Predicting children and young people's needs in UK mental health services

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CAMHS Evidence Based Practice Unit

UCL

Caring for young minds
Anna Freud Centre

CORC
CAMHS Outcomes Research Consortium

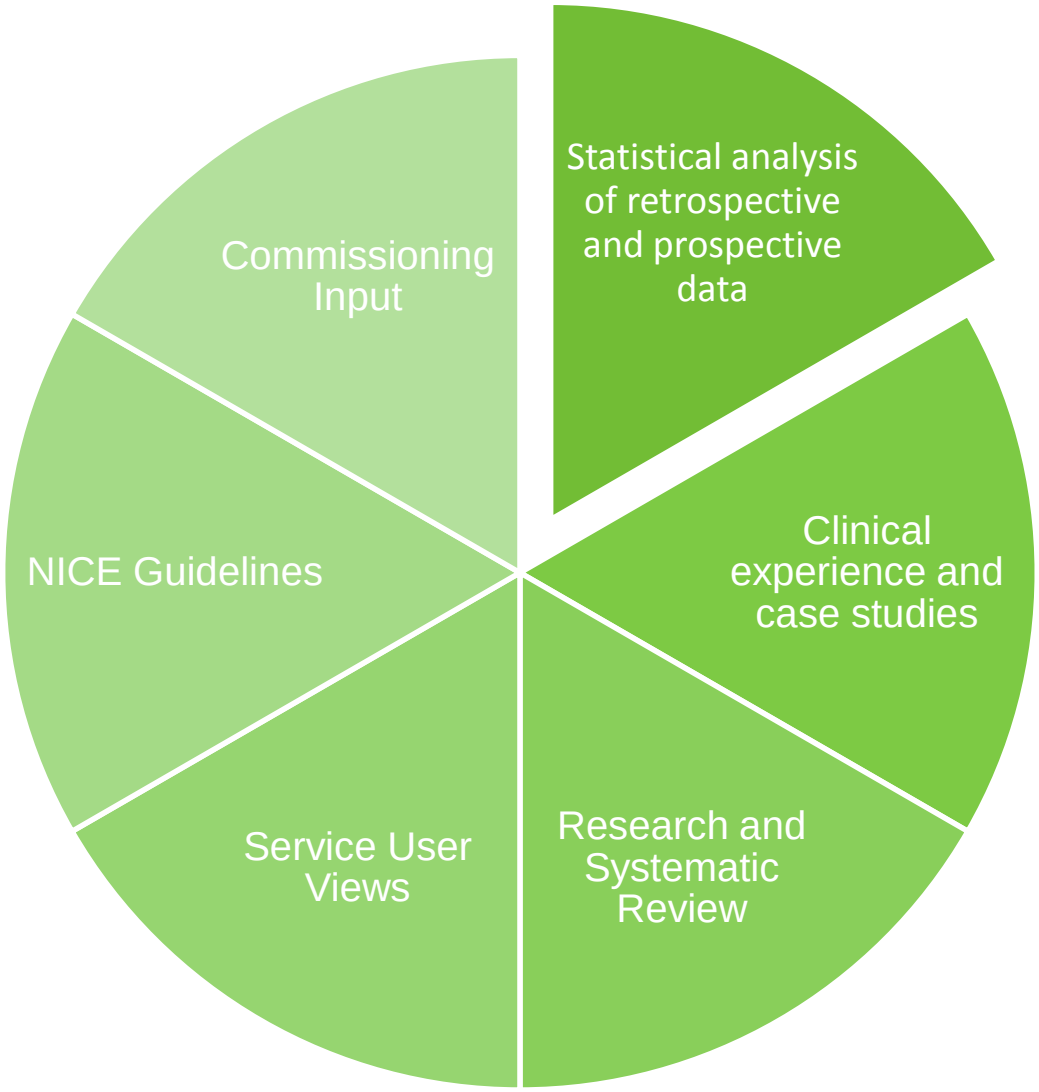
The basic questions

1. What factors predict resource need in routine CAMHS practice?
2. What's the best way to discretise continua predicting need?
3. How can we integrate analyses from routine practice with other sources of info, e.g., best practice guidelines?

Why?

- Part of the TPFKA-CAMHS-PbR project
  - Development of care clusters, (like) HRGs: "clinically meaningful group of diagnoses and interventions that consume similar levels of NHS resources"
- Planning services, e.g., to support CAPA
  - How many clinicians do we need?
- Clinical reasoning about individual cases
  - Have I got the formulation right?
  - How's treatment going?

Combining information…



WHAT WE KNEW?

“No-one really knows what the average number of appointments or clinical hours clients have in Core Partnership work.”

(York & Kingsbury, 2013)

Number of face-to-face contacts

- York and Kingsbury (2013) review a range of audits; average works out around 7.5 for core partnership work
- Average cost data reviewed by NICE guidelines
- Goodman (1997) and Kelvin (2005) provide estimates of input needs
- Very rare to see published data from routine practice conditioned on interesting predictors
- Tear-jerkingly beautiful notable exception from Stockholm…

Examples from Lundh et al 2012 (note filtered so min. duration one month)

Diagnosis	Number of visits				
	N	Mean	SD	median	range
Dissociative disorder	76	33.1	37.7	19.5	1–212
Sexual and gender identity disorder	28	27.5	40.8	11.5	1–198
Schizophrenia, psychotic disorder	23	25.0	24.7	21	1–110
Suicide attempt	302	24.4	26.9	14	1–157
Post Traumatic Stress disorder	440	21.7	22.1	13	1–179
Eating disorder	613	21.0	23.3	14	2–235
Identity problem	529	19.8	21.7	13	1–198
Obsessive-Compulsive Disorder	606	18.2	17.8	14	1–198
Mood disorders including bipolar disorder	2213	17.9	18.3	12	1–212
Somatoform disorder	71	17.8	14.4	13	2–68
Substance-related disorder	78	17.8	17.7	13.5	1–116
Anxiety disorder	2446	17.3	19.0	11	1–235
Pervasive developmental disorder	1053	15.2	13.0	12	1–110
Oppositional defiant disorder	643	14.5	16.1	9	1–174
Attention-deficit/hyperactivity disorder	1169	14.0	13.2	10	1–104
Conduct disorder	390	12.4	11.9	8	1–123
Tic disorder	151	11.7	10.5	9	2–60
Eating disorder, early childhood	19	9.5	8.6	7	2–30

Interesting corner of physical health PbR: multiple trauma

- Uses ICD-10 and OPCS-4 complexity scores, e.g.,
  - S72.40 Fracture of lower femur: closed (7)
  - W20.8 Other specified primary open reduction of fracture of bone and extramedullary fixation (9)
- Sum individuals' codes to get two scores
- Look up HRG derivation grid (an algorithm?):

Proc score => Diag score	0	1 - 8	9 - 18	19 - 29	30 - 44	>=45
<=23	VA10A	VA11A	VA12A	VA13A	VA14A	VA15A
24 - 32	VA10B	VA11B	VA12B	VA13B	VA14B	VA15B
33 - 50	VA10C	VA11C	VA12C	VA13C	VA14C	VA15C
>=51	VA10D	VA11D	VA12D	VA13D	VA14D	VA15D

Case	Age	Length of Stay (days)	Diagnoses (ICD-10)	Procedures (OPCS-4)	HRG4
C	15	25	S12.90 Fracture of neck, part unspecified: closed + S82.40 Fracture of fibula alone: closed + S82.51 Fracture of medial malleolus: open + S85.0 Injury of popliteal artery + S14.1 Other and unspecified injuries of cervical spinal cord + S81.9 Open wound of lower leg, part unspecified + V03.9 Pedestrian injured in collision with car, pick-up truck or van: Unspecified whether traffic or non traffic accident	W25.1 Closed reduction of fracture of bone and fixation to skeleton HFQ + W33.2 Debridement of open fracture of bone + Z78.1 Shafts of tibia and fibula in combination + Z94.2 Right sided operation + W92.4 Examination of joint under anaesthetic + Y53.5 Approach to organ under image intensifier + Z84.6 Knee joint + Z94.2 Right sided operation + T55.6 Release fasciotomy of leg NEC + Z94.2 Right sided operation + V37.8 Other specified primary fusion of joint of cervical spine + V55.1 one level of spine + V45.2 Open reduction of fracture of spine NEC + V55.1 one level of spine	Diagnosis score = 6 + 7 + 7 + 4 + 7 + 5 + 0 = 36 Procedure score = 10 + 8 + 0 + 0 + 7 + 0 + 0 + 0 + 8 + 0 + 10 + 0 + 10 + 0 = 53 Therefore the HRG is VA15C Multiple trauma diagnoses, score 33 - 50 with interventions, score >=45

Diagnosis Score ICD10		Procedure Score OPCS					
		0	1-8	9-18	19-29	30-44	>=45
<=23	No. of cases	9,466	2,952	4,822	946	194	15
	LOS	4.4	4.6	8.9	9.6	15.2	27.8
24 – 32	No. of cases	3,088	970	2,198	614	187	33
	LOS	11.4	10.8	16.8	15.6	19.7	26.6
33 – 50	No. of cases	2,367	756	1,847	676	337	82
	LOS	18.8	18.0	24.4	25.0	29.9	35.9
>=51	No. of cases	645	279	680	421	308	189
	LOS	33.3	36.0	40.1	43.7	47.4	62.2

http://www.londontraumaoffice.nhs.uk/silo/files/s1-national-update-k-willett.pdf

Compare and contract: algorithm for predicting cluster 1 in adult MH PbR

exp((274.1261×Item1_Score_0 + 231.374×Item2_Score_0 + 74.79094×Item3_Score_0 + 1116.246×Item4_Score_0 + 0×Item5_Score_0 + 643.8571×Item6_Score_0 + 135.7461×Item7_Score_0 + 219.093×Item8_Score_0 + 429.2262×Item9_Score_0 + 69.18559×Item10_Score_0 + 0×Item11_Score_0 + 232.9812×Item12_Score_0 + 42.61629×Item13_Score_0 + 43.61732×ItemA_Score_0 + 334.1883×ItemB_Score_0 + 0×ItemC_Score_0 + 122.8488×ItemD_Score_0 + 203.1964×ItemE_Score_0 + 278.323×Item1_Score_1 + 230.8871×Item2_Score_1 + 68.66777×Item3_Score_1 + 1118.597×Item4_Score_1 + 0×Item5_Score_1 + 655.0367×Item6_Score_1 + 282.4226×Item7_Score_1 + 467.9079×Item8_Score_1 + 429.2671×Item9_Score_1 + 72.16214×Item10_Score_1 + 0×Item11_Score_1 + 232.2064×Item12_Score_1 + 40.46893×Item13_Score_1 + 39.20682×ItemA_Score_1 + 337.9674×ItemB_Score_1 + 0×ItemC_Score_1 + 103.0121×ItemD_Score_1 + 201.9949×ItemE_Score_1 + 276.9076×Item1_Score_2 + 233.1237×Item2_Score_2 + 76.34718×Item3_Score_2 + 1120.471×Item4_Score_2 + 0×Item5_Score_2 + 587.0671×Item6_Score_2 + 51.84121×Item7_Score_2 + 90.04503×Item8_Score_2 + 431.6853×Item9_Score_2 + 66.49924×Item10_Score_2 + 0×Item11_Score_2 + 232.6356×Item12_Score_2 + 14.69476×Item13_Score_2 + 39.19009×ItemA_Score_2 + 349.5469×ItemB_Score_2 + 0×ItemC_Score_2 + 113.5403×ItemD_Score_2 + 201.7448×ItemE_Score_2 + 310.5489×Item1_Score_3 + 242.7606×Item2_Score_3 + 69.52968×Item3_Score_3 + 1133.2×Item4_Score_3 + 0×Item5_Score_3 + 0×Item6_Score_3 + 56.5532×Item7_Score_3 + 66.51422×Item8_Score_3 + 425.317×Item9_Score_3 + 87.08731×Item10_Score_3 + 0×Item11_Score_3 + 234.038×Item12_Score_3 + 23.89605×Item13_Score_3 + 18.36489×ItemA_Score_3 + 13.40368×ItemB_Score_3 + 0×ItemC_Score_3 + -20.17667×ItemD_Score_3 + 252.9833×ItemE_Score_3 + 0×Item1_Score_4 + 0×Item2_Score_4 + 0×Item3_Score_4 + 0×Item4_Score_4 + 0×Item5_Score_4 + 0×Item6_Score_4 + 0×Item7_Score_4 + 0×Item8_Score_4 + 0×Item9_Score_4 + 0×Item10_Score_4 + 0×Item11_Score_4 + 0×Item12_Score_4 + 0×Item13_Score_4 + 0×ItemA_Score_4 + 0×ItemB_Score_4 + 0×ItemC_Score_4 + 0×ItemD_Score_4 + 0×ItemE_Score_4 − 2282.15)/10)

MINING SERVICES' EXISTING DATA

The shape of resource data

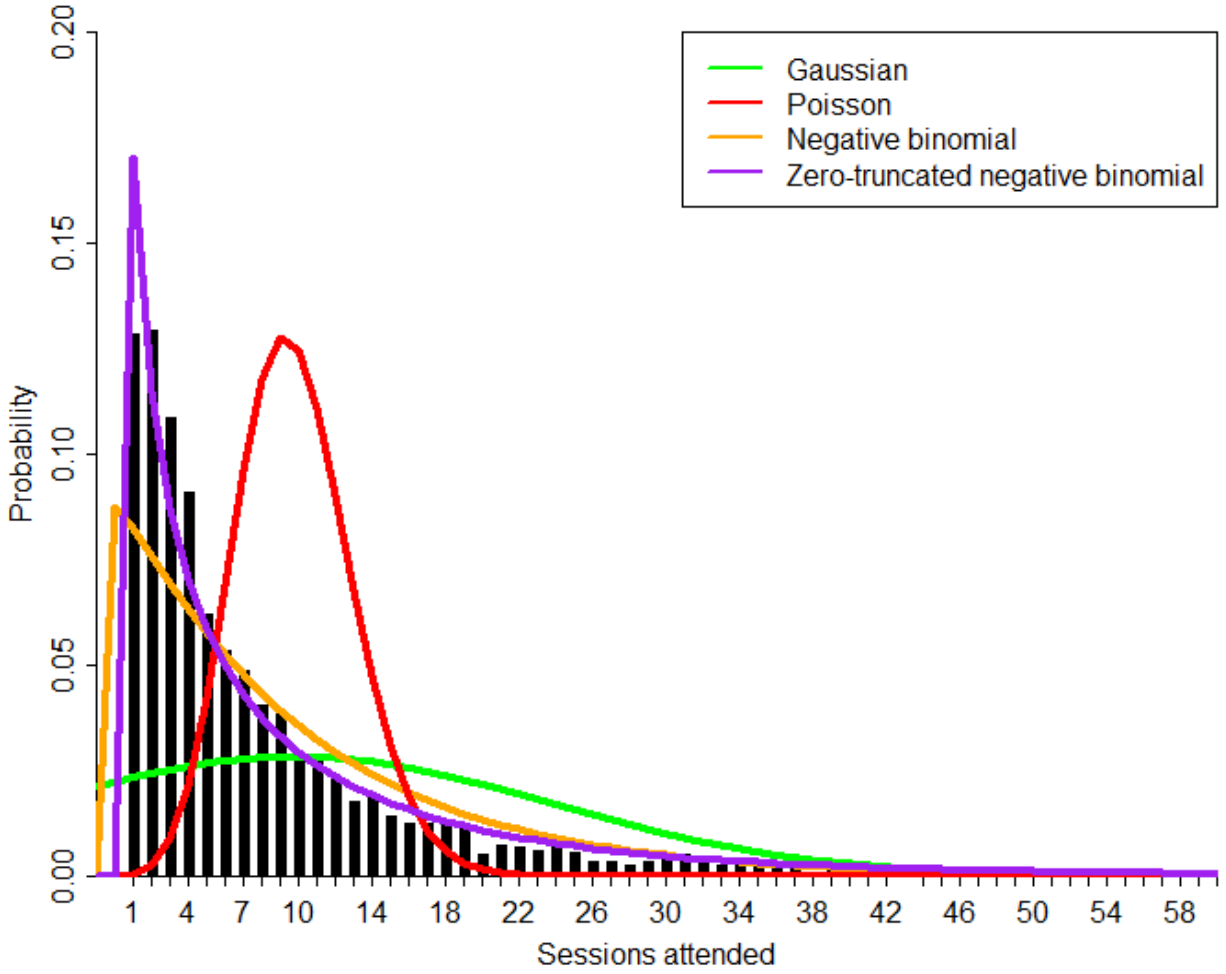


Illustration of current work

- Statistical model fitted to predict number of appointments attended
- Tier 3 CAMH service in England
- Predictors
  - **Presenting problems** (15 combinations), e.g., eating disorder, emotional, emotional and conduct problems
  - **General functioning** (Children's Global Assessment Scale; CGAS)
  - Age, gender, and locality

Descriptives (N = 2932 closed cases)

Variables	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	SD	Missing
Number of sessions	1	2.0	4	8.81	10	202	13.81	0%
Treatment duration (in weeks)	0	3.6	13	24.82	31	675	37.36	0%
Age	4	9.1	13	12.10	15	18.8	3.81	0%
CGAS	1	50.0	60	59.66	70	100	14.06	37%
Parent SDQ Total Diff	0	13.0	18	18.05	23	40	7.33	53%
Child SDQ Total Diff	0	12.0	17	16.95	22	38	6.86	70%
Parent SDQ Total Impact	0	1.0	3	3.53	5	10	2.80	53%
Child SDQ Total Impact	0	0.0	2	2.78	4	10	2.64	71%

Pattern	Mean	Median	SD	N	%
Psychosis	31.84	21	31.77	37	1%
Eating	19.48	11	26.15	31	1%
Emotional & LD	12.85	5	22.66	40	1%
Emotional & Conduct	10.69	6	14.40	127	4%
Emotional & Self-Harm	10.41	8	10.96	86	3%
Emotional	10.07	6	13.11	801	27%
Conduct	8.86	5	12.24	156	5%
Hyperkinetic	8.33	5	8.28	86	3%
Hyperkinetic & Emotional	8.20	5	8.29	20	1%
Learning Disabilities	7.62	5	8.32	47	2%
Other	7.33	3	13.92	958	33%
Self-Harm	7.24	3	14.56	151	5%
Autism	7.03	6	5.46	58	2%
Other Problems	6.35	3	9.06	297	10%
Emotional & Other Prob.	4.76	4	3.17	37	1%

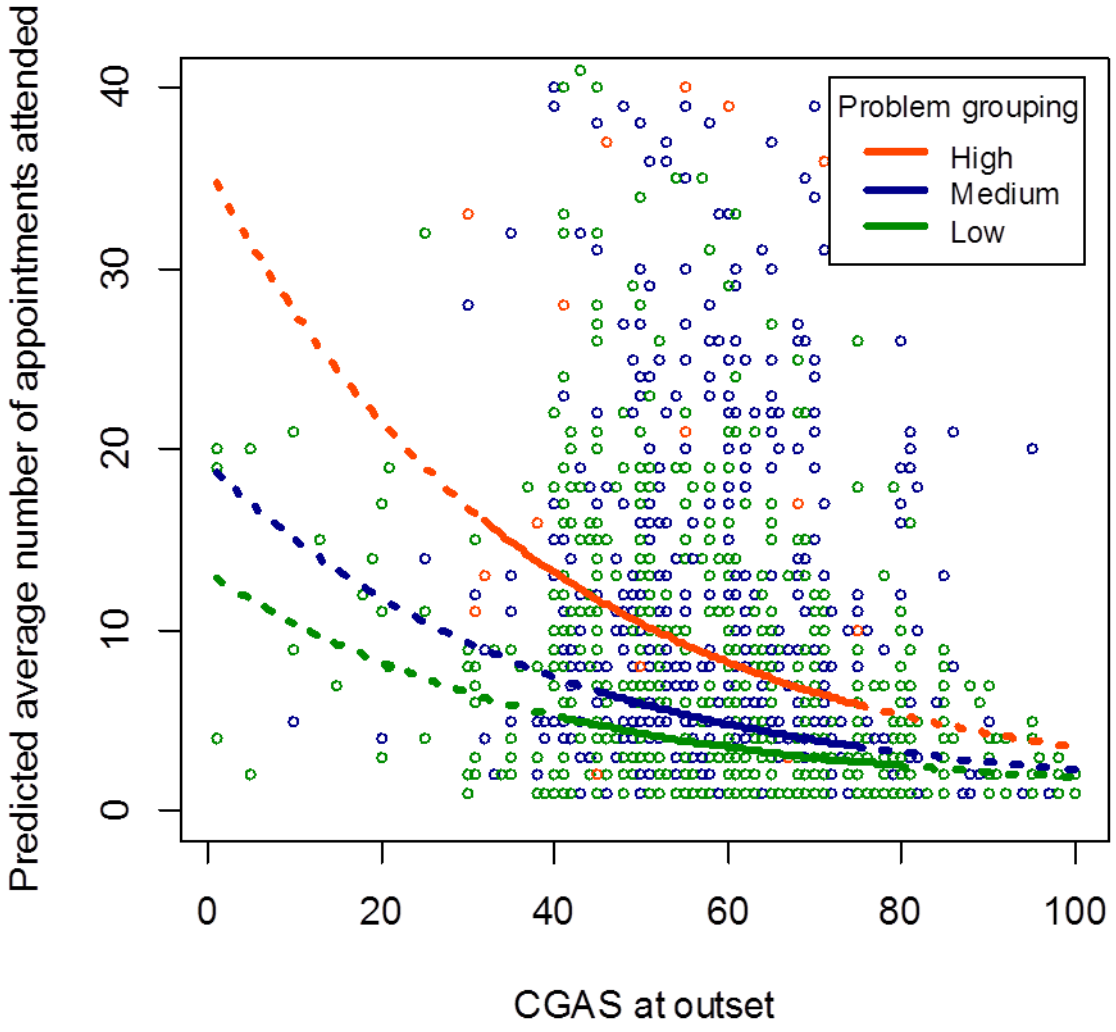
Model predictions

High: e.g.,
- Eating disorders
- Psychosis

Medium: e.g.,
- Emotional problems
- Mixed emotional & conduct problems

Low: e.g.,
- Autism assessment

(Solid line shows middle 80% of data for CGAS by grouping)



Moderating effect of age

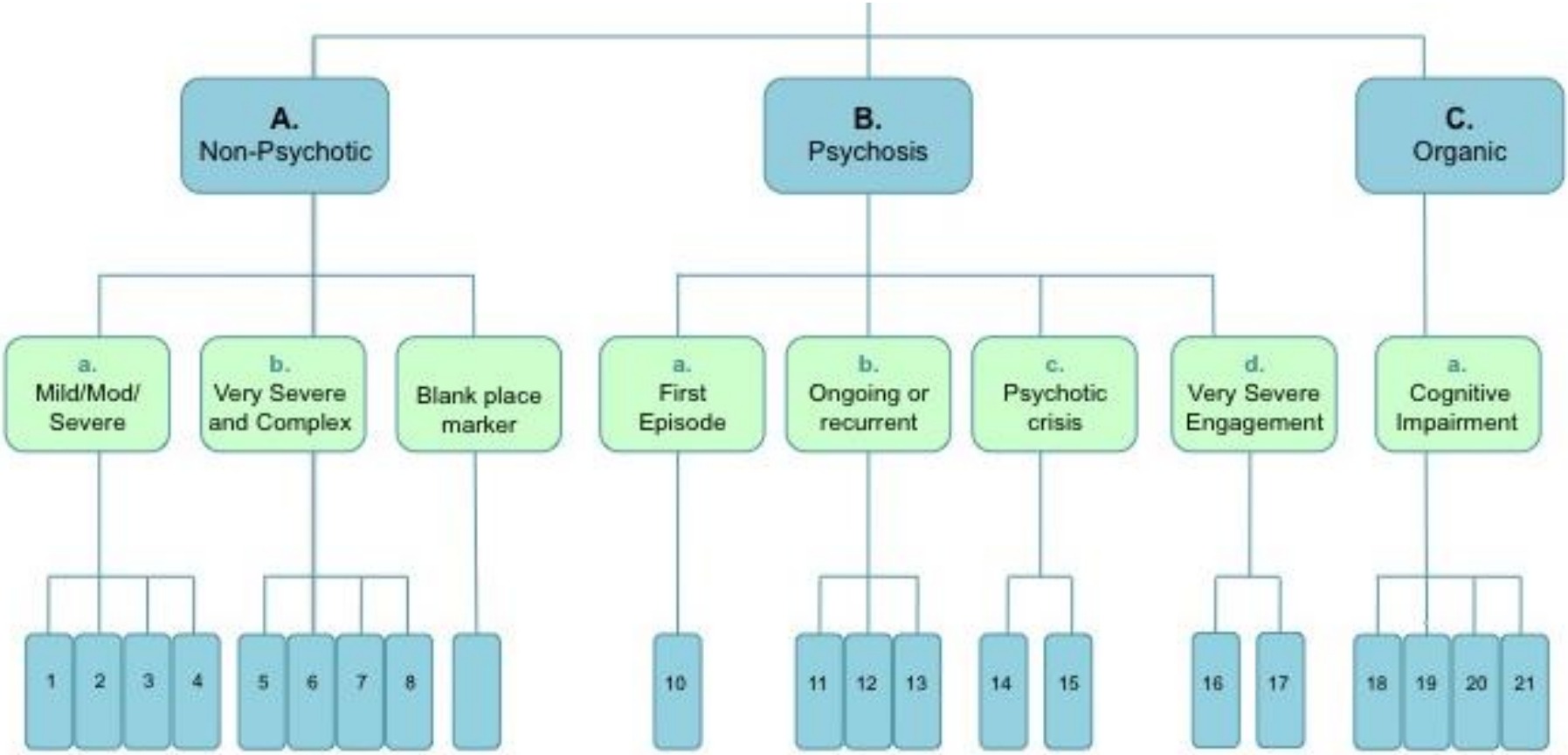
- Main effect: the older you are, the more appointments you have (z = 2.2)
- Also interactions with autism (*z* = 2.6) and eating disorder (*z* = 2.0): older again means more sessions

What about parent-report (from SDQ)?

	Estimate	Std. Error	z value
Intercept μ	1.433	0.335	4.27
Intercept k	-0.567	0.096	-5.89
SDQ Hyperkinetic	**-0.046**	**0.019**	**-2.41**
SDQ Emotional	0.011	0.017	0.64
SDQ Conduct	0.026	0.023	1.16
SDQ Peer	0.015	0.022	0.68
SDQ Prosocial	-0.006	0.021	-0.28
SDQ Extent Difficulties	-0.034	0.079	-0.43
SDQ Problem Duration	0.014	0.06	0.23
SDQ Distress	-0.03	0.044	-0.67
SDQ Home Life	-0.035	0.046	-0.76
SDQ Friends	-0.025	0.046	-0.57
SDQ Classroom	**0.081**	**0.039**	**2.08**
SDQ Leisure	**0.083**	**0.043**	**1.94**
SDQ Family Burden	**0.219**	**0.06**	**3.66**

HOW CAN WE DISCRETISE THIS STUFF?

What PbR looks like in AMHS



Using CART (illustration from another service's data; CGAS + ICD10 primary diagnosis)

Cluster 1: F25 (Schizoaffective disorders), F29 (Unspecified nonorganic psychosis), F52 (Sexual dysfunction not caused by organic disorder/disease), F64 (Gender identity disorders), Z61 (Problems related to negative life events in childhood, e.g., abuse)

Cluster 2: F20 (Schizophrenia), F50 (Eating disorders), F60 (Specific personality disorders)

Cluster 3: CGAS ≤ 53 and none of the above

Cluster 4: CGAS > 53 and one of F10 (alcohol), F16 (hallucinogen), F24 (Induced delusional disorder), F31 (Bipolar affective disorder), F32 (Depressive episode), F33 (Recurrent depressive disorder), F34 (Persistent mood [affective] disorders), F41 (Other anxiety disorders), F42 (Obsessive-compulsive disorder), F43 ("Reaction to severe stress, and adjustment disorders"), F51 (Nonorganic sleep disorders), F63 (Habit and impulse disorders), F83 (Mixed specific developmental disorders), F88 (Other disorders of psychological development), F91 (Conduct disorders), F92 (Mixed disorders of conduct and emotions), F93 (Emotional disorders with onset specific to childhood), F94, F95, Z03, Z72

Cluster 5: CGAS > 53 and one of F12, F19, F23 (Acute and transient psychotic disorders), F39 (Unspecified mood [affective] disorder), F40 (Phobic anxiety disorders), F45 (Somatoform disorders), F48 (Other neurotic disorders), F70 (Mild mental retardation), F79 (Unspecified mental retardation), F80 (Specific developmental disorders of speech and language), F81 (Specific developmental disorders of scholastic skills), F84 (Pervasive developmental disorders), F90 (Hyperkinetic disorders), Z71 (consulting, advice)

How about using the regression models?

- Eye-ball possible for CORC presenting problems
- Tricky for ICD10 codes
- Can do solely based on correlations between problems, which will lead to combinations of e.g., anxiety & depression
  - But current retrospective data not rich enough
  - Also this approach won't lead to groups with similar needs
- Can also do top-down, but would help to see what the data tells us too – meet in the middle

Dummy encoding categorical predictors in regression

- A predictor with *n* levels gets encoded as *n*−1 binary predictors
- For example, one with three levels:

$$y = \cdots + B_1 \times \text{conduct} + B_2 \times \text{autism} + \cdots$$

Emotional disorder	0	0
Conduct disorder	1	0
Autism	0	1

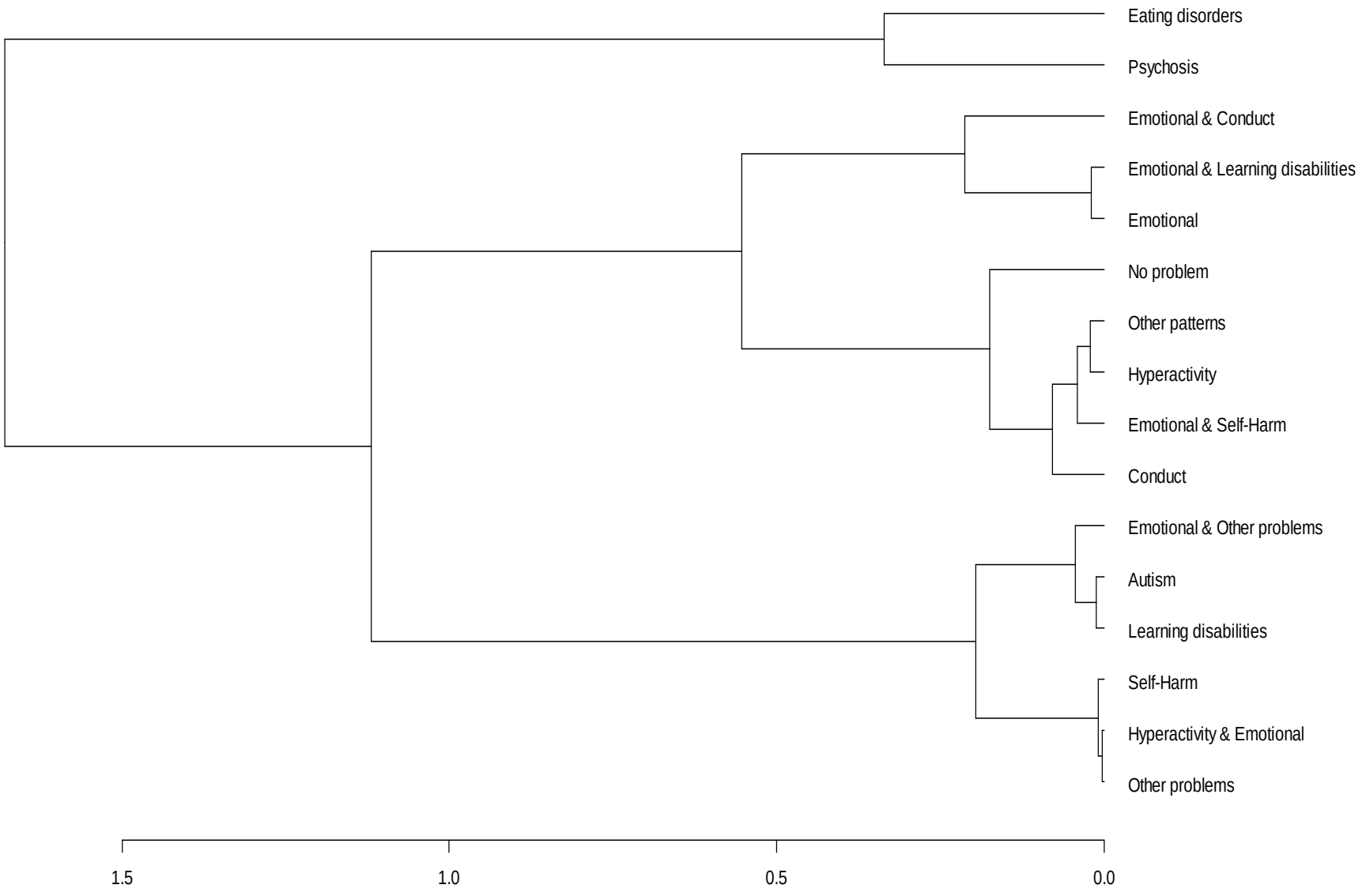
- So B_1 gives difference between conduct and emotion whilst adjusting whatever else is in the model; B_2 gives autism versus emotion

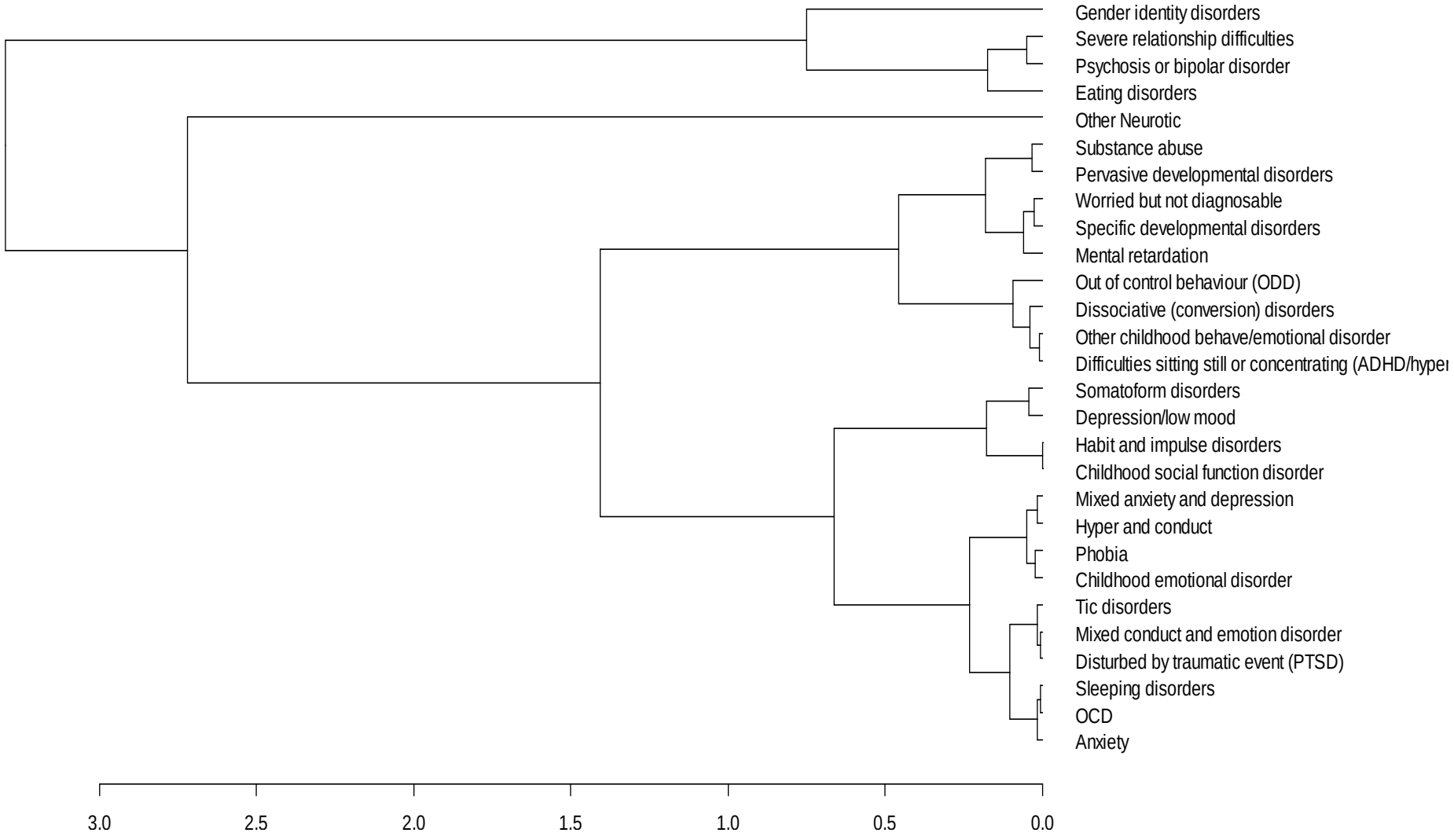
Approach to merging

- Fit models to work out all pairwise comparisons
- Make a matrix of *absolute* differences

	A	B	C	D	E
A	0				
B	3.1	0			
C	21.4	10.3	0		
D	2.1	0.5	4.0	0	
E	3.3	4.5	2.1	3.1	0

- Different methods: slope, *z* (slope / *SE*), or maximum difference based on 95% CIs
- Feed into hierarchical clustering
- Aside: Type I error probably fine here!


Eating disorders
Psychosis
Emotional & Conduct
Emotional & Learning disabilities
Emotional
No problem
Other patterns
Hyperactivity
Emotional & Self-Harm
Conduct
Emotional & Other problems
Autism
Learning disabilities
Self-Harm
Hyperactivity & Emotional
Other problems
1.5
1.0
0.5
0.0


Gender identity disorders
Severe relationship difficulties
Psychosis or bipolar disorder
Eating disorders
Other Neurotic
Substance abuse
Pervasive developmental disorders
Worried but not diagnosable
Specific developmental disorders
Mental retardation
Out of control behaviour (ODD)
Dissociative (conversion) disorders
Other childhood behave/emotional disorder
Difficulties sitting still or concentrating (ADHD/hype
Somatoform disorders
Depression/low mood
Habit and impulse disorders
Childhood social function disorder
Mixed anxiety and depression
Hyper and conduct
Phobia
Childhood emotional disorder
Tic disorders
Mixed conduct and emotion disorder
Disturbed by traumatic event (PTSD)
Sleeping disorders
OCD
Anxiety
3.0
2.5
2.0
1.5
1.0
0.5
0.0

“INDIRECT” CONTACTS

What's the difference between "direct" and "indirect"

Mostly Direct

- Treatment
- Assessment
- Review Meetings
- Group Work
- Treatment - family
- Visits and Observations
- Psychometric Assessment
- Treatment - individual
- ASD Assessment
- Psychiatric Assessment
- Emergency Assessment
- Other Developmental assessment
- Psychometric Assessment

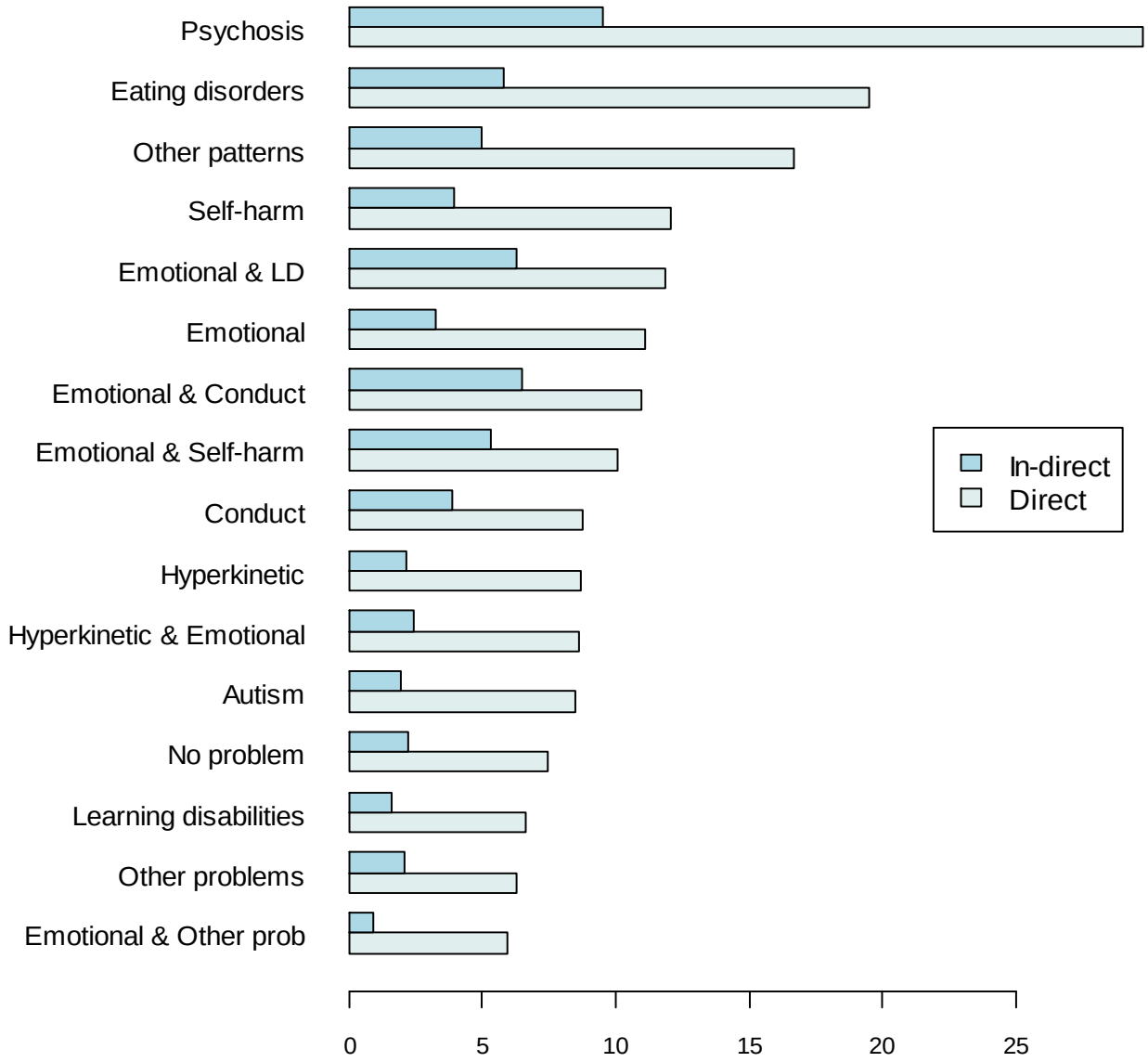
Ambiguous

- Others
(35% direct - 65% indirect)
- Other Meetings
(48% - 52%)
- Commissioning Meeting
(49% - 51%)
- Case Conferences
(67% - 33%)
- Legal Work (40% - 60%)

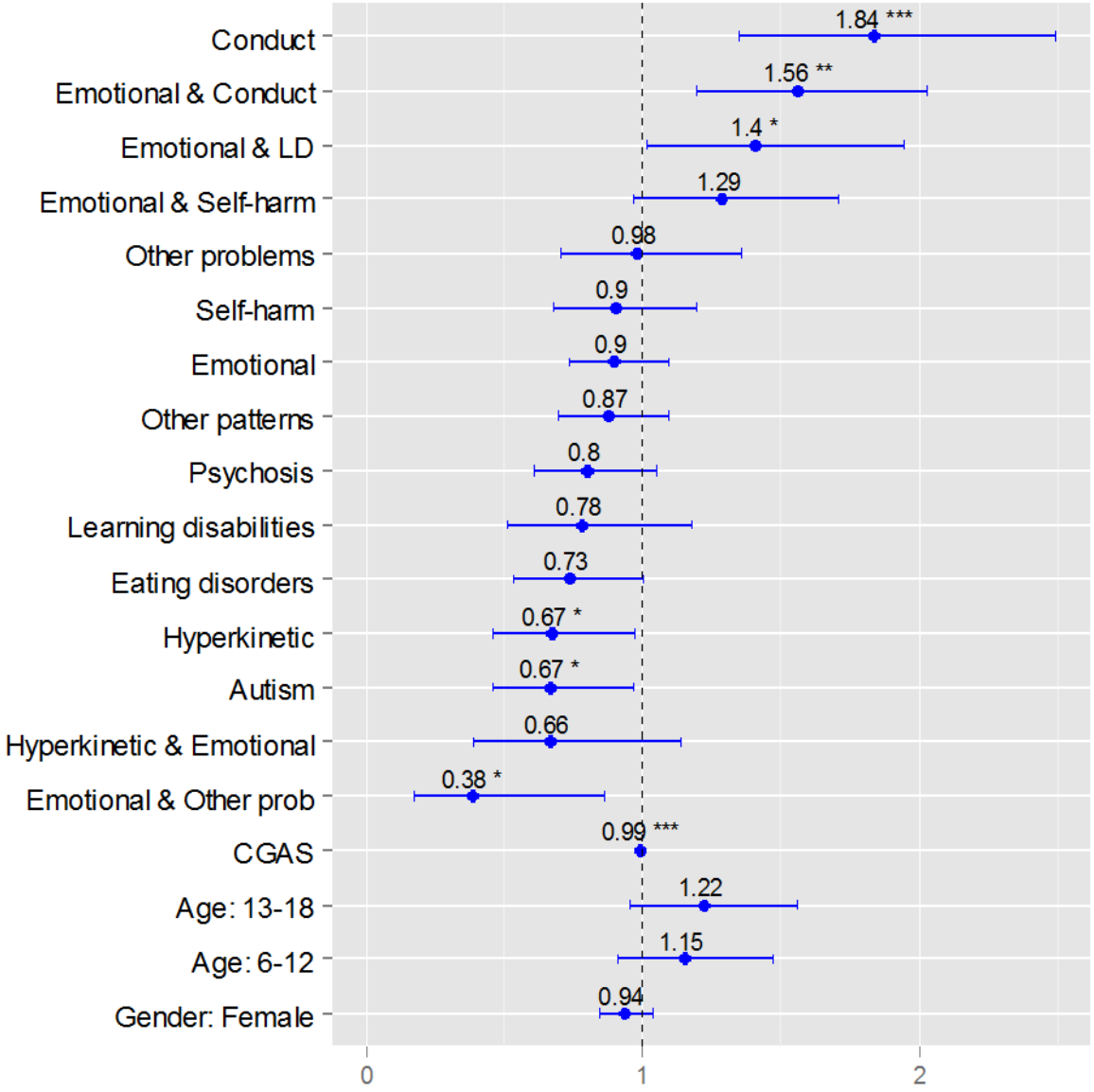
Mostly Indirect

- Telephone
- Consultation
- Liaison

Average number of direct and indirect contacts

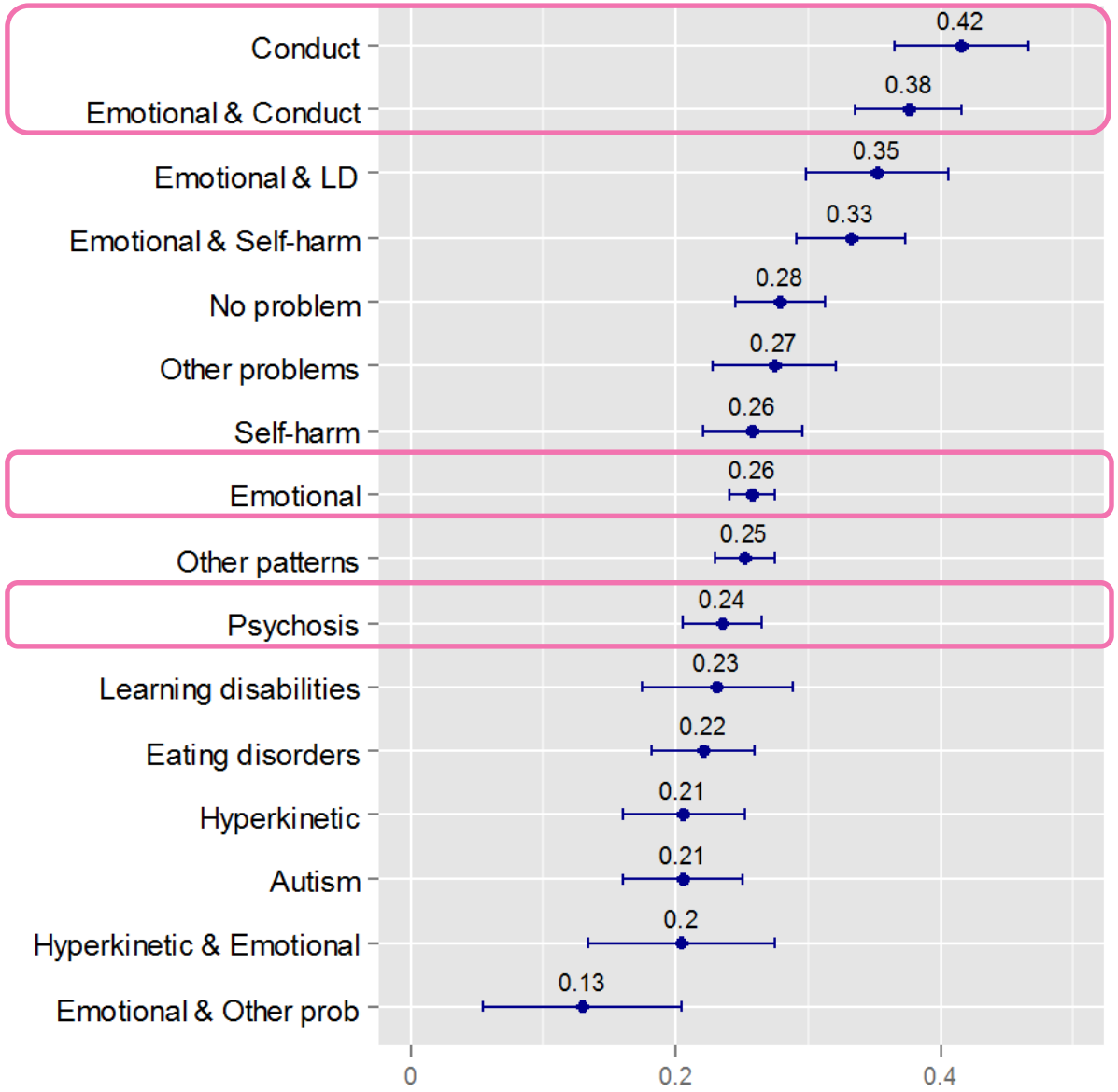


The proportion of indirect contacts is moderated by problems and CGAS



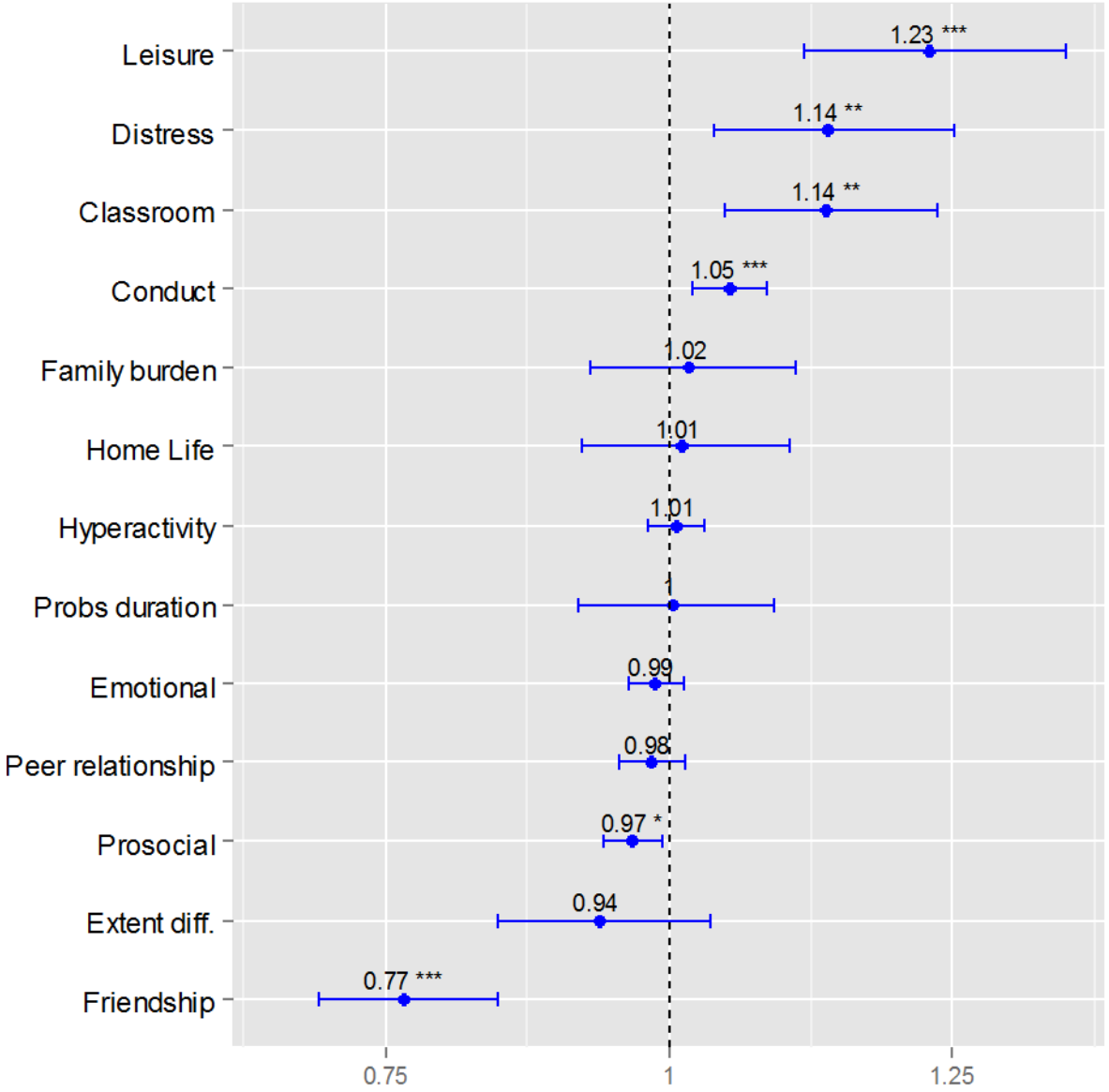
- Odds ratios with 95% confidence intervals
- (“No problems” as reference category)

Model-estimated proportion controlling for CGAS and demographics



- All the other predictors are fixed:
  - ✓ Male
  - ✓ 13-18 years old
  - ✓ CGAS equal to 60 at outset
- Bars show the 95% CIs

Proportion of indirect contacts is also predicted by SDQ-Parent



- logistic regression predicting the probability of indirect contact
- Estimates of the odds ratio with 95% confidence intervals

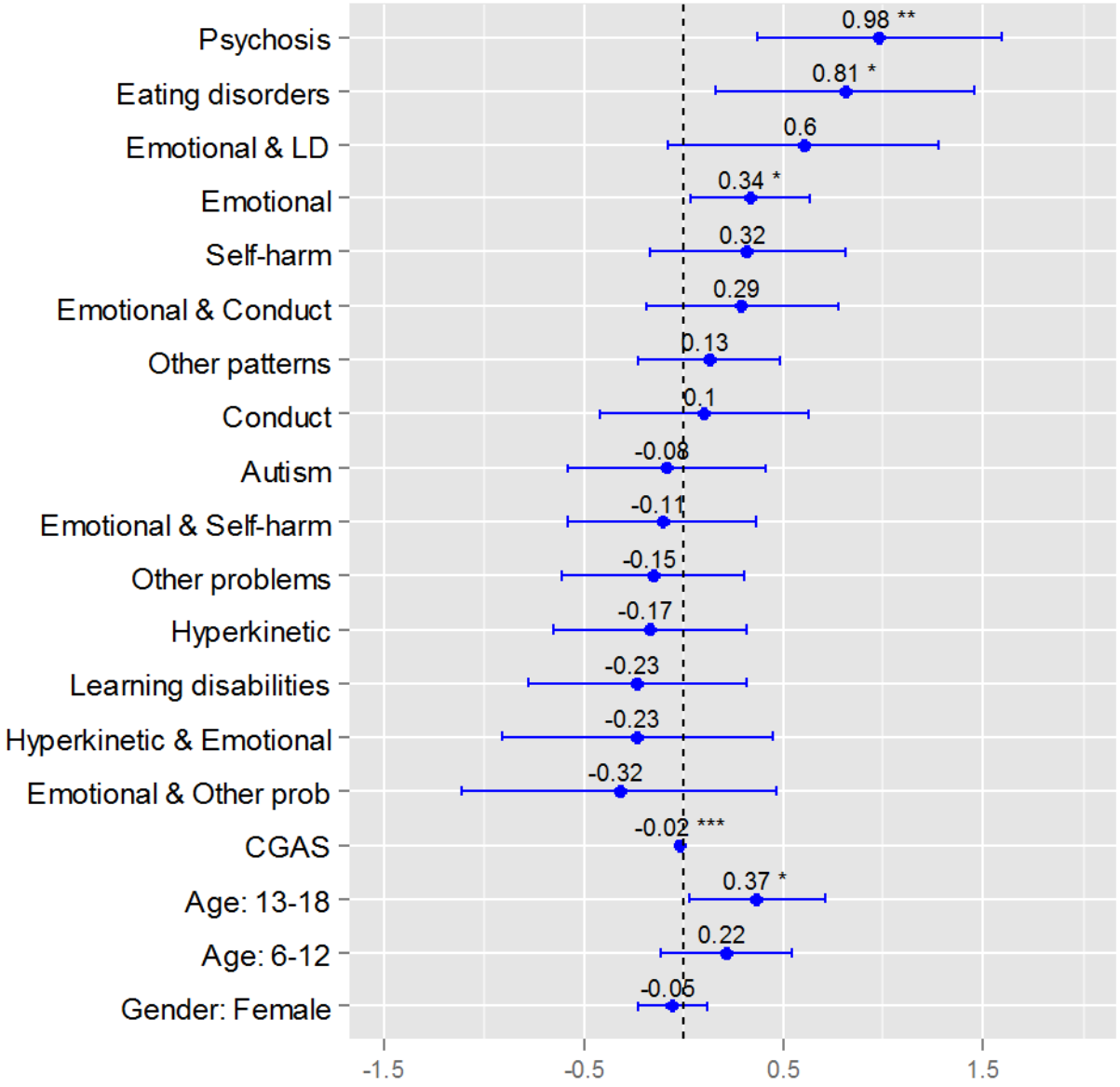
On-going work: estimating mean number of contact hours

Assumptions:

- Unattended or cancelled activities: ½ hr
- Duration (in hours) was assigned to attended activities depending on the type of action and the location
- Total hours per patient obtained by summing all durations of all the activities related the same patient

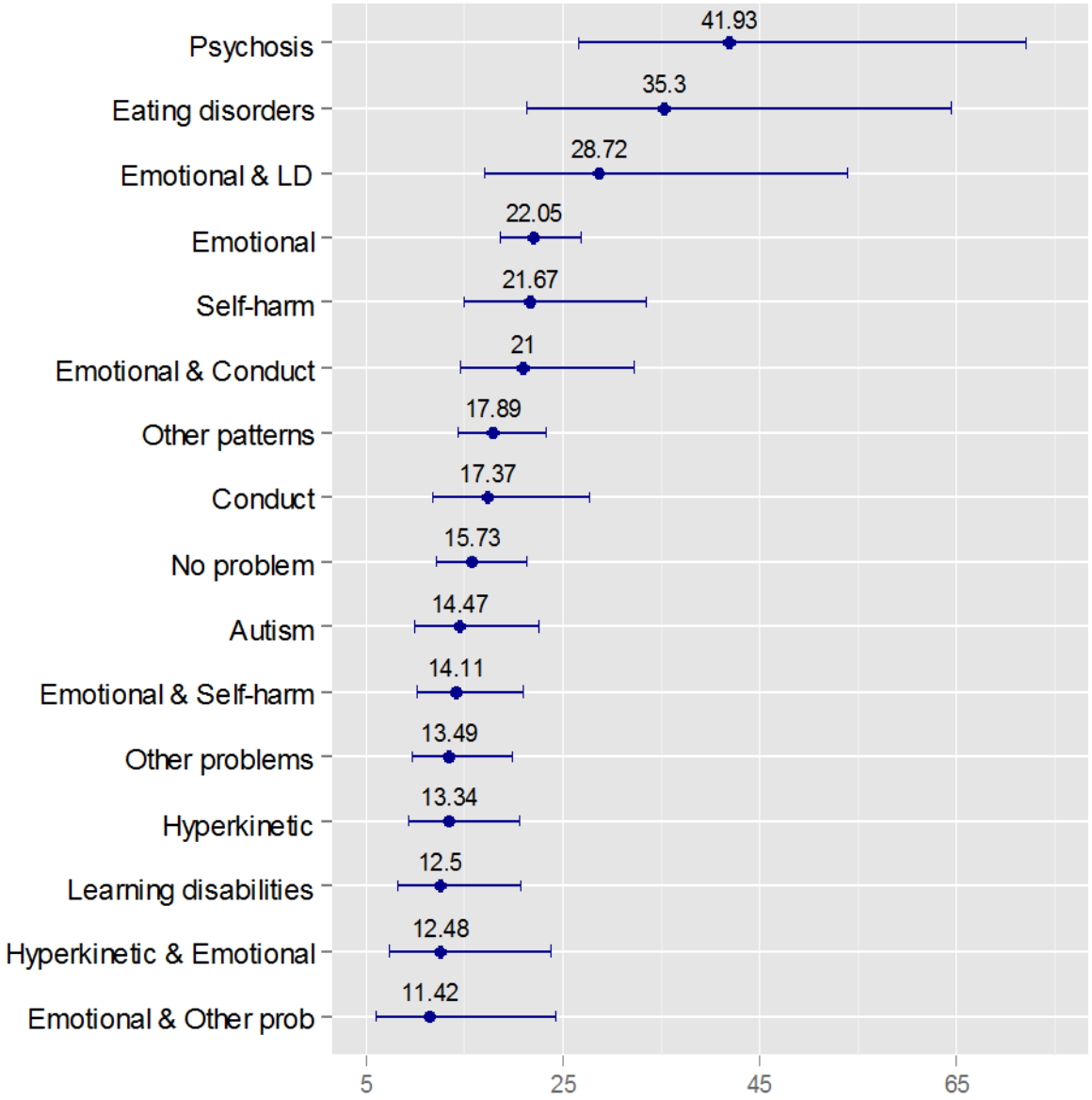
Action type	CAMHS Based	Outreach
ASD Assessment	2.5	3.5
Assessment	2	3
Case Conferences	4	4
Commissioning Meeting	1.5	1.5
Consultation	0.5	1.5
Emergency Assessment	2.5	3.5
Group Work	3.5	3.5
Legal Work	7.5	7.5
Liaison	0.5	1
Other Developmental assessment	2	3
Other Meetings	1.5	2.5
Others	2	2
Psychiatric Assessment	2	3
Psychometric Assessment	2.5	3.5
Psychotherapy Assessment	2	3
Review Meetings	2	3
Telephone	0.25	0.25
Treatment	1.5	2.5
Treatment - family	1.5	2.5
Treatment - individual	1.5	2.5
Visits and Observations	3	3

First attempt at modelling



- Gamma regression (e.g., used in NICE guidelines for costing) with log link
- Coefficients show the increase (or decrease) in the total amount of hours (in the log scale)

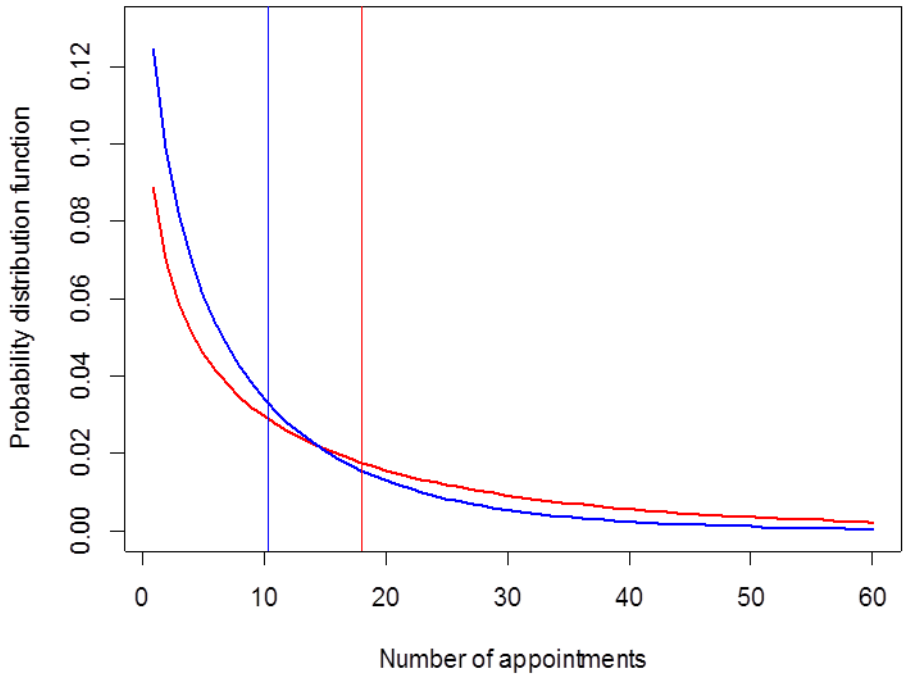
Comparisons between problems



- Gamma regression
- Model-based estimated confidence intervals, holding fixed:
  - ✓ Gender: Male
  - ✓ Age: 13-18 yo
  - ✓ CGAS: 60

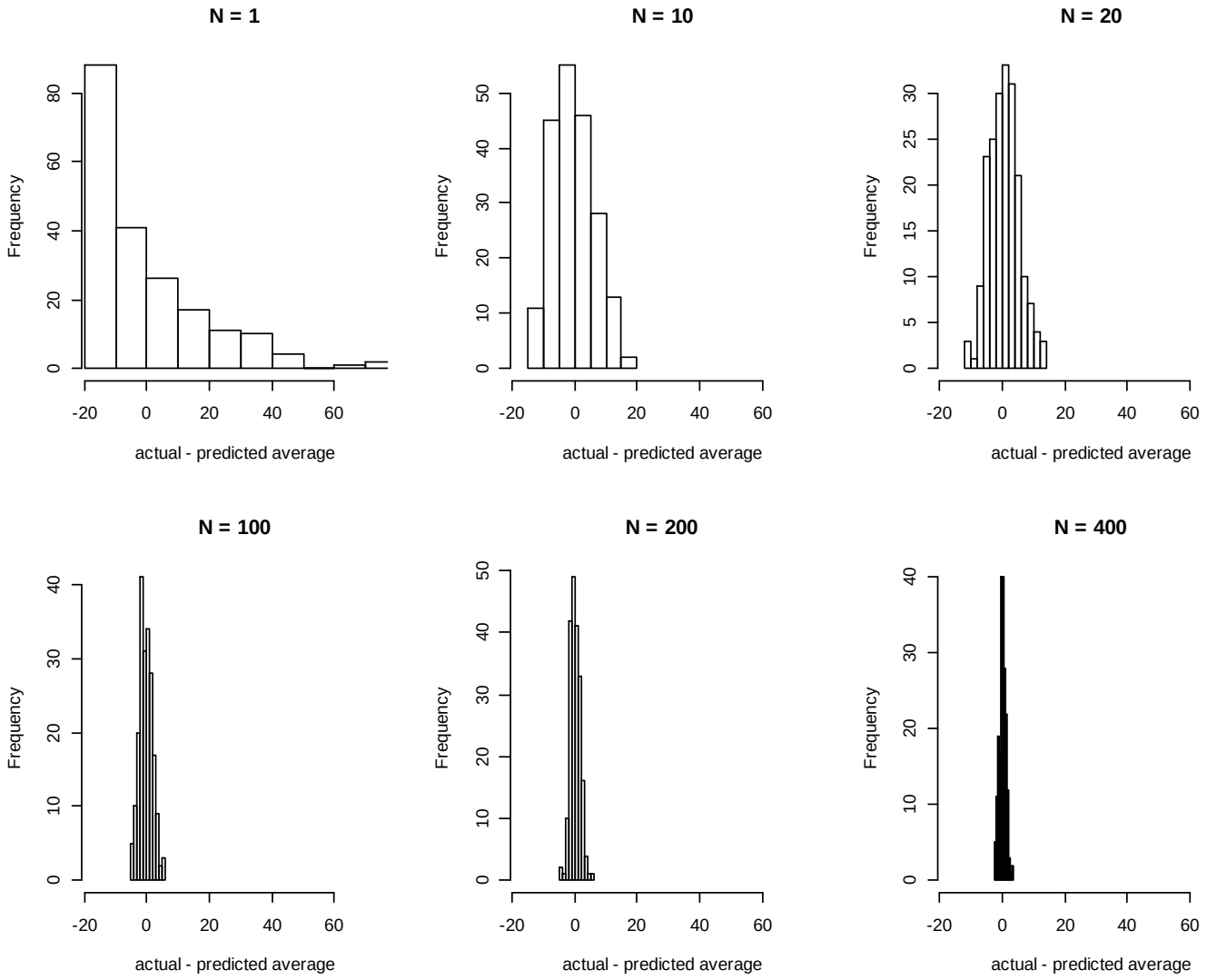
WHAT HAPPENS WHEN YOU START TO TOTAL PREDICTIONS?

Simulate model consequences

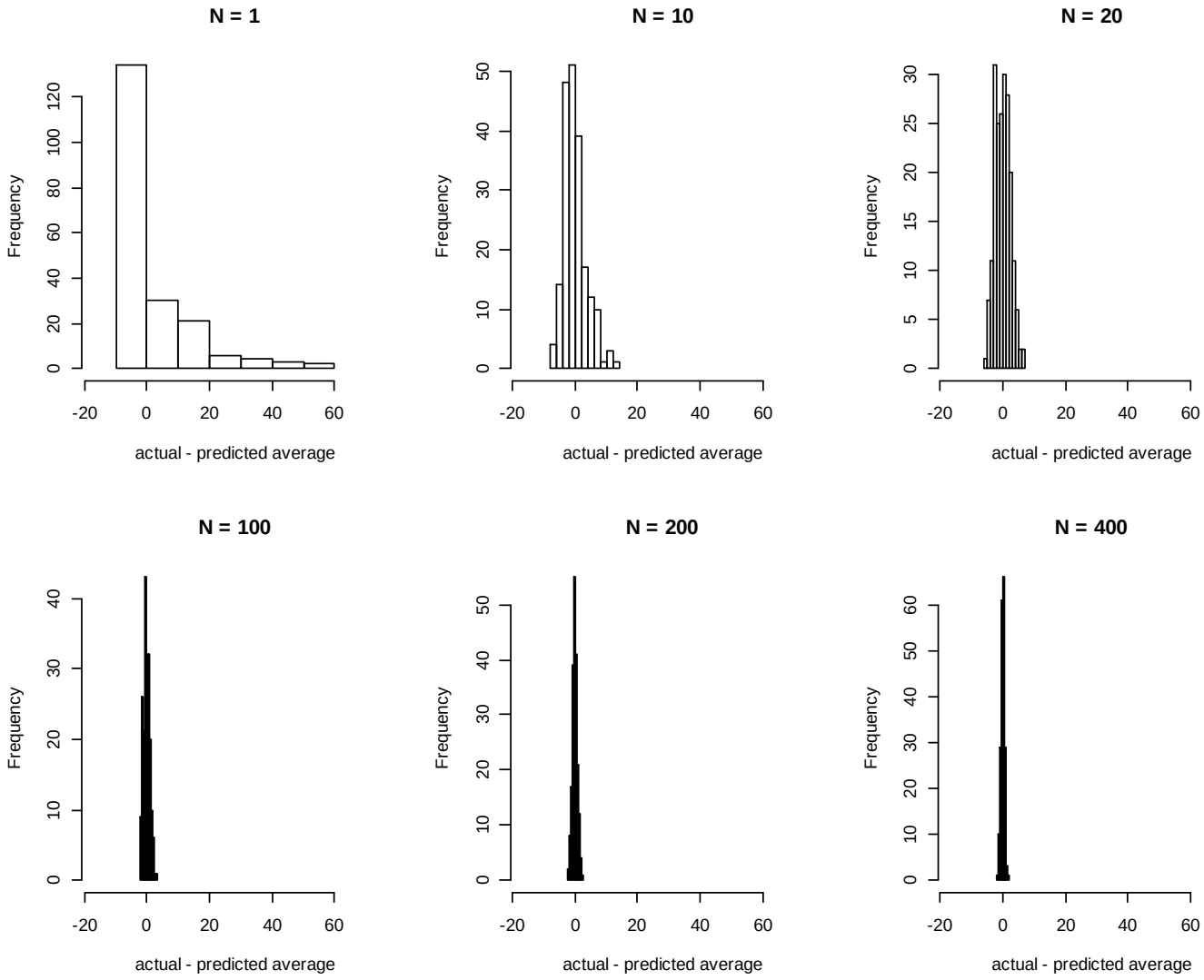


Presenting problem	Gender	Age	CGAS at start	Predicted average number of sessions attended
Eating disorder	Female	13–18	60	18.05
Emotional problem	Male	6–12	60	10.44

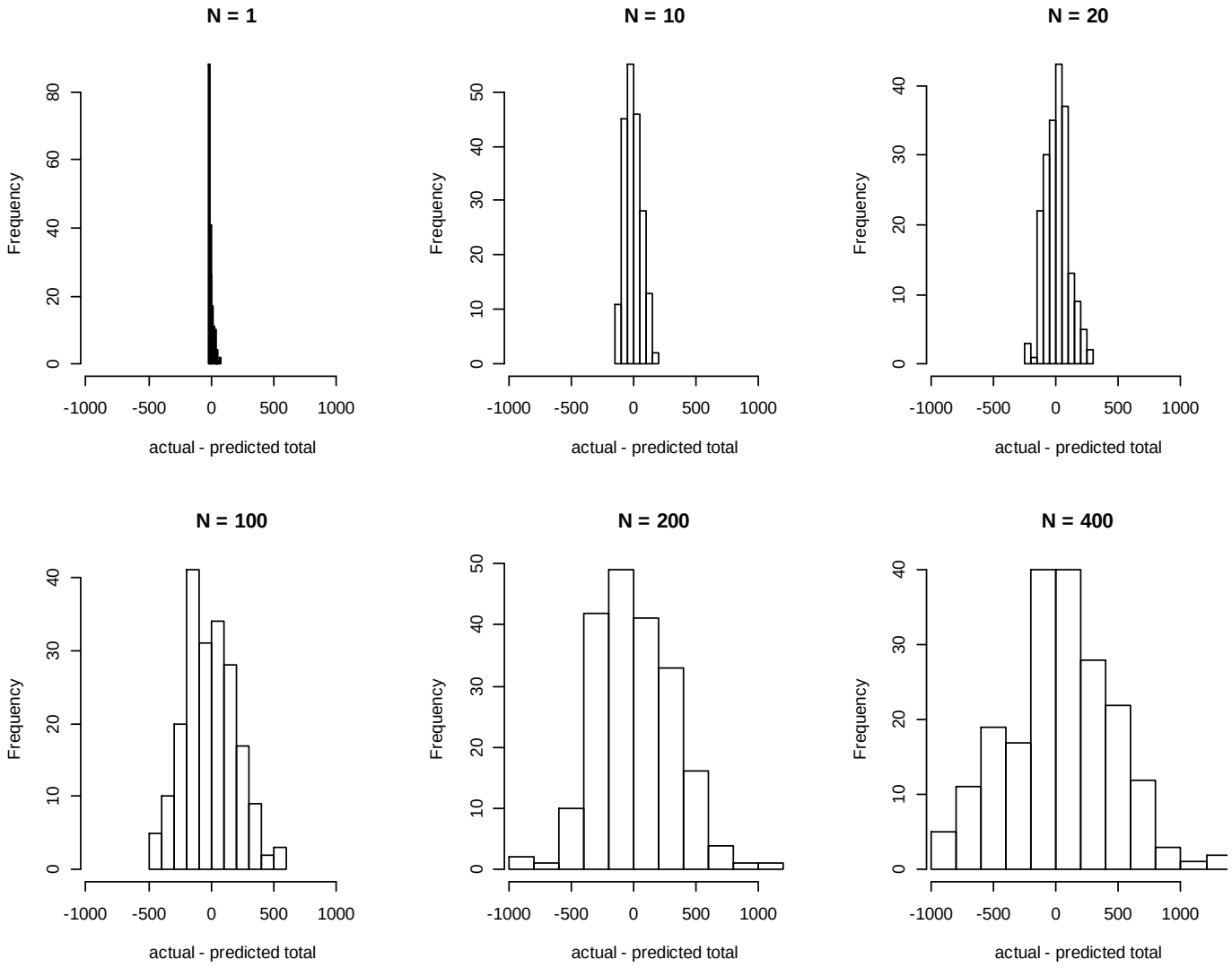
Actual average – predicted average (eating disorder)



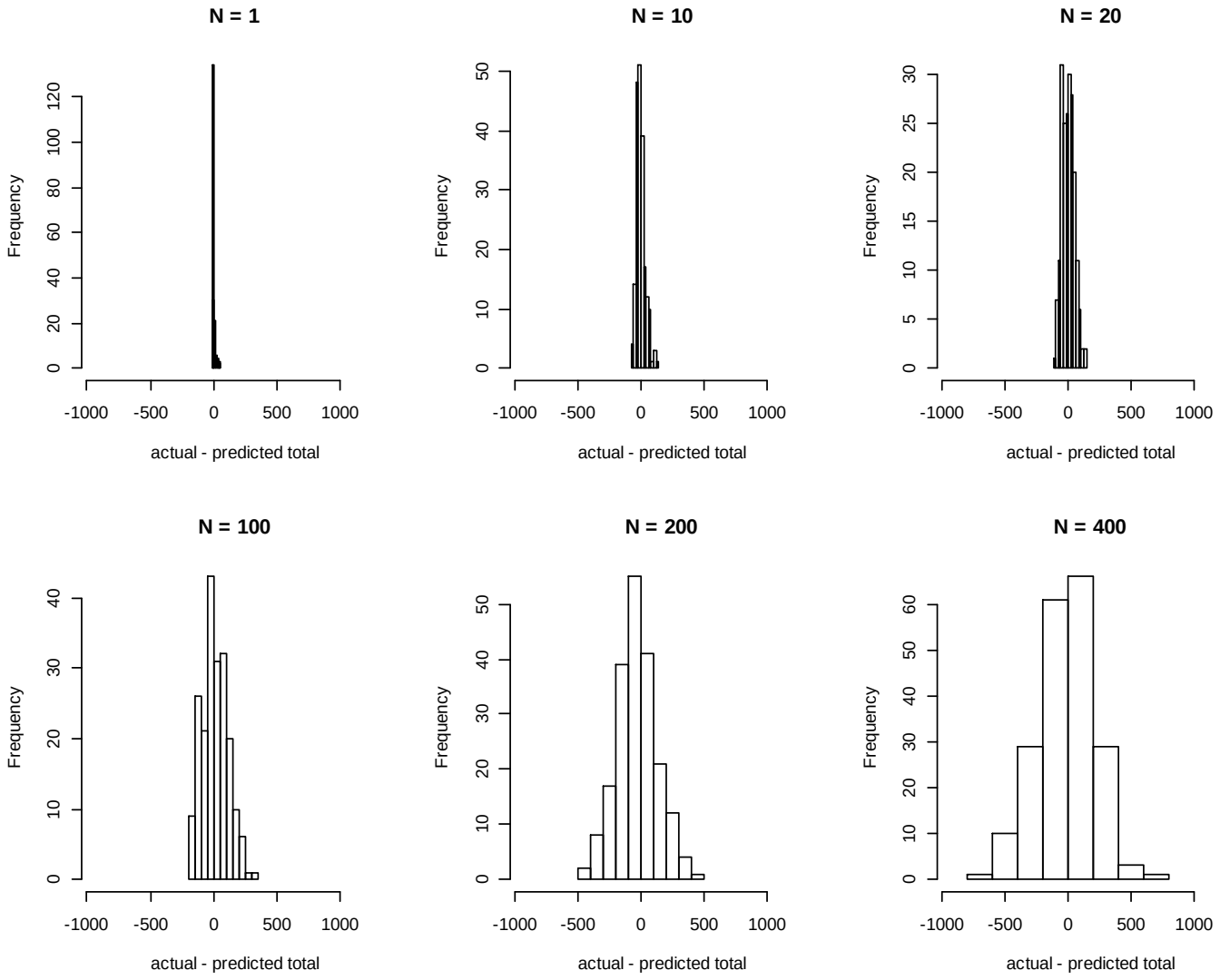
Actual average – predicted average (emotional disorder)



Actual total – predicted average (eating disorder)



Actual total – predicted average (emotional disorder)

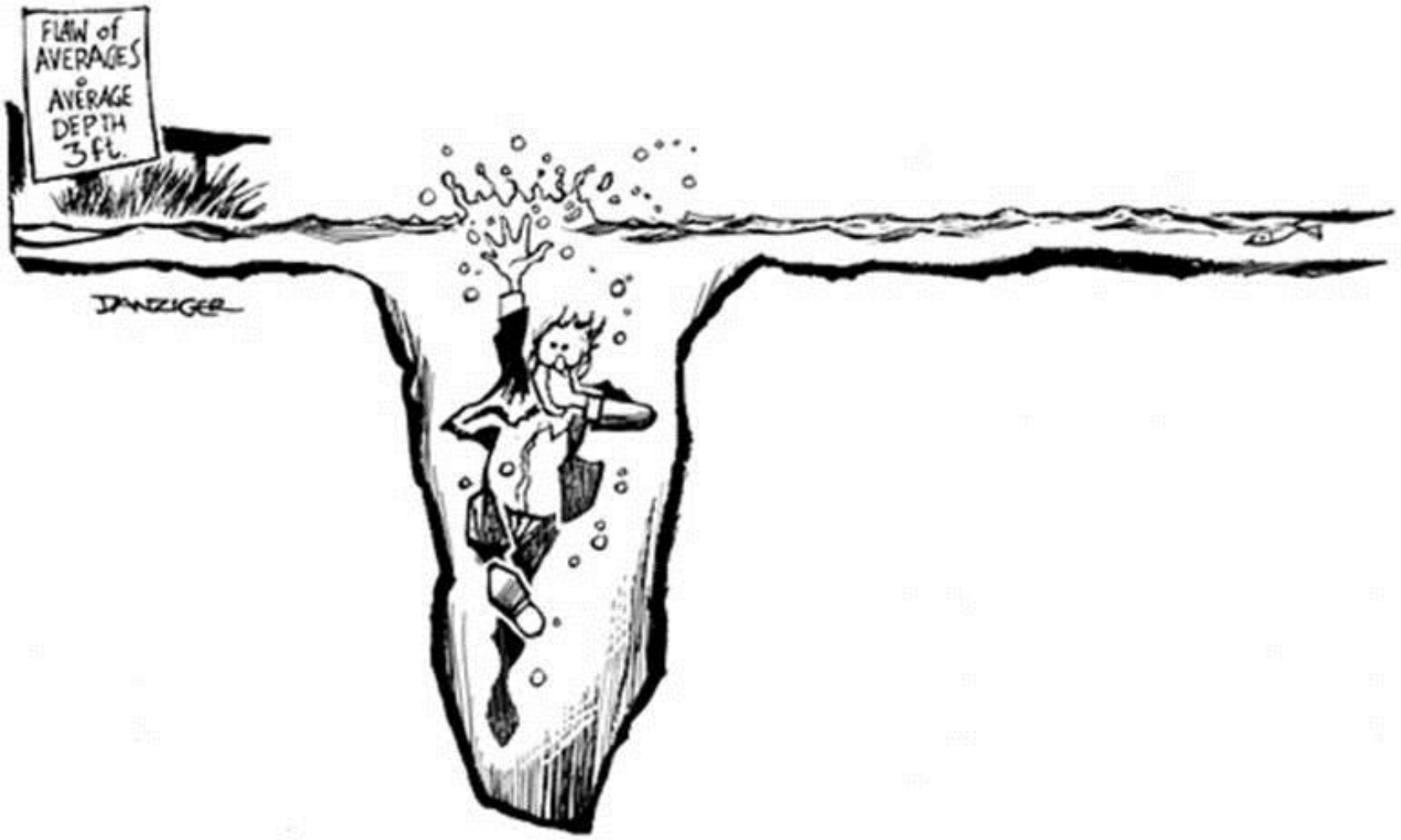


BUT… remember total resources used at service

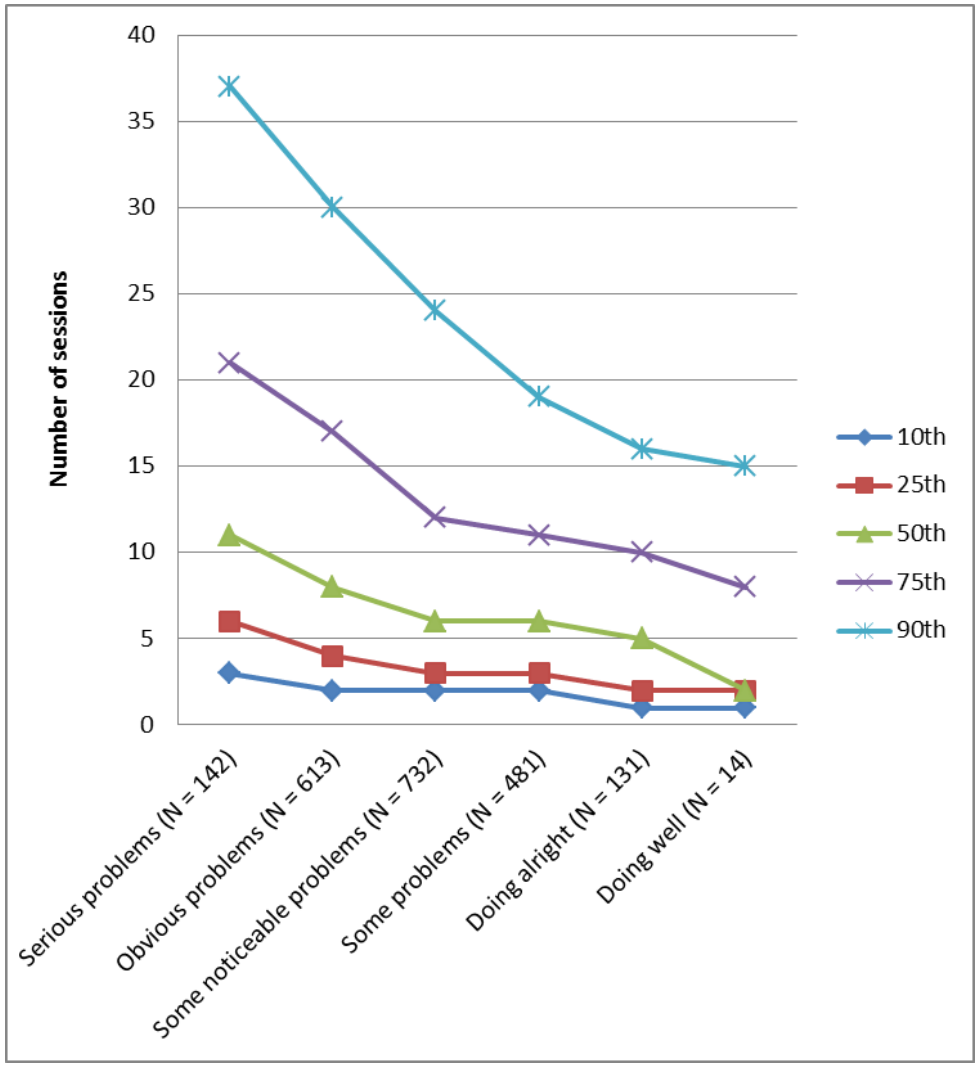
- Fewer cases seen at CAMHS with eating disorder than with emotional problems
- Difference between actual and prediction amplified for emotional problems

REASONING ABOUT INDIVIDUAL CASES – A PEAK AHEAD

The problem with averages



Towards a quantile-regression model (for another day…)



Ongoing work

- Prospective study data incoming
- Uses the CYP IAPT data specification
- Session-by-session event information
- Heading towards a multilevel model of costs

Direct contact with child, young person, or carers (e.g., assessment/treatment)
Observation of child, young person, or carers
Contact with professional about child, young person, or carers (e.g., consultation, case discussion)
Questionnaire completion by child, young person, or family
Missed appointment (DNA)
Travel
Report writing
Administration
Block of completed **external work** (use to record, e.g., 4 hours of input from an external agency)
Other contact

THANK YOU!