formula.[14] Smoothing was used with a 5-year bandwidth to reduce instability in estimates.

We calculated standard errors (SEs) of incidence rates and cumulative incidence curves using the jackknife repeated replications simulation method[15] considering both the weighting and geographical clustering of WMH data. In choosing WMH samples with geographical clustering, the typical design began by dividing the population into a series of mutually exclusive and collectively exhaustive geographically clustered strata made up of the equivalent of US counties or metropolitan areas (which could include multiple counties). When a metropolitan area was so populous that it entered the sample with certainty given the sampling fraction, it was referred to as a self-representing stratum. In all other cases, a single county or metropolitan area was chosen as the primary sampling unit within each stratum. These non-self-representing primary sampling units were then collapsed into pairs to create pseudostrata, and the primary sampling units within the pseudostrata were used to define sampling error calculation units for the jackknife repeated replications estimation. In the case of self-representing strata, geographically clustered half-samples were created to define a pair of sampling error calculation units in each stratum.

The approach we used to estimate conditional probability of first disorder onset within specific years of life considered right censoring (ie, the fact that not all respondents had reached age t as of the time of the survey) by excluding (ie, censoring) respondents who were not yet age t years from the denominator. The restriction of estimates to respondents no older than $t+10$ years reduced the effects of bias due to premature mortality. However, premature mortality bias could still occur if mortality depended on a history of mental disorders and systematic non-response on the basis of factors related to age-specific disorder risks. This possibility of residual bias is inevitable in community surveys, although it can be addressed in population registry data.[16] The direction of this potential bias cannot be assessed rigorously in the absence of information about disorder risk and censoring. However, as people with mental disorders have reduced life spans,[17] and people with known histories of being admitted to psychiatric hospitals have been shown to have comparatively low response rates in epidemiological surveys,[18] assuming that bias is in the direction of underestimating risk is reasonable.

We compared lifetime prevalence estimates by sex with Wald χ^2 tests and two-sided p values. We show these estimates along with 95% CIs. As WMH survey data are both geographically clustered and weighted, we used the design-based Taylor series linearisation method implemented in SAS version 9.4 to estimate SEs. An interactive data-visualisation website is available; age-specific and sex-specific data underlying the figures can be downloaded from this website.

Missing data at the symptom level were coded conservatively as being absent; subgroup mean imputation was used for other variables.

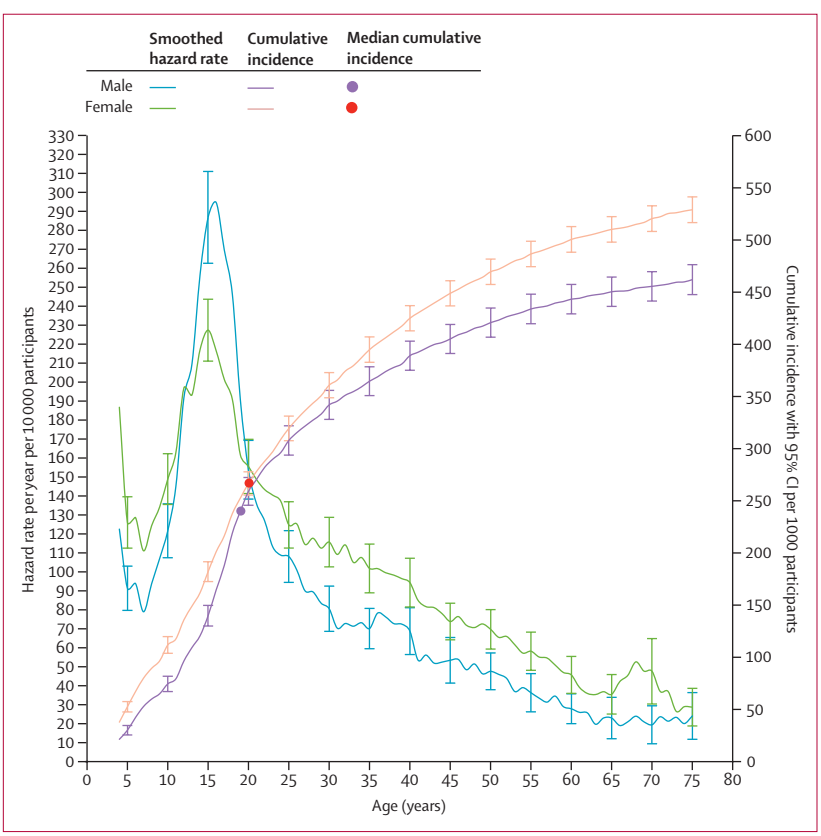


Figure 1: **Smoothed hazard rate per year of age and cumulative incidence of first onset by age and sex for any mental disorder**

Error bars represent 95% CIs. Incidence of first onset is smoothed to 5-year bandwidths and the hazard rate (ie, incidence rate) curves were calculated per year of age per 10 000 people, defined as the ratio of the number of disorder onsets at an age among people who never had the disorder at any time until that age and who lived through that age. We used information only from respondents in the age range between age of conditional probability of first onset at each year of life (t) up to $t+10$ years to minimise the effects of recall bias. Cumulative incidence (or morbid risk) curves were calculated on the basis of the age-specific incidence rates at each year of life with the standard exponential formula.[14]

Role of the funding source

There was no funding source for this analysis.

Results

We obtained data from 32 WMH surveys conducted in 29 countries, including 12 low-income and middle-income countries and 17 high-income countries. These surveys included 156 331 participants (85 308 [54·5%] female respondents and 71 023 [45·4%] male respondents). The overall weighted response rate across all surveys was 63·6% (table 1). 21 (66%) of the 32 surveys

were based on nationally representative household samples, whereas 11 (34%) were based on regional samples. Ethnicity was not assessed.

Lifetime prevalence of any mental disorder was 28·6% (95% CI 27·9–29·2) for male respondents and 29·8% (29·2–30·3) for female respondents (table 2). Lifetime prevalence of any anxiety disorder was 11·3% (10·9–11·7) for male respondents and 18·8% (18·3–19·2) for female respondents, and of any mood disorder was 9·5% (9·2–9·7) for male respondents and 15·4% (15·1–15·7) for female respondents (table 2). The three mental disorders with highest lifetime prevalence for male respondents were alcohol abuse (13·7%, 13·3–14·1), major depressive disorder (7·5%, 7·2–7·7), and specific phobia (5·0%, 4·8–5·3), and those for female respondents were major depressive disorder (13·6%, 13·3–13·9), specific phobia (10·0%, 9·7–10·2), and PTSD (5·4%, 5·2–5·7).

Projected lifetime morbid risk by age 75 years for each mental disorder was higher than the observed lifetime

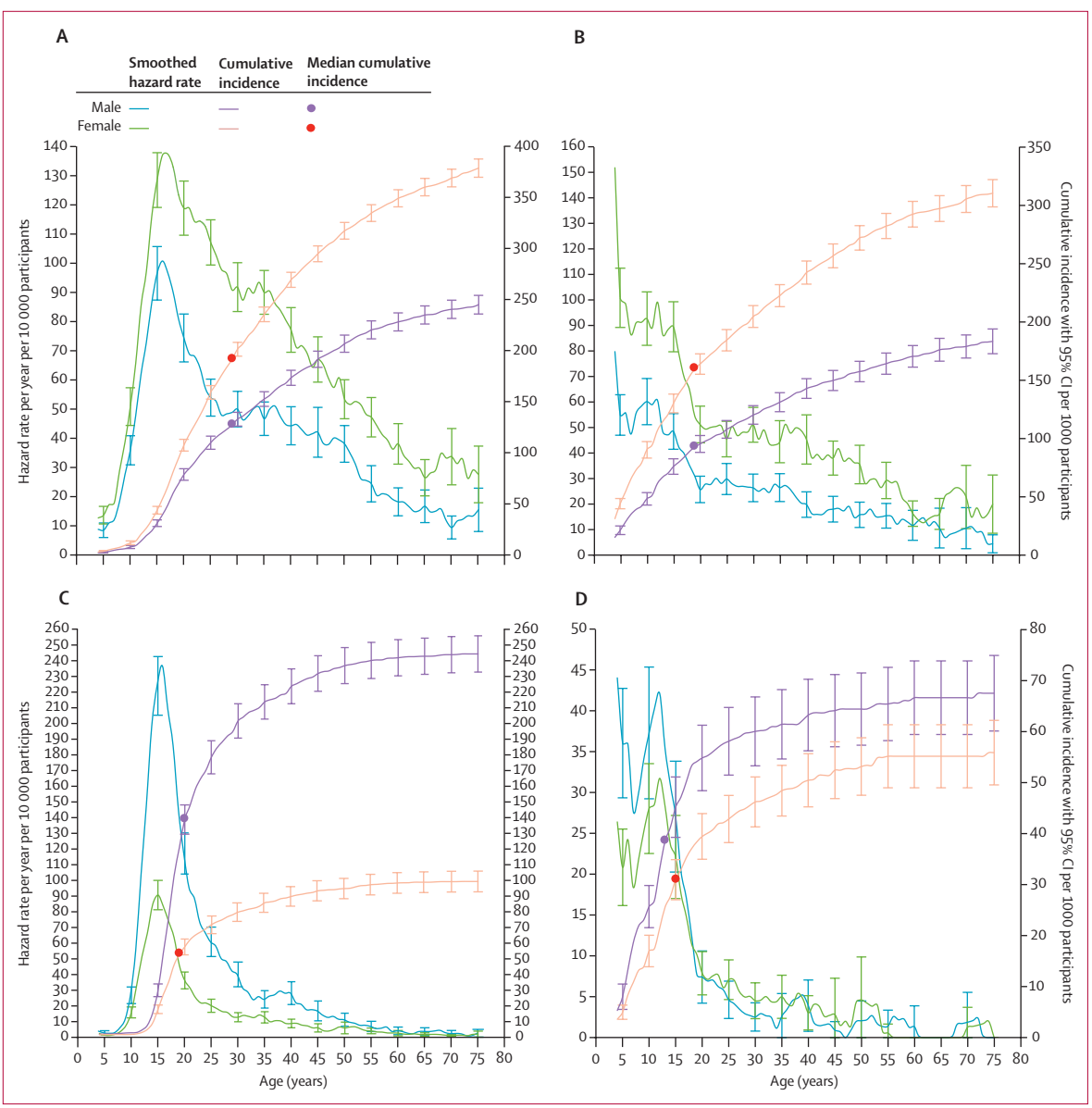
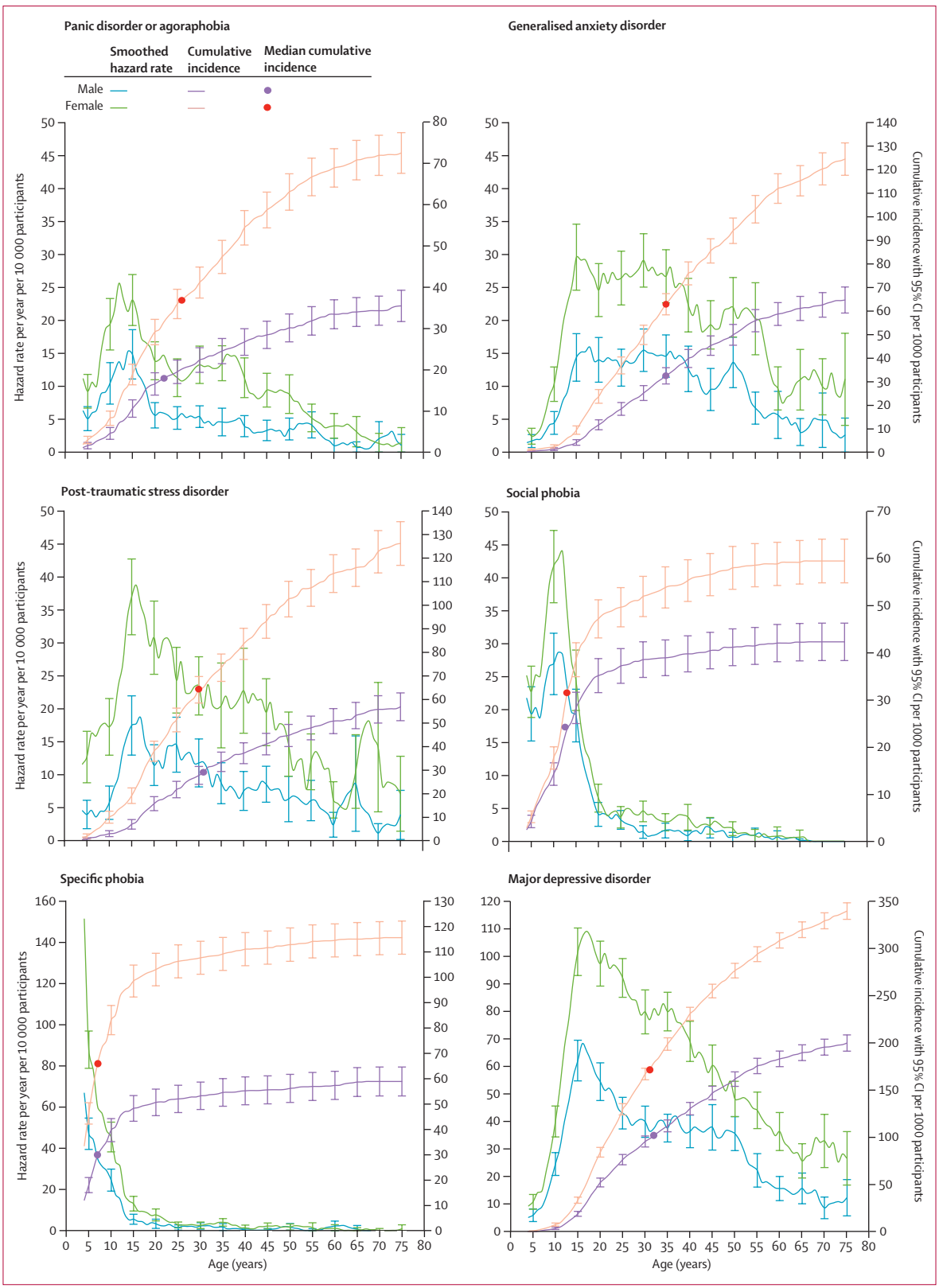


Figure 2: **Smoothed hazard rates and cumulative incidence by age and sex for any mood disorder (A), any anxiety disorder (B), any substance use disorder (C), and any externalising disorder (D)**

Error bars represent 95% CIs. Hazard rate (ie, incidence rate) curves were calculated per year of age per 10 000 people, defined as the ratio of the number of disorder onsets at an age among people who never had the disorder at any time until that age and who lived through that age. We used information only from respondents in the age range between age of conditional probability of first onset at each year of life (t) up to t+10 years to minimise the effects of recall bias. Cumulative incidence (or morbid risk) curves were calculated on the basis of the age-specific incidence rates at each year of life with the standard exponential formula.[14]

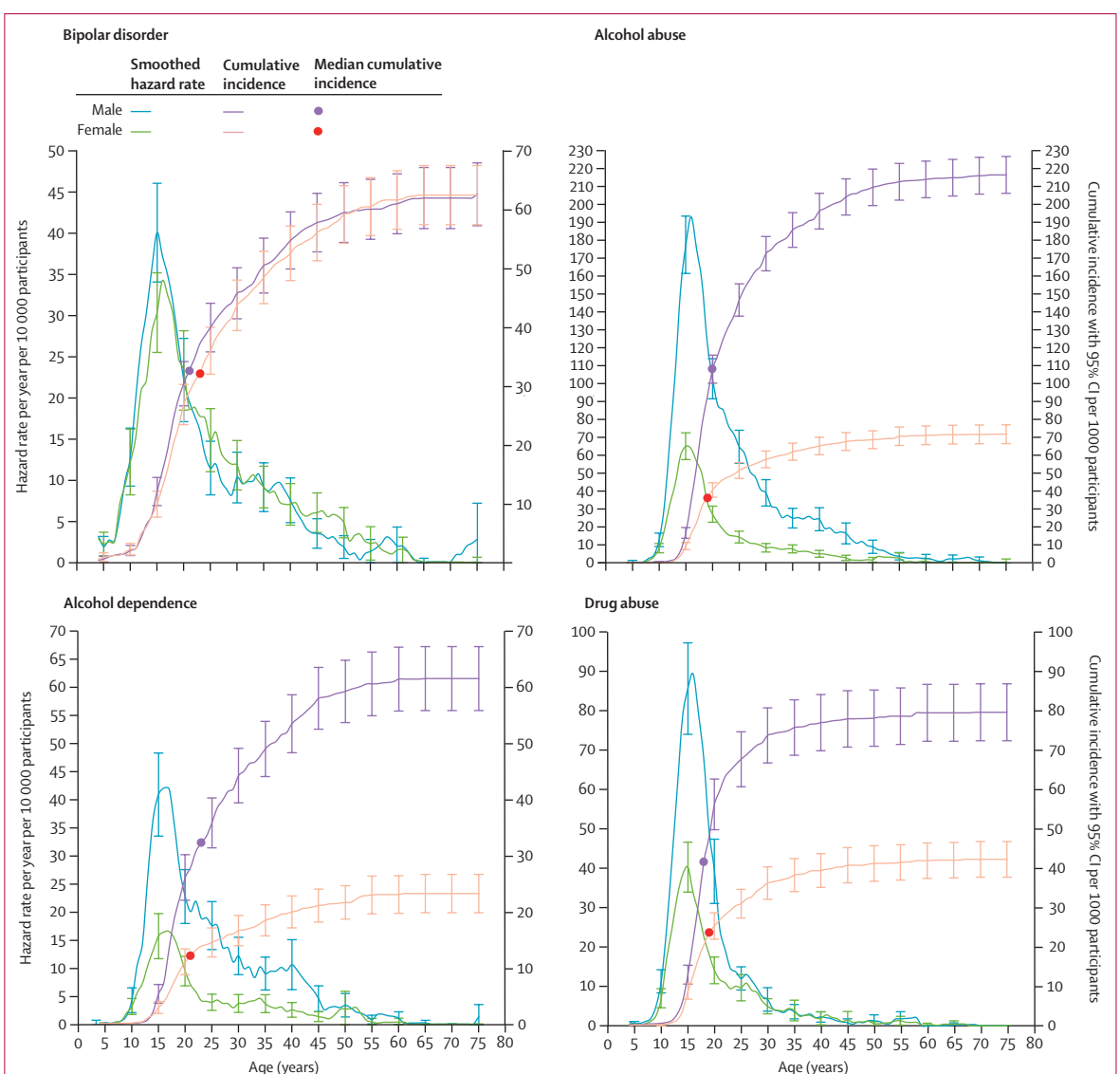


(Figure 3 continues on next page)

prevalence at interview. Lifetime morbid risk of any mental disorder as of age 75 years was 46·4% (44·9–47·8) for male respondents and 53·1% (51·9–54·3) for female respondents (table 3). The three disorders with highest lifetime morbid risk for male respondents were alcohol abuse (21·6%, 20·6–22·7), major depressive disorder (20·1%, 19·2–20·9), and drug abuse (7·9%, 7·2–8·7), and those for female respondents were major depressive disorder (34·0%, 33·2–34·9), PTSD (12·6%, 11·7–13·5), and generalised anxiety disorder (12·5%, 11·8–13·2).

The minimum, maximum, median, and IQR of cumulative lifetime risk as of age 75 years are in the appendix (p 5). For the incidence of first onset of any disorder, peak incidence was approximately at age 15 years. At age 15 years, male respondents had higher incidence (hazard rate 288·0 [95% CI 263·7–312·3] per 10 000 participants) than female respondents (228·2 [211·8–244·6] per 10 000 participants; figure 1). Across the rest of the lifespan, incidence was mostly slightly higher among female than male respondents. Cumulative risk curves (per 1000 people) were higher across the lifespan for female than male respondents. For any mental disorder, the median age of onset of the first disorder was 19 years (IQR 14–32) for male respondents and 20 years (12–36) for female respondents.

The ratio of morbid risk to lifetime prevalence shows the relatively high proportion of mental disorders that first occur in childhood, adolescence, or young adulthood (table 3). Disorders with earlier onsets have ratios closer to 1, whereas disorders with a wider onset distribution have ratios greater than 1. For male respondents, the lowest morbid risk to lifetime prevalence ratios were for



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ADHD, social phobia, and specific phobia, and the highest ratio was for major depressive disorder. For female respondents, the lowest ratios were for ADHD, social phobia, and specific phobia, and the highest ratio was for bipolar disorder.

The distributions of incidence rate and cumulative incidence differed when disaggregated by broad general disorder categories (figure 2) or specific disorder types (figure 3). For example, any externalising disorder shows an early peak incidence in the first decade of life, whereas incidence of any substance use disorder peaks around age 15 years. Both types of disorder were more common among male respondents than female respondents. Mood disorders and anxiety disorders were more common among female respondents than male respondents across the lifespan, but the peak incidence of any anxiety disorder was at age 5 years, compared with age 15 years for any mood disorder. The Wald χ^2 test compared the lifetime prevalence for each specific disorder and broad general category (table 2), showing that mood and anxiety disorders were more common among female respondents and substance use disorders and externalising disorders were significantly more common among male respondents.

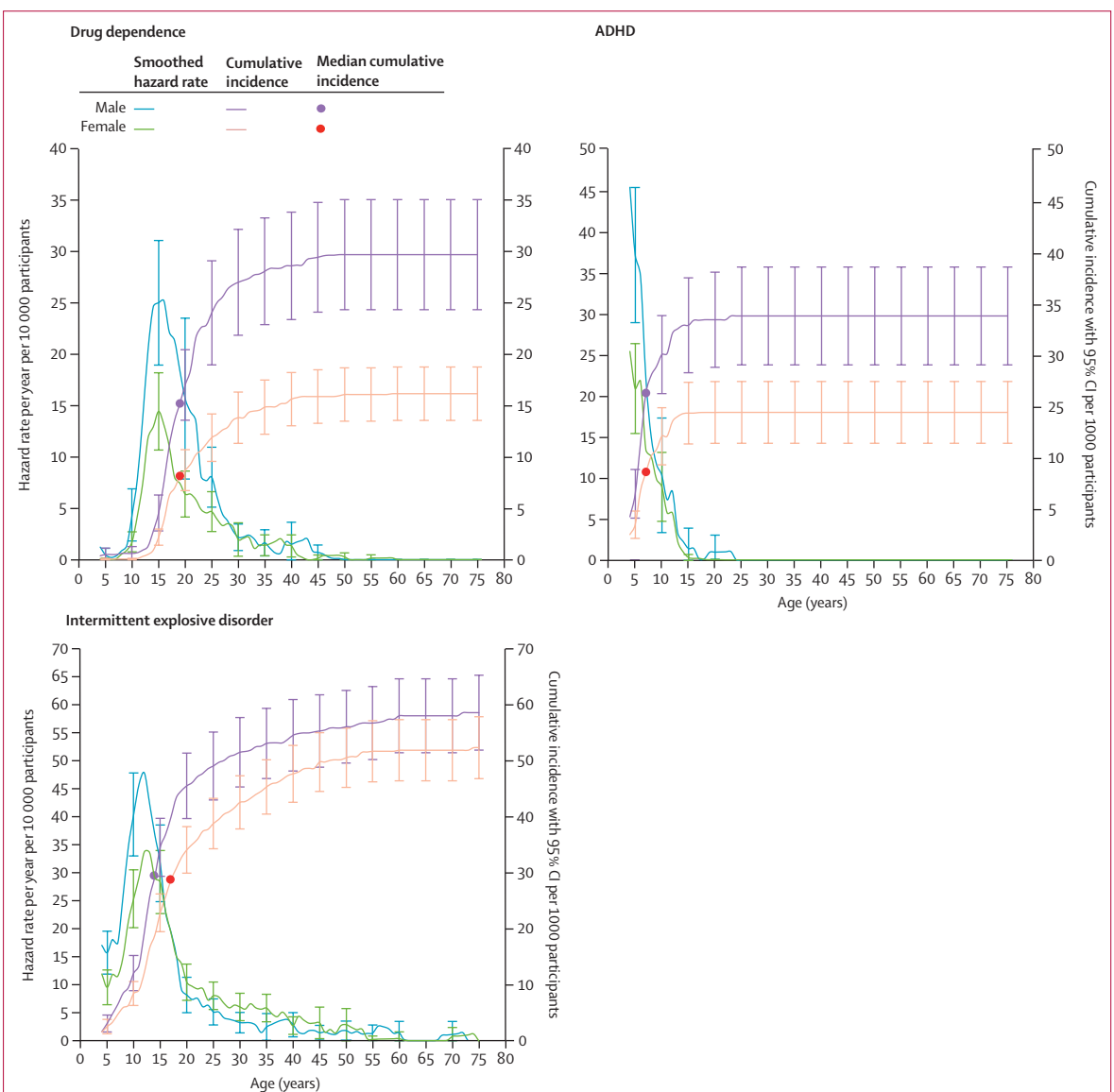

Figure 3: **Smoothed hazard rate and cumulative incidence by age and sex for 13 specific disorders**
Error bars represent 95% CIs. Hazard rate (ie, incidence rate) curves were calculated per year of age per 10 000 people, defined as the ratio of the number of disorder onsets at an age among people who never had the disorder at any time until that age and who lived through that age. We used information only from respondents at age of conditional probability of first onset in the age range between each year of life (t) up to t+10 years to minimise the effects of recall bias. Cumulative incidence (or morbid risk) curves were calculated on the basis of the age-specific incidence rates at each year of life with the standard exponential formula.[14]

The WMH surveys were conducted during a wide range of years. To assess whether the results differed depending on time of survey, we replicated all analyses for broad classes of disorders and any disorder separately for the 81 342 respondents in the 2007 paper and the 74 989 additional respondents from more recent surveys. Results showed broad consistency in relative prevalence across disorders and in comparing male versus female respondents (appendix p 6). There was broad consistency in morbid risk to lifetime prevalence ratios between the earlier and more recent surveys (appendix p 7), as well as for age of onset distributions (appendix pp 8–11).

Discussion

Based on WMH surveys in 29 countries, we estimated that by age 75 years, about one in two individuals will develop at least one of the mental disorders considered. We found that the incidence of anxiety and mood disorders was higher in female respondents, and that the incidence of externalising disorders was higher in male respondents. Our findings are based on more accurate estimates of age-of-onset distributions than previous studies, and they support the idea that many mental disorders have their first onset during childhood, adolescence, or young adulthood and that some disorders have earlier ages of onset than others.

Most studies of age-of-onset distributions have used data from register-based studies of treated mental disorders,[19] and both commonalities and differences can be seen between those studies and our population-based findings. First, as expected, the lifetime morbid risk of any treated mental disorders based on register data is lower than our estimates. This difference can be explained by the finding that many people with mental disorders never receive treatment.[20] Second, because of the well documented delays in seeking treatment after the first onset of mental disorders,[21] the age-of-onset distributions for register-based studies tend to be right-shifted (ie, delayed) compared with population-based studies. This bias is sex dependent, as female respondents are more likely than male respondents to seek treatment and to do so more quickly.[22]

A key finding is the substantial proportion of mental disorders that have early first onsets. We found that half of people who develop a mental disorder before age 75 years have their first onset by age 19 years for male respondents or 20 years for female respondents. In addition to the traditional childhood-onset disorders (eg, ADHD, social phobia, and specific phobia), common mental disorders (eg, major depressive disorder, generalised anxiety disorder, panic disorder, and drug use disorders) were found often to have their first onsets between childhood and early adulthood. This observation supports the need to invest in mental health services that have a particular focus on young people.[23] Although the median ages of onset for many disorders in male respondents and female respondents were similar, our findings indicate sex differences in lifetime prevalence for each of the mental disorders examined, with anxiety disorders and major depressive disorder more common among female respondents compared with impulse control and substance use disorders, which were more common among male respondents. These differences are consistent with previous studies.[24]

This study has important limitations. First, surveys were conducted over more than two decades, although there was good consistency of results. Second, all data were based on retrospective reports. Recall bias increases with the length of recall and can lead to under-identification of more temporally distant events,[7] as shown in birth cohort studies.[6] We based our estimates on onsets within 10 years of interview to attempt to minimise this bias. Third, our definition of disorder onset was based on single questions rather than detailed diagnostic assessments for first recalled occurrence, leading to possible downwardly biased estimates of age of onset. Fourth, the surveys could have been biased due to differential response. Fifth, although the sample was large enough to generate relatively precise, pooled disorder-specific estimates, it was not large enough to investigate between-country differences. Sixth, not all mental disorders were included in the CIDI. Finally, we did not consider comorbidity. There is increasing understanding that comorbidity is common within different types of mental disorders (eg, individuals with one type of mental disorder are at increased risk of subsequently developing other types of mental disorders)[25–27] and that the burden of illness is strongly influenced by comorbidity. Although our analysis provided lifetime estimates for any mental disorder and for specific types of disorders, we did not consider patterns of comorbidity and how they change during the life course.[26] We hope to investigate this issue in future studies.

We provided updated estimates of age-of-onset distributions, lifetime prevalence, and morbid risk for a range of mental disorders using improved methods to reduce the effects of recall bias. These estimates will be of value to service planners, researchers interested in the burden of disease, and genetic epidemiologists.

Contributors

JJM and RCK conceptualised and designed the analysis. NAS and RCK supervised the analysis. WTC and NAS analysed the data. JJM, RCK, AA-H, JA, YA, LHA, RB, JMCdA, SC, LD, FF, OG, JMH, EGK, GK, SMK, VK-M, MM, JM, FN-M, DN, JP-V JCS, DJS, CV, PWW, and ZZ provided data. All authors had access to all data for this analysis; JJM, RCK, NAS, and WTC directly accessed and verified the data. JJM and RCK drafted the initial manuscript. All authors reviewed the manuscript and were responsible for the decision to submit for publication.

Declaration of interests

LD receives educational grants from Indivior and Seqirus. OVD receives funding from Kowa Research Institute and has been an advisor in the PROMINENT trial. SMK and PWW receive grant funding from Hamad Medical Corporation through the Cambridgeshire and Peterborough National Health Service Foundation trust and from Qatar University. PWW has received financial support from the Qatar National Research Fund and an honorarium from Gresham College. RCK has been a consultant for Cambridge Health Alliance, Canandaigua Veterans Affairs

Medical Center, Holmusk, Partners Healthcare, RallyPoint Networks, and Sage Therapeutics. He holds stock options in Cerebral, Mirah, Prepare Your Mind, Roga Sciences, and Verisense Health. DN receives honoraria from AIG General Insurance and Takeda Pharmaceutical and financial support from Startia, En-power, and MD.net. DJS receives royalties from American Psychiatric Press, Cambridge University Press, and Elsevier–Academic Press. He has received honoraria from Discovery Vitality, Johnson & Johnson, Kanna, L'Oreal, Lundbeck, Orion, Sanofi, Servier, Takeda, and Vistagen. He was the president of the African College of Neuropsychopharmacology and is financially supported by the Medical Research Council of South Africa. All other authors declare no competing interests.

Data sharing

Access to the cross-national World Mental Health (WMH) data is governed by the organisations responsible for funding and survey data collection in each country. These organisations made data available to the WMH survey consortium through restricted data sharing agreements that do not allow data to be released to third parties. US data are available for secondary analysis via the Inter-University Consortium for Political and Social Research (http://www.icpsr.umich.edu/icpsrweb/ICPSR/series/00527). A complete list of all within-country and cross-national WMH publications is available (http://www.hcp.med.harvard.edu/wmh/). No additional data or materials will be made available.

Acknowledgments

Financial and technical support for the World Mental Health (WMH) Survey Initiative were provided by WHO, the US National Institute of Mental Health (R01 MH070884), the John D and Catherine T MacArthur Foundation, the Pfizer Foundation, the US Public Health Service (R13-MH066849, R01-MH069864, and R01 DA016558), the Fogarty International Center (FIRCA R03-TW006481), the Pan American Health Organization, Eli Lilly, Ortho-McNeil Pharmaceutical, GlaxoSmithKline, and Bristol-Myers Squibb. We thank the staff of the WMH data collection and data analysis coordination centres for assistance with instrumentation, fieldwork, and consultation on data analysis. The 2007 Australian National Survey of Mental Health and Wellbeing is funded by the Australian Government Department of Health and Ageing. The Argentina survey (Estudio Argentino de Epidemiología en Salud Mental) was funded by a grant from the Argentinian Ministry of Health (Ministerio de Salud de la Nación; 2002–17270/13–5). The São Paulo Megacity Mental Health Survey is funded by the State of São Paulo Research Foundation Thematic Project grant (03/00204–3). The Bulgarian epidemiological study of common mental disorders (EPIBUL) is funded by the Bulgarian Ministry of Health and the National Center for Public Health Protection. EPIBUL 2 is funded by the Bulgarian Ministry of Health and European Economic Area grants. The Colombian National Study of Mental Health is funded by the Colombian Ministry of Social Protection. The Mental Health Study Colombia–Medellín was conducted and funded by the Center for Excellence on Research in Mental Health and the Secretary of Health of Medellín. The European Study of The Epidemiology of Mental Disorders is funded by the European Commission (QLG5–1999–01042, SANCO 2004123, and EAHC 20081308), the Piedmont Region, Fondo de Investigación Sanitaria, Instituto de Salud Carlos III in Spain (FIS 00/0028), Ministerio de Ciencia y Tecnología in Spain (SAF 2000–158-CE), Generalitat de Catalunya (2017 SGR 452 and 2014 SGR 748), Instituto de Salud Carlos III (CIBER CB06/02/0046, RETICS RD06/0011 REM-TAP), other local agencies, and an unrestricted educational grant from GlaxoSmithKline. Implementation of the Iraq Mental Health Survey and data entry were conducted by the staff of the Iraqi Ministry of Health and Ministry of Planning with direct funding from the Japanese and European Funds through UN Development Group Iraq Trust Fund. The Israel National Health Survey is funded by the Israeli Ministry of Health with funding from the Israel National Institute for Health Policy and Health Services Research and the National Insurance Institute of Israel. The WMH Japan Survey is funded by the Grant for Research on Psychiatric and Neurological Diseases and Mental Health (H13-SHOGAI-023, H14-TOKUBETSU-026, H16-KOKORO-013, and H25-SEISHIN-IPPAN-006) from the Japan Ministry of Health, Labour, and Welfare. The Lebanese Evaluation of the Burden of Ailments and Needs of the Nation is funded by the Lebanese Ministry of Public Health; WHO (Lebanon); the National Institute of Health–Fogarty International Center (R03 TW006481–01); anonymous private donations to the Institute for Development, Research, Advocacy and Applied Care in Lebanon; and unrestricted grants from Algorithm, AstraZeneca, Benta, Bella Pharma, Eli Lilly, GlaxoSmithKline, Lundbeck, Novartis, OmniPharma, Pfizer, Phenicia, Servier, and Union Pharmaceutique d'Orient. The Mexican National Comorbidity Survey is funded by The National Institute of Psychiatry Ramon de la Fuente (INPRFMDIES 4280) and by the National Council on Science and Technology (CONACyT-G30544-H), with supplemental funding from the Pan American Health Organization. Te Rau Hinengaro: The New Zealand Mental Health Survey is funded by the New Zealand Ministry of Health, Alcohol Advisory Council, and the Health Research Council. The Nigerian Survey of Mental Health and Wellbeing is funded by WHO, WHO (Nigeria), and the Federal Ministry of Health, Abuja, Nigeria. The Northern Ireland Study of Mental Health was funded by the Health and Social Care Research and Development Division of the UK Public Health Agency. The Peruvian WMH Study was funded by the National Institute of Health of the Ministry of Health of Peru. The Polish Epidemiology of Mental Health and Access to Care Project (PL 0256) was conducted by the Institute of Psychiatry and Neurology in Warsaw, the Department of Psychiatry–Medical University in Wroclaw, and the National Institute of Public Health–National Institute of Hygiene in Warsaw in partnership with Psykiatrist Institut Vinderen–Universitet, Oslo. The project was funded by the European Economic Area Financial Mechanism and the Norwegian Financial Mechanism. The Polish Epidemiology of Mental Health and Access to Care Project was co-financed by the Polish Ministry of Health. The Portuguese Mental Health Study was conducted by the Department of Mental Health, Faculty of Medical Sciences at the Nova University of Lisbon with collaboration from the Portuguese Catholic University and was funded by Champalimaud Foundation, Gulbenkian Foundation, Foundation for Science and Technology, and Portuguese Ministry of Health. The WMH Qatar Study was conducted by the Social and Economic Survey Research Institute at Qatar University and Hamad Medical Corporation. The Romania WMH study projects, Policies in Mental Health Area and National Study regarding Mental Health and Services Use, were conducted by the Romanian National School of Public Health and Health Services Management (formerly the National Institute for Research and Development in Health); received technical support from Metro Media Transilvania, the National Institute of Statistics–National Centre for Training in Statistics, Cheyenne Services, and Statistics Netherlands; and were funded by the Romanian Ministry of Public Health (formerly the Ministry of Health) and Eli Lilly Romania. The Saudi National Mental Health Survey is conducted by the King Salman Center for Disability Research and is funded by Saudi Basic Industries Corporation, King Abdulaziz City for Science and Technology, Saudi Arabia Ministry of Health, and King Saud University. Funding was also provided by King Faisal Specialist Hospital and Research Center and the Ministry of Economy and Planning, General Authority for Statistics. The South Africa Stress and Health Study is funded by the US National Institute of Mental Health (R01-MH059575) and National Institute of Drug Abuse with supplemental funding from the South African Department of Health and the University of Michigan. The Shenzhen Mental Health Survey is funded by the Shenzhen Bureau of Health and the Shenzhen Bureau of Science, Technology, and Information. The Psychiatric Enquiry to General Population in Southeast Spain-Murcia Project is funded by the Regional Health Authorities of Murcia (Servicio Murciano de Salud and Consejería de Sanidad y Política Social) and Fundación para la Formación e Investigación Sanitarias of Murcia. The Ukraine Comorbid Mental Disorders during Periods of Social Disruption study is funded by the US National Institute of Mental Health (R01-MH61905). The US National Comorbidity Survey Replication is funded by the National Institute of Mental Health (U01-MH60220) with supplemental financial support from the National Institute of Drug Abuse, the Substance Abuse and Mental Health Services Administration, the Robert Wood Johnson Foundation (044708), and the John W Alden Trust.

Editorial note: The Lancet Group takes a neutral position with respect to territorial claims in published institutional affiliations, tables, figures, and text.

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