Missing MRI data in the ABCD study: Associations with study variables and the impact of rs-fMRI Quality Control Stringency

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Objective

Excluding participants due to image quality is a standard practice in resting state MRI analysis (Power et al., 2014). We describe the impact of exclusions on the characteristics of the ABCD sample at several levels of exclusion and motion thresholding.

Methods

We utilized data from the ABCD Community Collection (Feczko et al., 2021), with supplemental QC flags from ABCD release 4.0. Participants were flagged under the following QC conditions:

Level	Description
Full (**F**)	Entire sample
ABCD 4 Tabulated (**T**)	rsFMRI tabulated data available (at least 1 T1 and 1 rsFMRI were complete and passed visual inspection)
ABCC (**C**)	Included in the ABCD Community Collection
ABCC < .5mm	ABCC + censoring at threshold*
ABCC < .4mm	"
ABCC < .3mm	"
ABCD 4 Recommended (**R**)	T1 and rsFMRI recommended in 'ABCD Recommended Imaging Inclusion' table (includes 375 frames at <.2mm FD)
ABCD < .2mm	ABCC + censoring at .2mm threshold
ABCD < .1mm	"

*In ABCC, Framewise displacement for each scan was filtered for respiratory artifact (Fair et al., 2020). Frames with filtered FD above threshold, as well as series with less than five contiguous frames between filtered frames, were considered unusable. Participants with <375 usable frames were excluded.

Importantly, inclusion recommendations in Tabulated and Community collection were substantially non-overlapping (see upset plot, right). These discrepancies likely stem from changes in ABCD over time (i.e. coding changes and re-acquired scans).

We ran a logistic regression model for each exclusion variable where behavioral and demographic variables predicted the adjusted odds of exclusion. Significant coefficients are starred in figures; adjusted odds ratios are presented in right panel table.

Conclusions

- Exclusions due to scan quality (before motion censoring) are a major source of missingness.
- Inclusion recommendations may change markedly between releases/dataset versions.
- QC exclusions affect sample characteristics including parent education, neighborhood characteristics, sex, census race/ethnicity, psychopathology, age, cognitive performance, and BMI.

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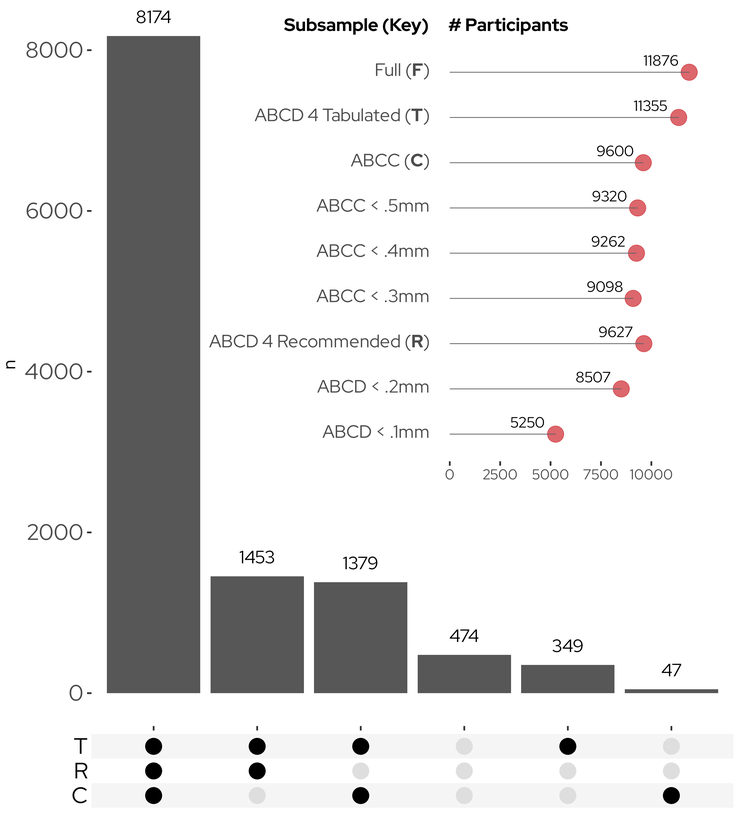
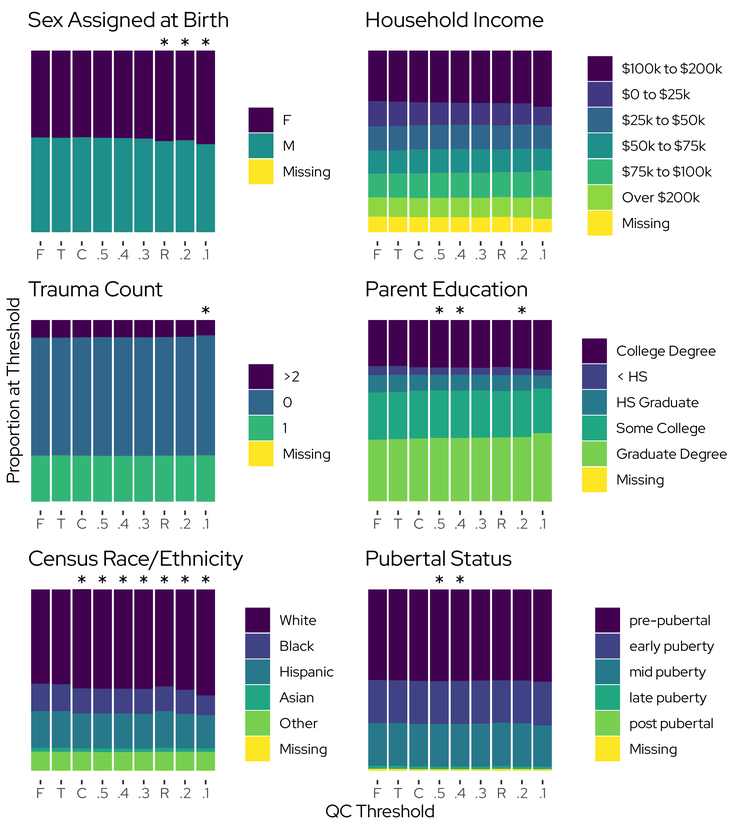
Differences in QC Inclusion Recommendations Alter the Representativeness of ABCD Resting-State Data

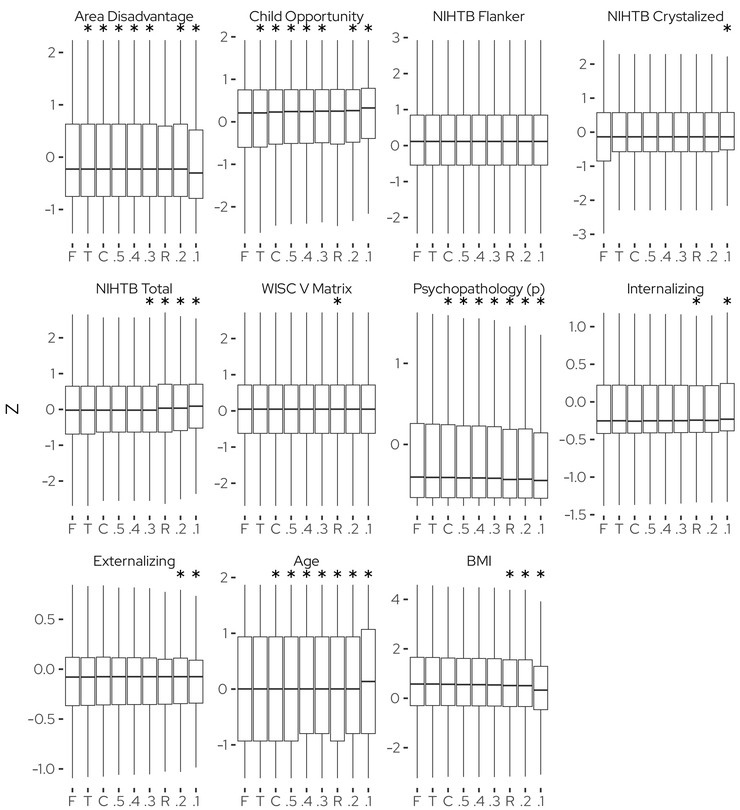
Inconsistencies in Inclusion Criteria across ABCD/C



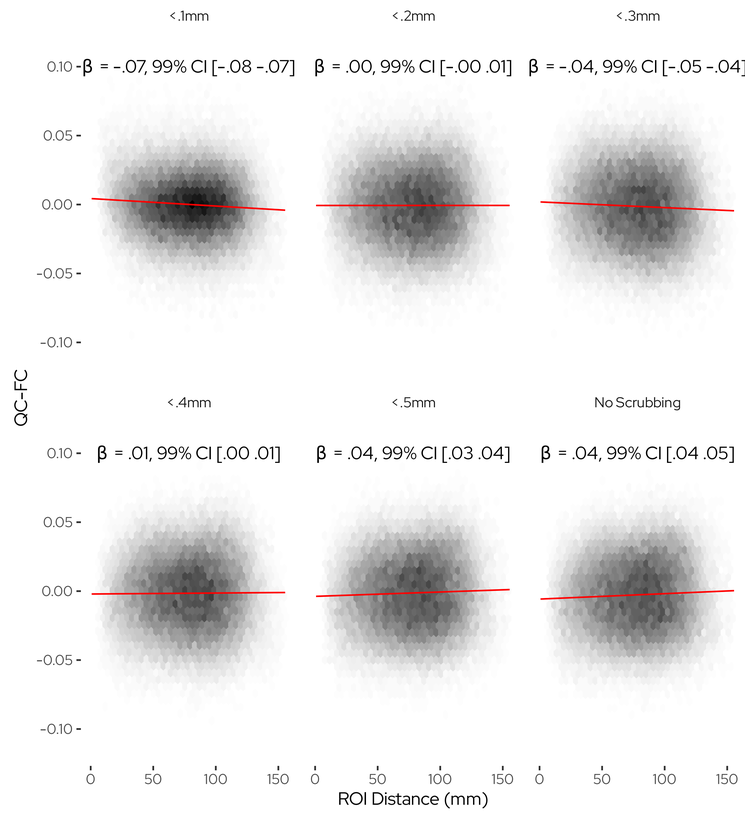
Categorical Variables by Inclusion Criteria



Continuous Variables by Inclusion Criteria



QC-FC correlations by distance at 6 scrubbing thresholds



Adjusted Odds Ratios

	T	C	0.5	0.4	0.3	R	0.2	0.1
Variable	OR	OR	OR	OR	OR	OR	OR	OR
Intercept	.04***	.16***	.18***	.19***	.20***	.14***	.25***	.81**
Sex (Male)	.99	.99	1.07	1.10	1.15	1.48***	1.26***	1.32***
Household Income (ref: $100-$200k)								
$0-$25k	1.41	1.09	1.14	1.16	1.10	1.17	1.11	1.03
$25-$50k	.87	.91	.89	.91	.91	.90	.86	.89
$50-$75k	1.04	.91	.90	.91	.91	1.06	.92	1.08
$75-$100k	1.06	.94	.96	.95	.98	.99	.93	.92
>$200k	1.04	.95	.98	.98	1.00	1.10	.98	.96
Highest Parental Education (ref: College Degree)								
<High School	.97	1.43	1.48*	1.49*	1.43	1.07	1.46*	1.30
HS Grad.	1.09	1.19	1.25	1.24	1.25	1.18	1.25	1.16
Some College	.69	.98	1.02	1.03	1.03	1.00	1.09	1.01
Graduate	1.06	1.16	1.13	1.12	1.13	1.02	1.14	1.05
Census Race/Ethnicity (ref: White)								
Black	1.36	1.85***	1.68***	1.62***	1.57***	1.20	1.51***	1.46***
Hispanic	1.04	1.32**	1.19	1.18	1.19	.87	1.11	1.09
Asian	2.10	1.89***	1.93***	1.88***	2.05***	1.87**	1.98***	1.52*
Other	1.20	1.37**	1.34**	1.34**	1.28*	.99	1.17	1.11
KSADS Trauma Count (ref: 0 Exposures)								
1 Trauma	.92	1.03	1.05	1.05	1.05	1.02	1.03	.96
>=2 Trauma	1.18	1.18	1.12	1.08	1.06	1.02	1.13	1.20*
Pubertal Status (ref: pre-pubertal)								
Early Puberty	1.14	1.01	1.02	1.02	.99	1.03	1.04	1.00
Mid Puberty	.97	1.01	1.03	1.03	1.03	1.04	1.01	1.08
Late Puberty	1.13	1.60	1.67*	1.65*	1.53	1.00	1.45	1.03
Post Pubertal	3.32	.51	.45	.44	.42	2.29	1.32	.96
Area Disadvantage	1.01	.67***	.70***	.72***	.73***	.97	.76***	.85***
Child Opportunity	1.12	.77***	.79***	.80***	.80***	.97	.83***	.85***
NIHTB Flanker	.86	1.01	1.02	1.01	1.02	.99	1.02	1.01
NIHTB Crystalized	.92	1.01	1.05	1.05	1.08	1.09	1.08	1.14*
NIHTB Total	.92	.95	.88	.88	.85*	.79**	.84*	.82***
WISC V Matrix	.84	1.00	1.00	.99	.98	.89**	.96	.96
Psychopathology	1.10	1.08*	1.11***	1.11***	1.11***	1.16***	1.13***	1.11***
Internalizing	1.01	.99	.98	.97	.96	.93*	.95	.92***
Externalizing	.96	.94	.94	.94	.94	.94	.94*	.93*
Age	.90	.88***	.85***	.85***	.84***	.82***	.82***	.82***
BMI	1.00	1.01	1.03	1.02	1.04	1.16***	1.09***	1.18***

All p values fdr corrected. *: p<.05, **p<.01, ***: p<.001

Multiply at Risk Cell Counts

Non-white (census) with psychopathology at z >= 1.5

F	T	C	.5	.4	.3	R	.2	.1
552	510	407	388	385	373	399	339	180

Male participants with NIH toolbox total scores of z <= -1.5

F	T	C	.5	.4	.3	R	.2	.1
382	343	275	254	248	235	232	207	94

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