Learning from the Data

CAMHS Payment System Project engagement events

Peter Martin, December 2014

Data Analysis – Aims

- To investigate the relationship between information from assessment and resource use in CAMHS, in order to develop currencies for CAMHS.
- To develop an algorithm using assessment information to suggest appropriate currency assignment. Clinicians will always be able to overrule the algorithm according to clinical judgement.

Notes of Caution

- Resource use in CAMHS is not the same as total resource use (which may include other agencies)
- Current resource use (either in CAMHS or in total) may or may not be meeting the needs of the child, young person, or family
- So current resource use in CAMHS may not reflect need for resources
- Data on resource use are imperfect and do not capture all activity in CAMHS

Data Sources

- **Child Outcomes Research Consortium (CORC, 2007 – 2013)**
  - 38794 periods of contact from 21 CAMH services
  - **Disadvantages**: Little detail on problem description; very few complexity factors; no contextual problems measured
  - **Advantages**: large sample size; large number of services; long coverage period
- **Payment Systems Pilot Project (Sep 2012 – June 2014)**
  - 4573 periods of contact from 11 CAMH services
  - **Disadvantages**: short coverage period (so that sample is biased towards shorter periods of contact); relatively smaller sample size
  - **Advantages**: Detailed assessment information on presenting problems, context and complexity factors (via Current View Form); focussed work with services to improve data quality

Data and Data Quality (Payment Systems Pilot Project)

- Assessment Information: Current View Form
  - Inter-rater reliability assessment

- Treatment Information: Number of direct appointments (face-to-face or telephone)
  - Number and type of professionals present was not analysed so far due to high proportion of missing values in these variables

- Inclusion criteria for periods of contact
  - Must be closed or without activity for at least six months
  - Must have Current View at Assessment
  - Must have information on activity
  - Must come from a service whose data quality overall was sufficiently strong

Appointments Data: Conceptual and Statistical Issues

- Study Period for Payment Systems Project: 22 months
- Since only closed cases were considered, long Periods of Contact (POCs) had a smaller chance to be in the sample than shorter POCs
- So the Payment Systems Pilot sample is biased towards shorter POCs

From CORC data, we estimate that:

- Around a quarter of POCs end after a single session
- More than a third of overall direct appointments are taken by the 5 % of periods of contact with the highest number of appointments (who attended over 30 appointments each)
  - This result does not account for repeated POCs by the same child (not identifiable in CORC)
- So a relatively small proportion of children is likely to take up a significant proportion of resources
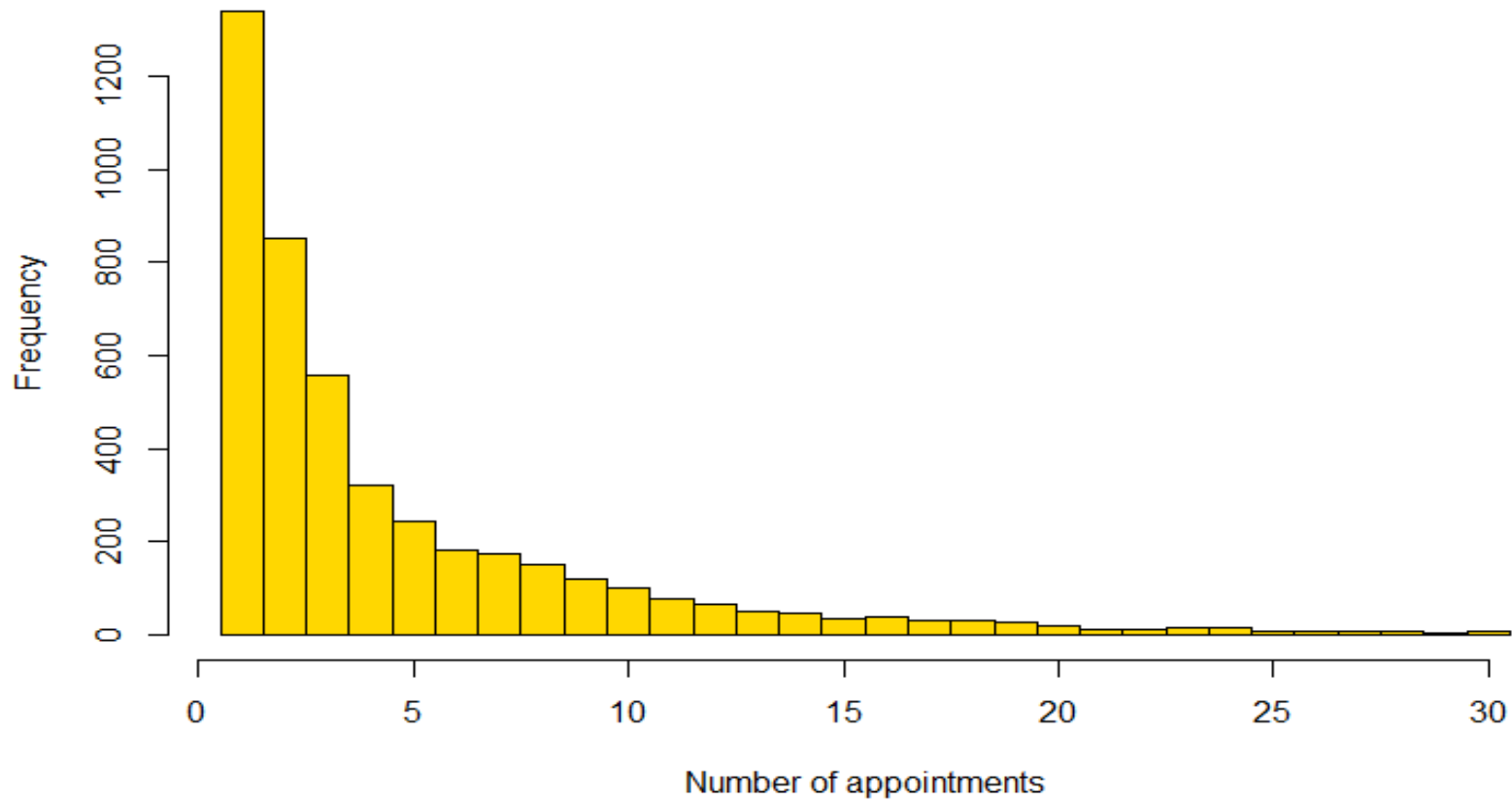
Payment Systems Pilot Sample:

Descriptive Results and classification by NICE guidance

Payment Systems Pilot Sample: Age and Gender

| Age Group	Boys	Girls	Total
0-4	64 %	36 %	135
5-9	66 %	34 %	910
10-14	48 %	52 %	1752
15-19	33 %	67 %	1672

Note: 21 POCs had no gender of child recorded; these are excluded from this table. Overall N = 4573.

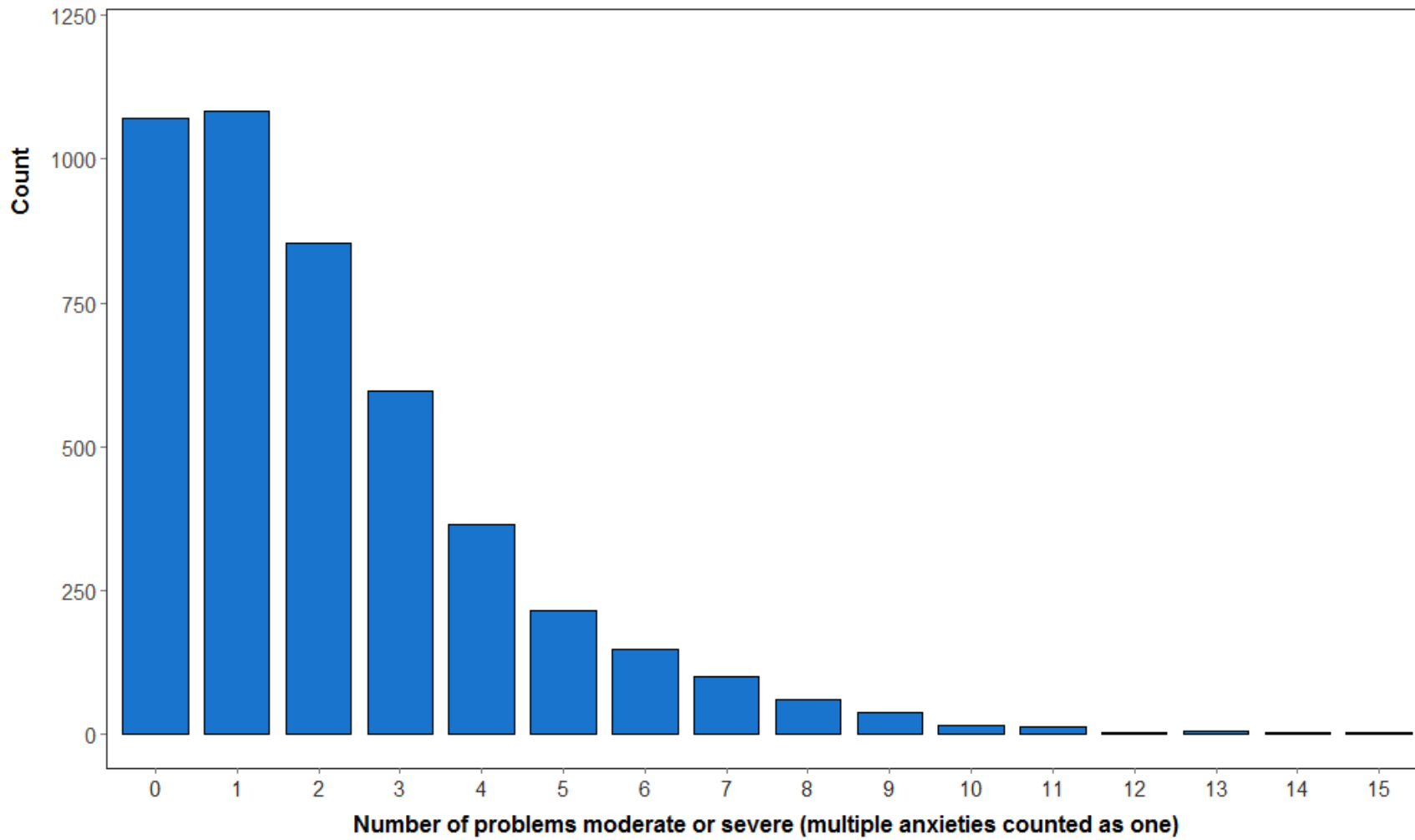**Number of appointments (Payment Systems Data)**

Note: 40 periods of contact were recorded to have attended more than 30 appointments. These are not shown in this graph, but are included in the analysis.
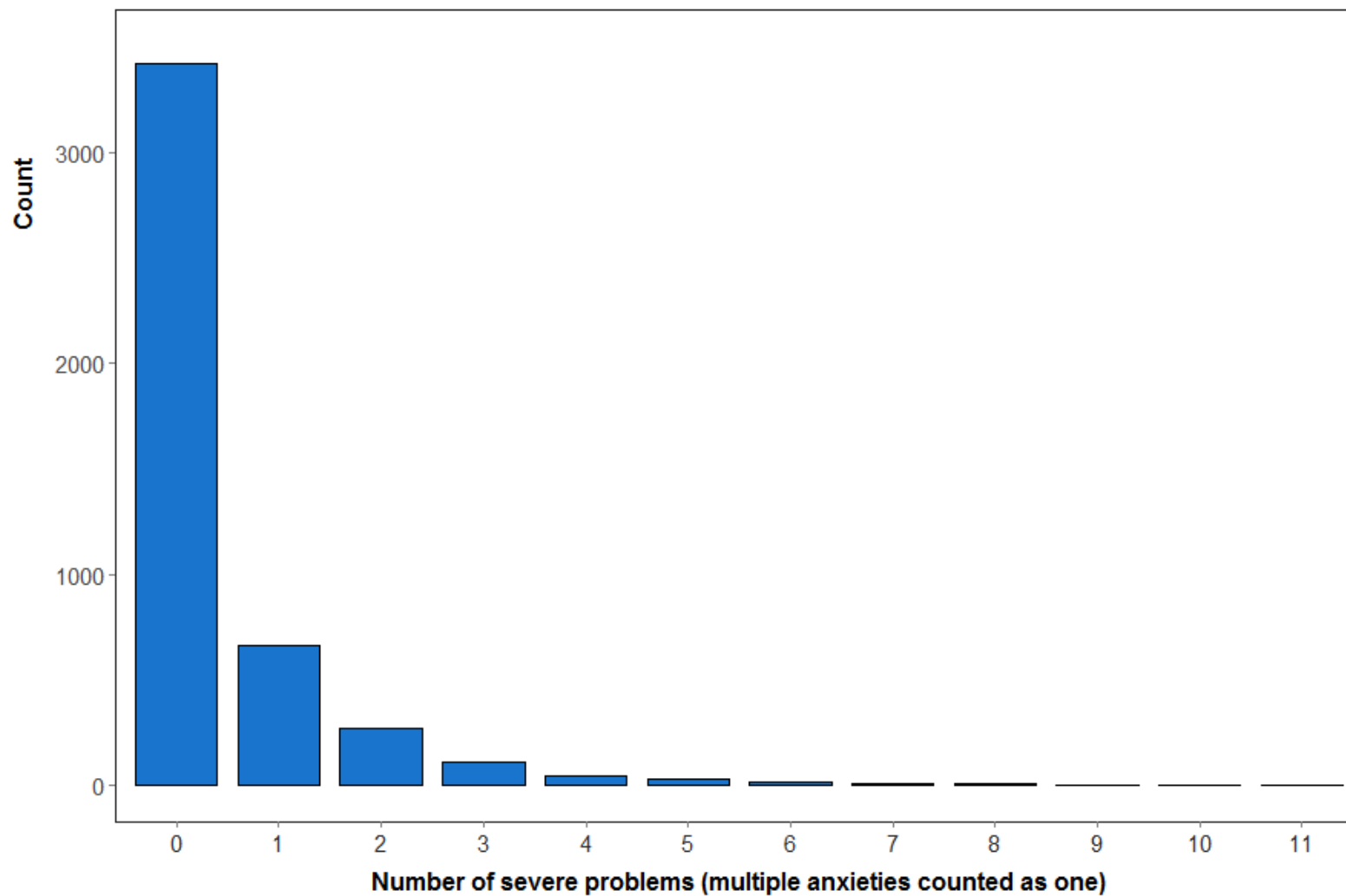
Current View Problem Descriptors
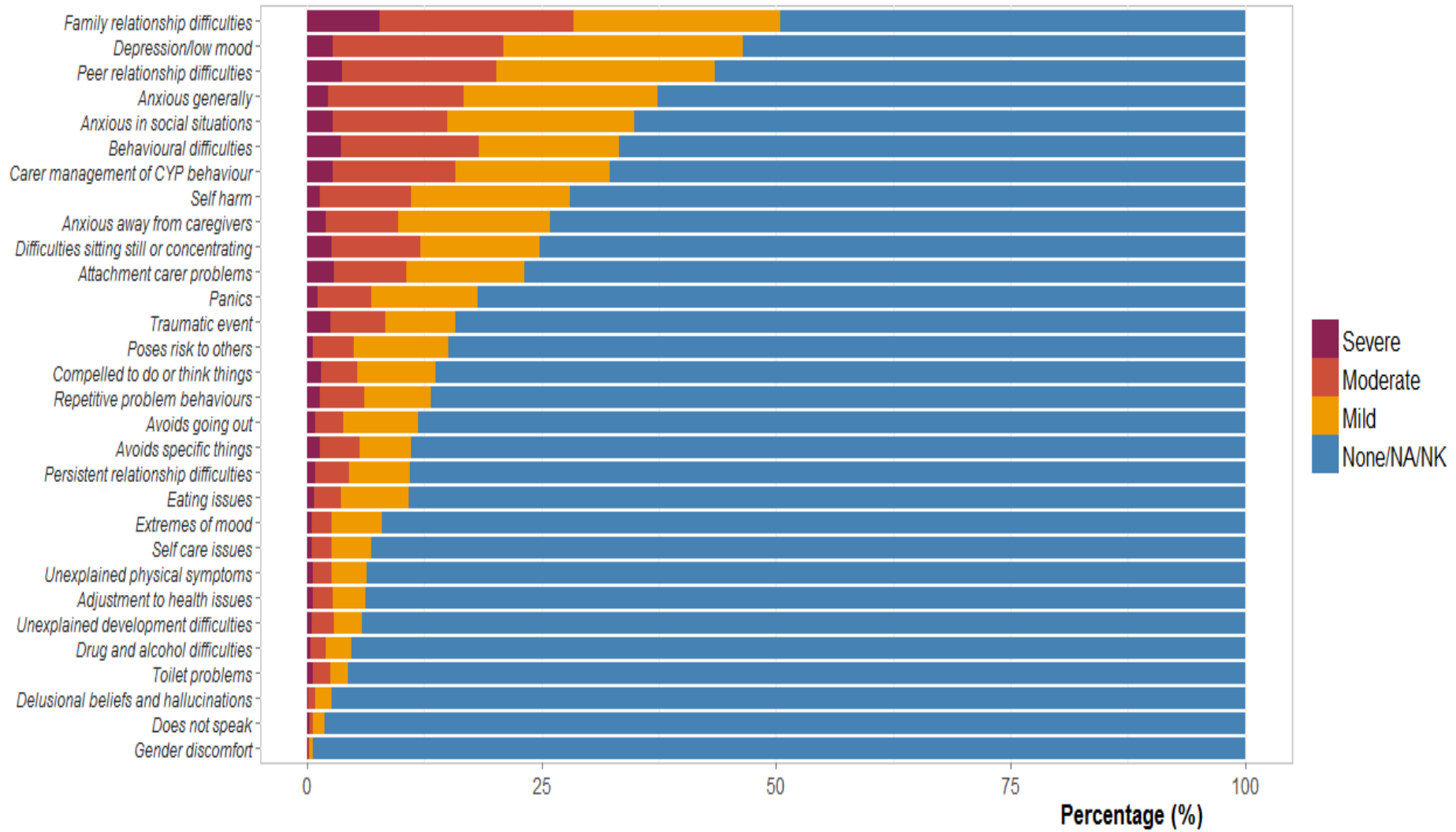
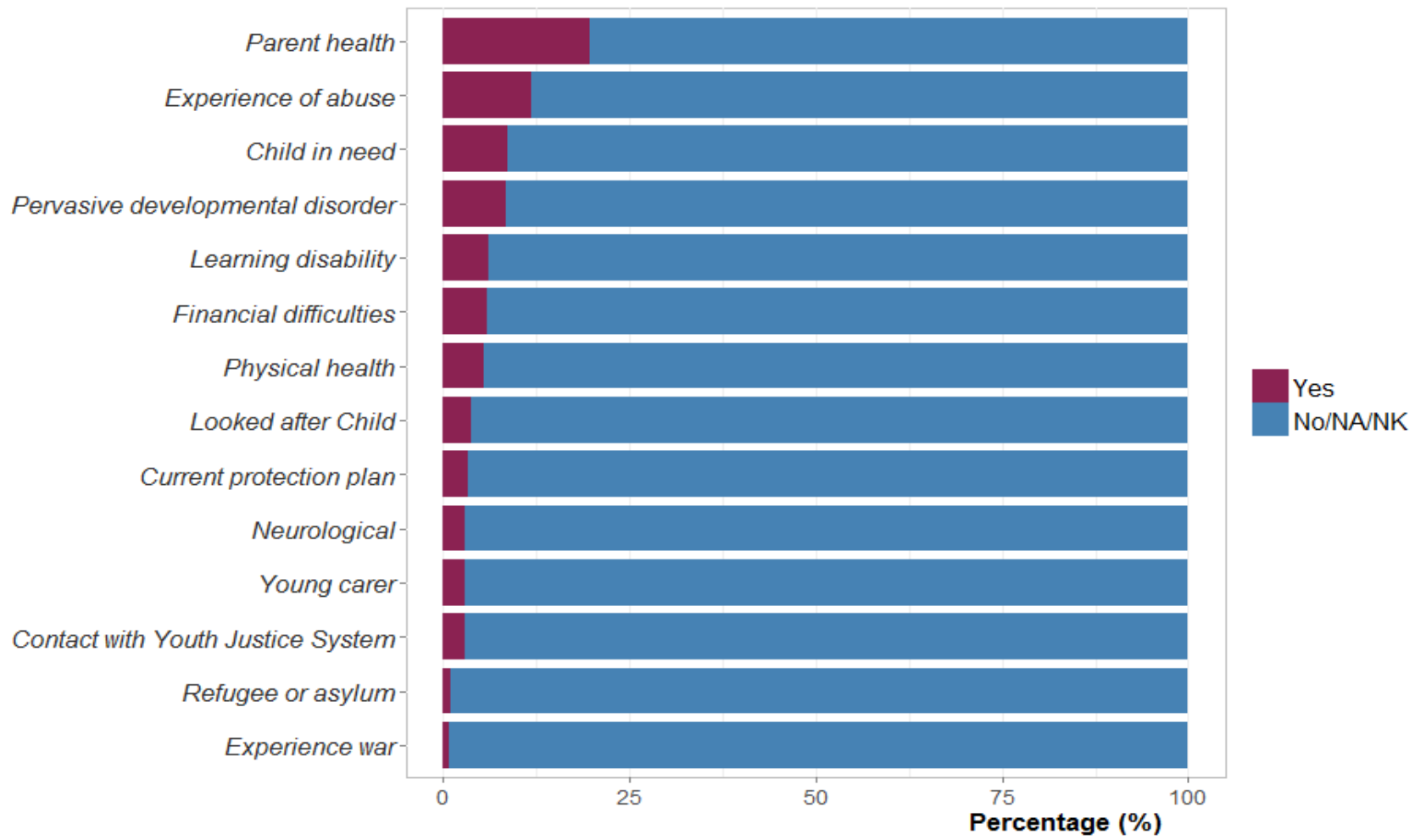## Number of Problems Rated Moderate or Severe

Note: For the purpose of this graph, multiple Anxieties were counted as if they constituted a single problem.
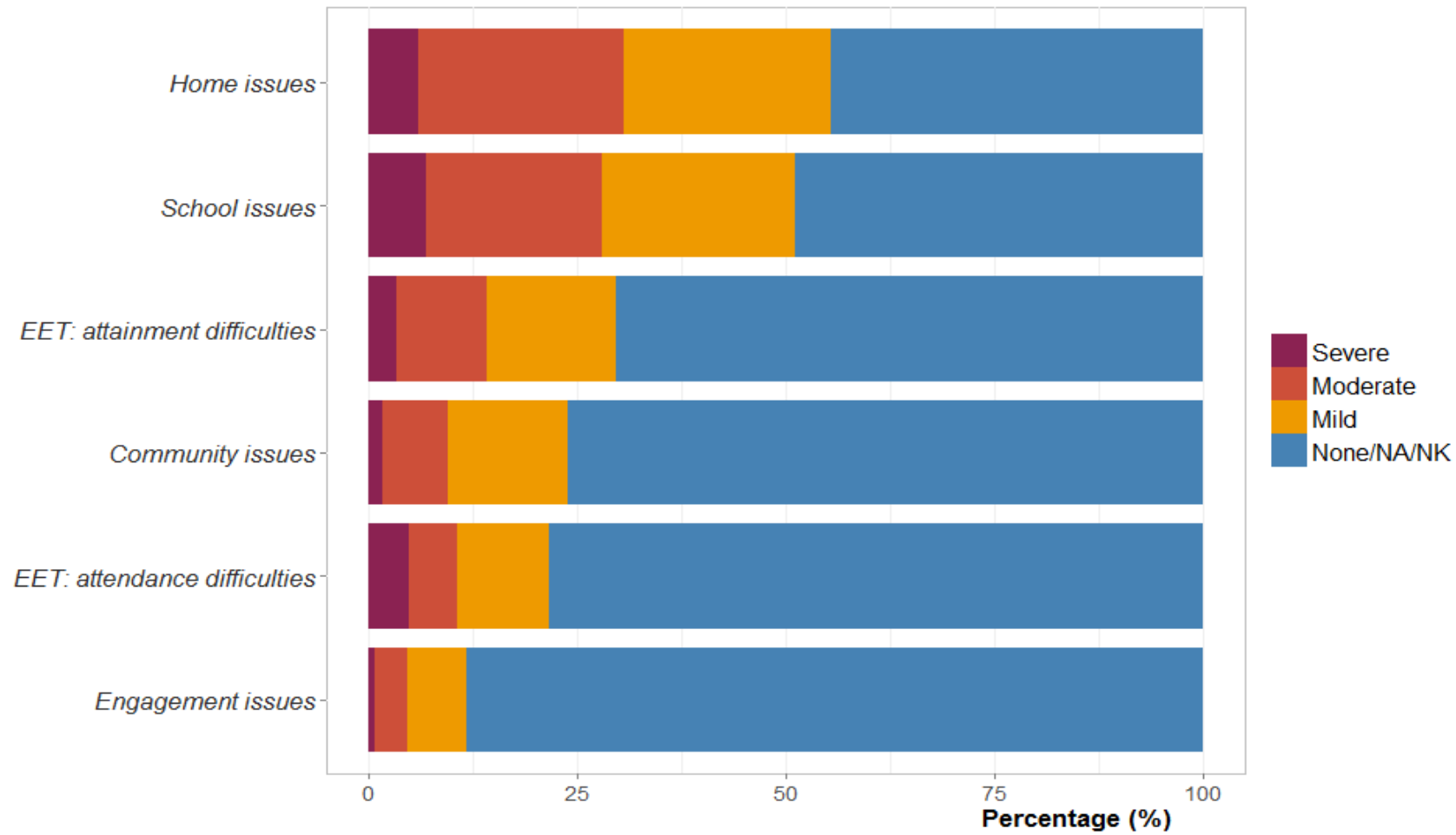
Number of Problems Rated Severe

Note: For the purpose of this graph, multiple Anxieties were counted as if they constituted a single problem.

Current View Complexity Factors

Current View Contextual Problems

Classification of periods of contact (POC) into NICE Guidance Categories

We identified 15 categories of presenting problems for which NICE guidance was available:

- ADHD
- Autism Assessment
- Autism Management
- Bipolar Disorder
- Conduct Disorder
- Depression
- Eating Disorder
- Emerging Borderline Personality Disorder
- Generalized Anxiety Disorder
- Obsessive-Compulsive Disorder
- Panic Disorder
- Psychosis
- PTSD
- Self Harm
- Social Anxiety

Classification of POCs into NICE Guidance Categories

Information from Current View Forms filled in at assessment was used to check, for each case, whether presenting problems appeared to 'fit' a NICE guidance. To 'fit' a NICE guidance, a POC had to fulfil the following criteria:

- Have the "signature problem" defined by the NICE guidance, rated 'moderate' or 'severe'
- Not have a significant "comorbidity" that would mean that NICE guidance may not be applicable in a straightforward way

Example:

To be classified into the NICE category "OCD", a POC had to:

- Have "**Compelled to do or think things**" rated moderate or severe (this is the "**signature problem**")
- Not have any of 23 specific other problems (e.g "Low Mood", "Delusional Beliefs or Hallucinations", etc.) rated at equal or higher severity compared to the signature problem

Classification of POCs into NICE Guidance Categories

- 44 % of POCs fitted one or two NICE categories
  - o Multiple categories included:
    - Self Harm in combination with Depression or Anxiety
    - Conduct problems in combination with Autism

- 56 % of POCs did not fit any NICE category
  - o These were divided into three groups:
    - **"MILD"**: POCs with mild problems only, or with a single 'moderate' problem, which did constitute a signature problem for any NICE category
    - **"MODERATE"**: POCs with multiple problems of moderate severity, and/or with a single severe problem that did not constitute a signature problem for any NICE category
    - **"SEVERE"**: POCs with multiple severe problems, where these either did not fit any NICE category, or indicated the presence of "comorbidity"

Percentage of POCs classified into NICE categories, by Age Group
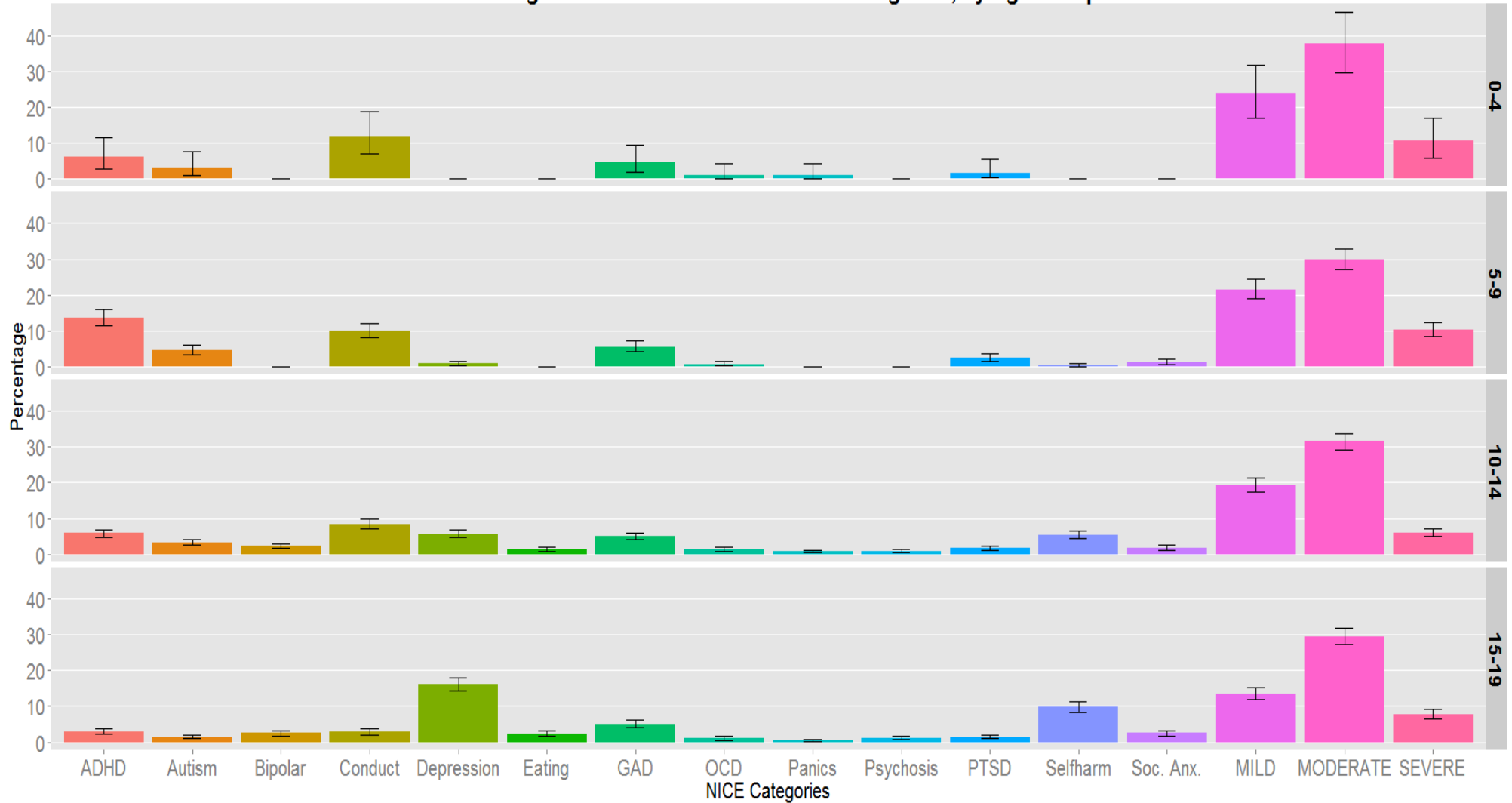
Note: For the purpose of this plot, a combination of Self Harm and Emotional Problems was classified as "Self Harm" (138 POCs); a combination of Conduct Problems and Autism was classified as "Autism" (31 POCs) ; and "Emerging Borderline Personality Disorder" was classified as "SEVERE" (2 POCs). Error bars show 95 % confidence intervals.

Cluster Development

Cluster Development

Approach 1: "Pure data driven" analysis

- Method: Regression Trees
- This resulted in models that were difficult to interpret and had poor statistical properties (model fit)

Approach 2: Theory-guided clustering using NICE guidance categories

- Method: Mixed-effects negative binomial regression
  - Dependent Variable: Number of appointments
  - Independent Variables: Clusters based on NICE guidance, plus complexity factors, contextual problems, and EET issues
- Three theoretically plausible models were compared:
  - Three Clusters
  - Five Clusters
  - Sixteen Clusters
- Model Comparison using statistical criteria (Akaike Information Criterion and Bayesian Information Criterion)

Three Cluster Model: Definition

Cluster	Current View Indicators
1: Coping	Has either: • No problem rated more than 'mild', or • A single problem rated as 'moderate', but does not fit into any category under Cluster 2
2: Getting Help	Fits one of the following NICE guidance categories: • ADHD, Autism Management, Conduct Disorder, Depression, Generalized Anxiety, OCD, Panic Disorder, PTSD, Social Anxiety Or: • Fits NICE guidance for Bipolar Disorder, with "Extremes of Mood" rated as moderate Or: • Does not fit any NICE category but has multiple problems rated at least moderate, but at most one problem rated as severe • Does not fit any NICE category and has exactly one severe problem
3: Getting More Help	Either: • Fits NICE guidance for "Psychosis" • Fits NICE guidance for "Bipolar Disorder" and "Extremes of Mood" rated as severe • Fits NICE guidance for "Eating Disorder" • Fits NICE guidance for Emerging Borderline Personality Disorder • Fits NICE guidance for Self Harm (may be combined with Depression or Anxiety) • Does not fit any NICE category but has multiple problems rated as severe

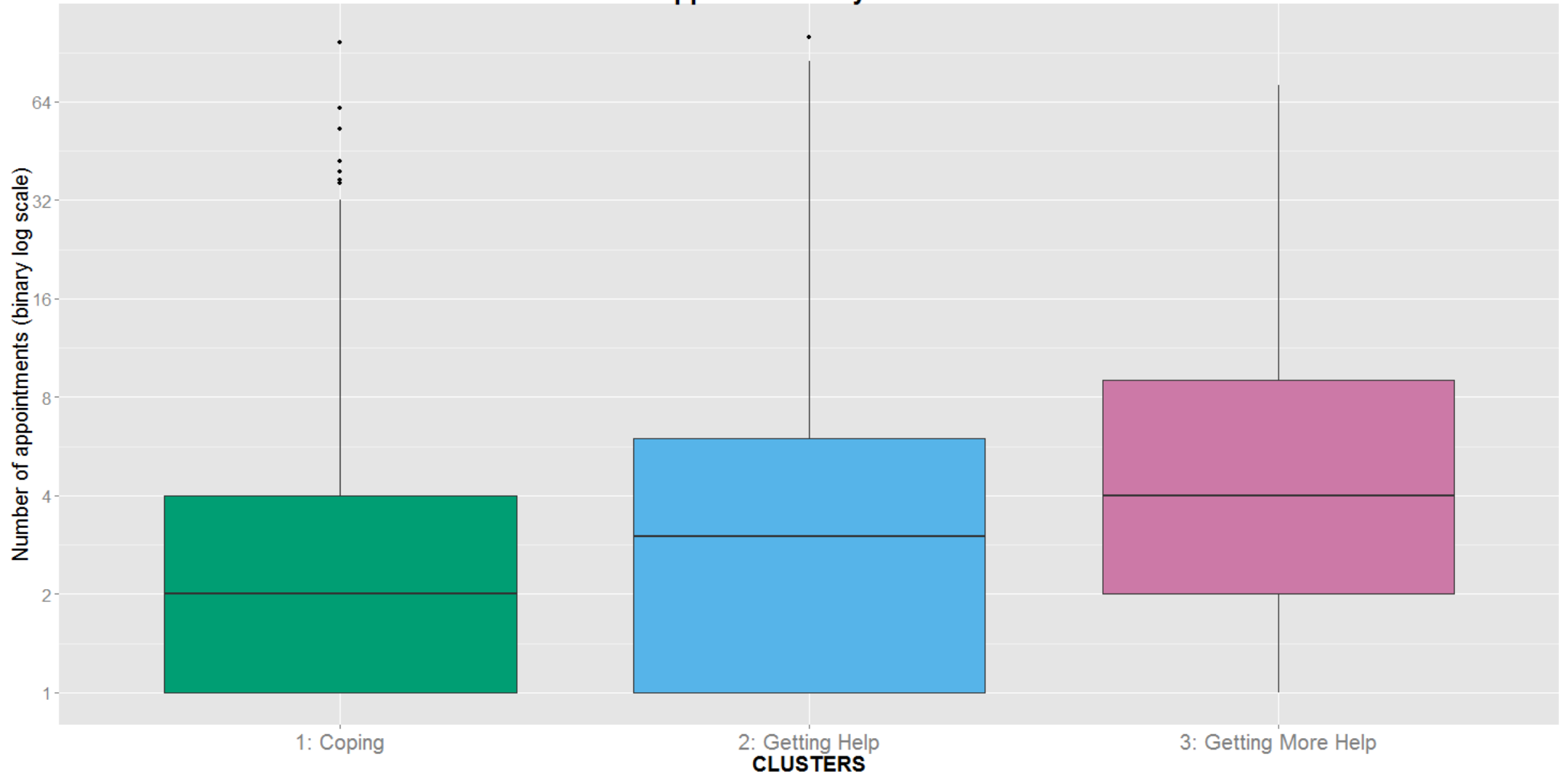# Three Clusters: Cluster Membership Proportions – by Age Group

Percentage of POCs in Clusters, by Age Group
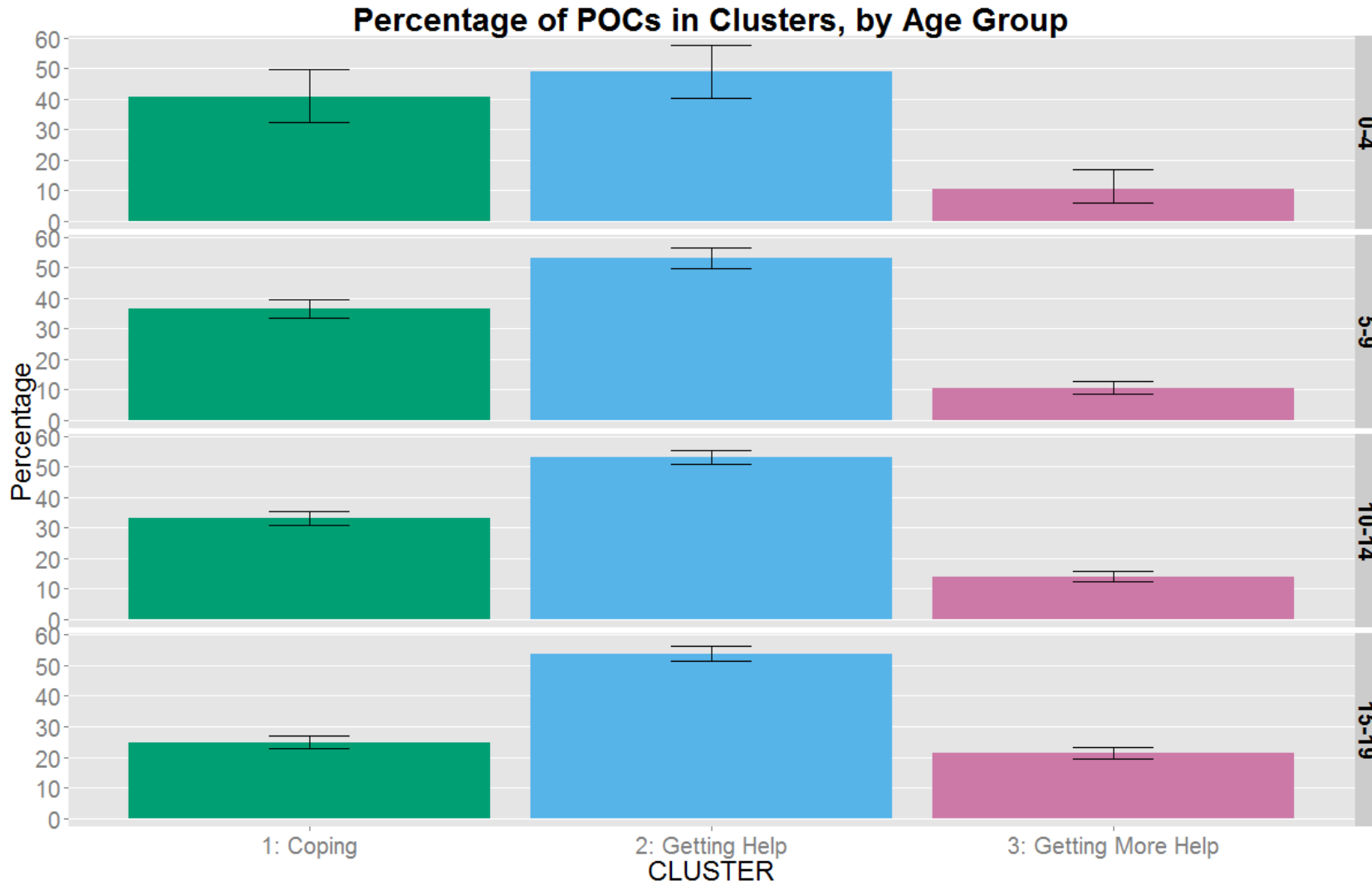
Proportion of POCs in each Cluster (Payment Systems Pilot Sample)

CLUSTER	Percentage of POC
1: Coping	31 %
2: Getting Help	53 %
3: Getting More Help	16 %

Note: Periods of Contact of shorter duration are more likely to be represented in the sample than periods of contact of longer duration. We therefore predict that membership in Cluster 3 is underestimated in these figures, while membership in Clusters 1 and 2 may be overestimated.
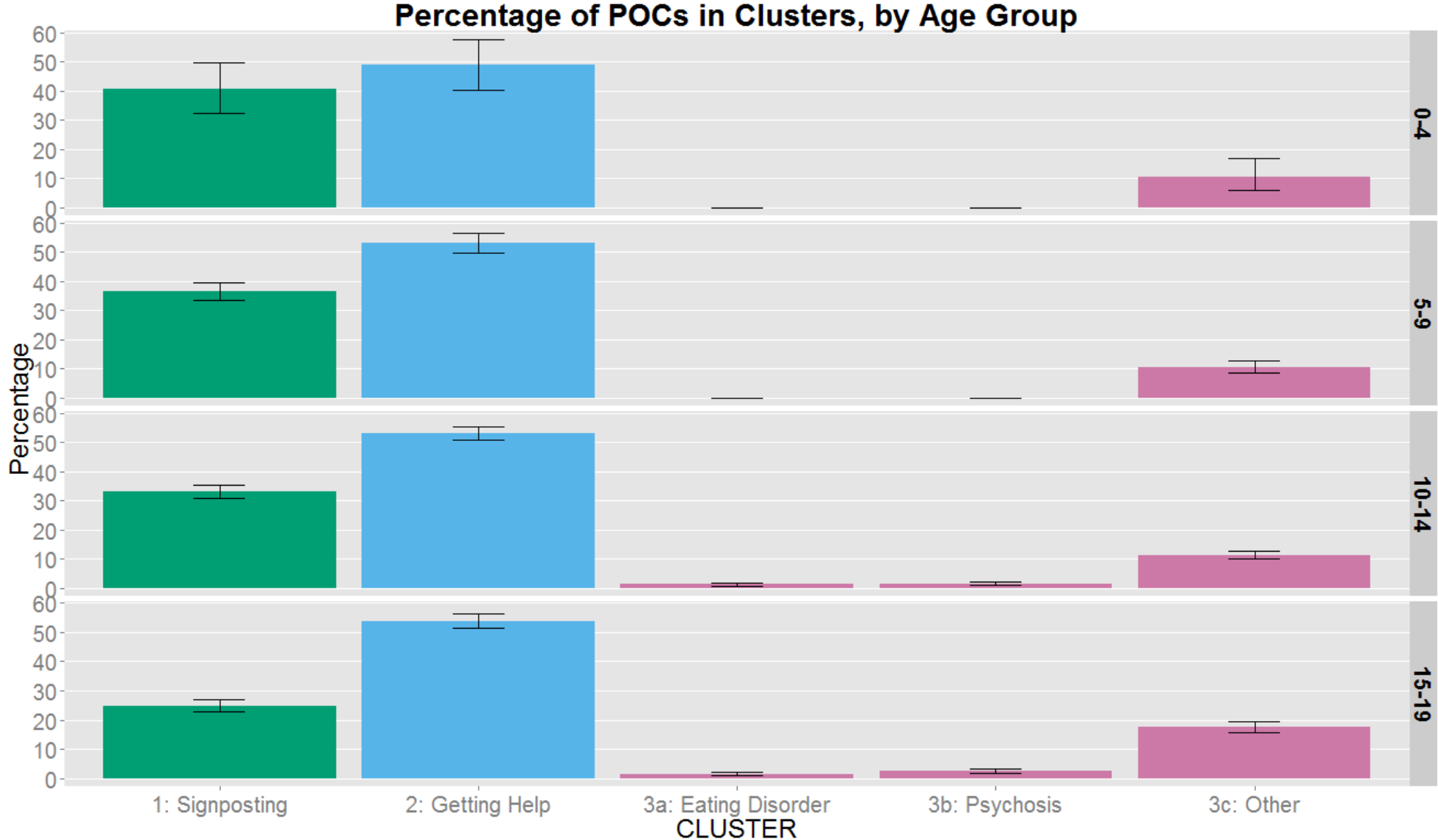
Appointments by Cluster

Five Cluster Model: Definition

Cluster	Current View Indicators
1: Coping	• (as before)
2: Getting Help	• (as before)
3a: Getting More Help: Psychosis	Either: • Fits NICE guidance for "Psychosis" • Fits NICE guidance for "Bipolar Disorder" and "Extremes of Mood" rated as severe
3b: Getting More Help: Eating Disorder	• Fits NICE guidance for an "Eating Disorder")
3c: Getting More Help: Other	Either: • Moderate or severe Self Harm (may be combined with Depression or Anxiety) • Emerging BPD • Does not fit any NICE category but has multiple problems rated as severe

Cluster Membership Proportions: Five Clusters

CLUSTER	Percentage of POC
1: Coping	31 %
2: Getting Help	53 %
3a: Getting More Help: Psychosis	1 %
3b: Getting More Help: Eating	1 %
3c: Getting More Help: Other	13 %

Five Clusters: Cluster Membership Proportions – by Age Group

Percentage of POCs in Clusters, by Age Group

Cluster Membership and Appointments: Five Clusters

Appointments by Cluster

16-cluster model: Definition

| Cluster	Current View Indicators
1: Coping	• (as before)
2: ADHD	• Fits NICE guidance for ADH
2: Autism	• Fits NICE guidance for Autism Management
2: Bipolar	• Fits NICE guidance for Bipolar (moderate severity)
2: Conduct	• Fits NICE guidance for Conduct Disorder
2: Depression	• Fits NICE guidance for Depression
2: General. Anxiety	• Fits NICE guidance for Generalised Anxiety Disorder
2: OCD	• Fits NICE guidance for OCD
2: Panics	• Fits NICE guidance for Panics
2: PTSD	• Fits NICE guidance for PTSD
2: Social Anxiety	• Fits NICE guidance for Social Anxiety
2: Multiple Moderate Problems	• Has multiple moderate problems, and/or one severe problem, but doesn't fit any NICE guidance (or has significant comorbidity)
3: Psychosis	• (as before)
3: Eating Disorder	• (as before)
3: Self Harm	• Fits NICE guidance for Self Harm (may be combined with Depression or Anxiety)
3: Multiple Severe Problems	• Emerging BPD, or • Does not fit any NICE category but has multiple problems rated as severe

16-cluster model: Cluster sizes

Cluster	Percentage of POC
1: Coping	32 %
2: ADHD	6 %
2: Autism	1 %
2: Bipolar	1 %
2: Conduct	5 %
2: Depression	6 %
2: Generalised Anxiety	4 %
2: OCD	1 %
2: Panics	0.3 %
2: PTSD	2 %
2: Social Anxiety	2 %
2: Multiple Moderate Problems	24 %
3: Psychosis	1 %
3: Eating Disorder	1 %
3: Self Harm	6 %
3: Multiple Severe Problems	8 %

Sixteen Clusters: Cluster Membership Proportions – by Age Group

Percentage of POCs in 16 Clusters, by Age Group
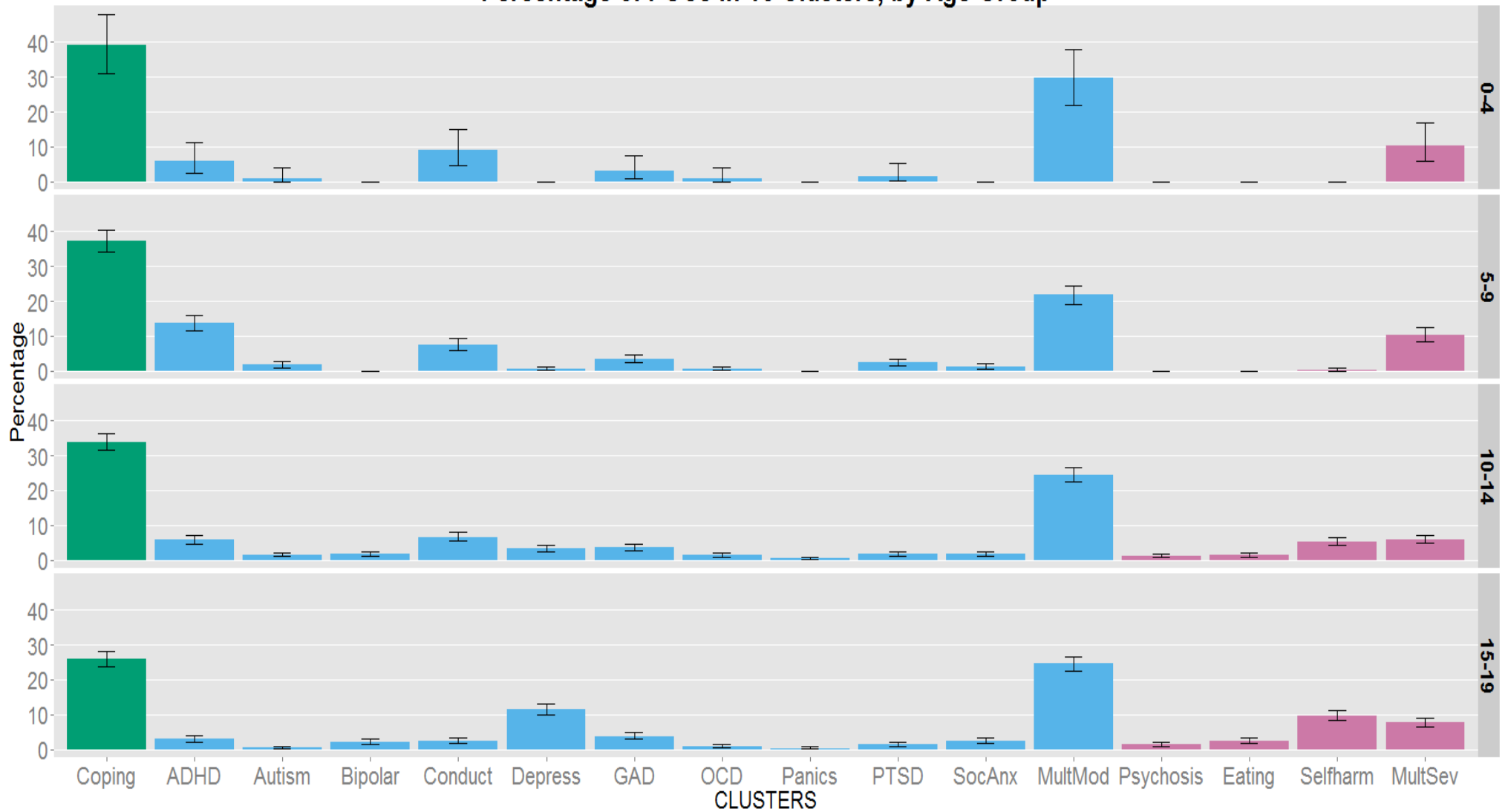
Appointments by Cluster
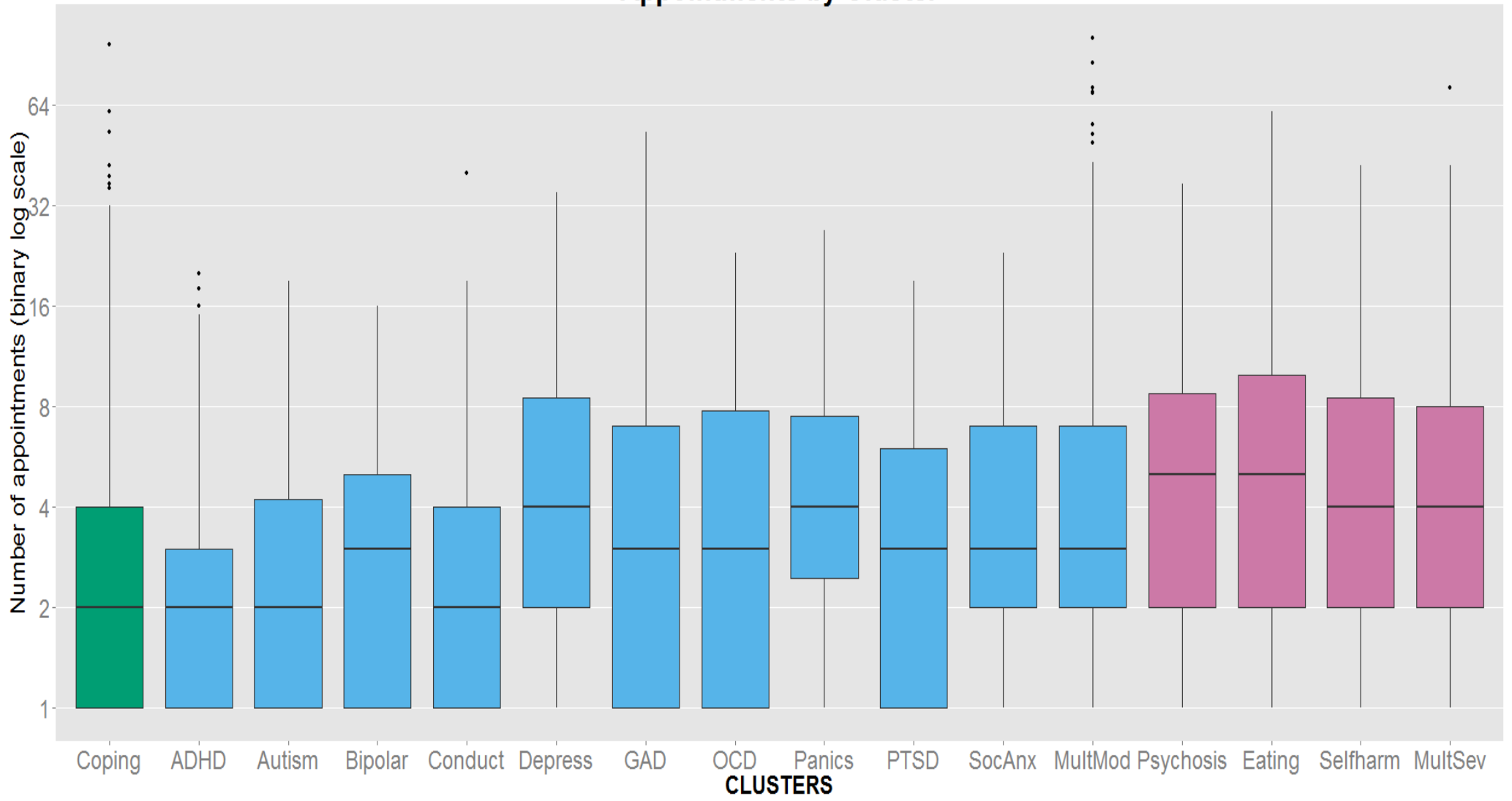
Model comparison: Mixed negative binomial regression

Model	Log-likelihood	Parameters	AIC	BIC
Three Clusters	-11940.4	5	23890.8	23922.9
Five Clusters	-11937.1	7	23888.2	23933.2
Sixteen Clusters	-11874.4	18	23784.8	**23900.5**
Sixteen Clusters + Complexity Factors, Contextual Problems & EET Issues	-11835.2	38	**23746.4**	23900.7

Note: All models include a random effect for service. AIC: Akaike Information Criterion. BIC: Bayesian Information Criterion. Dependent Variable: Number of appointments.

- AIC and BIC are model quality criteria. Each balances model fit ("log-likelihood") with model parsimony ("number of parameters") in a different way. For each AIC and BIC, a smaller number indicates a better model.
- According to the AIC, the 16-cluster model with additional factors is best.
- According to the BIC, the 16-cluster model is best, but taking into account additional factors does not make much of a difference.

16-cluster model: the influence of context and complexity on appointments
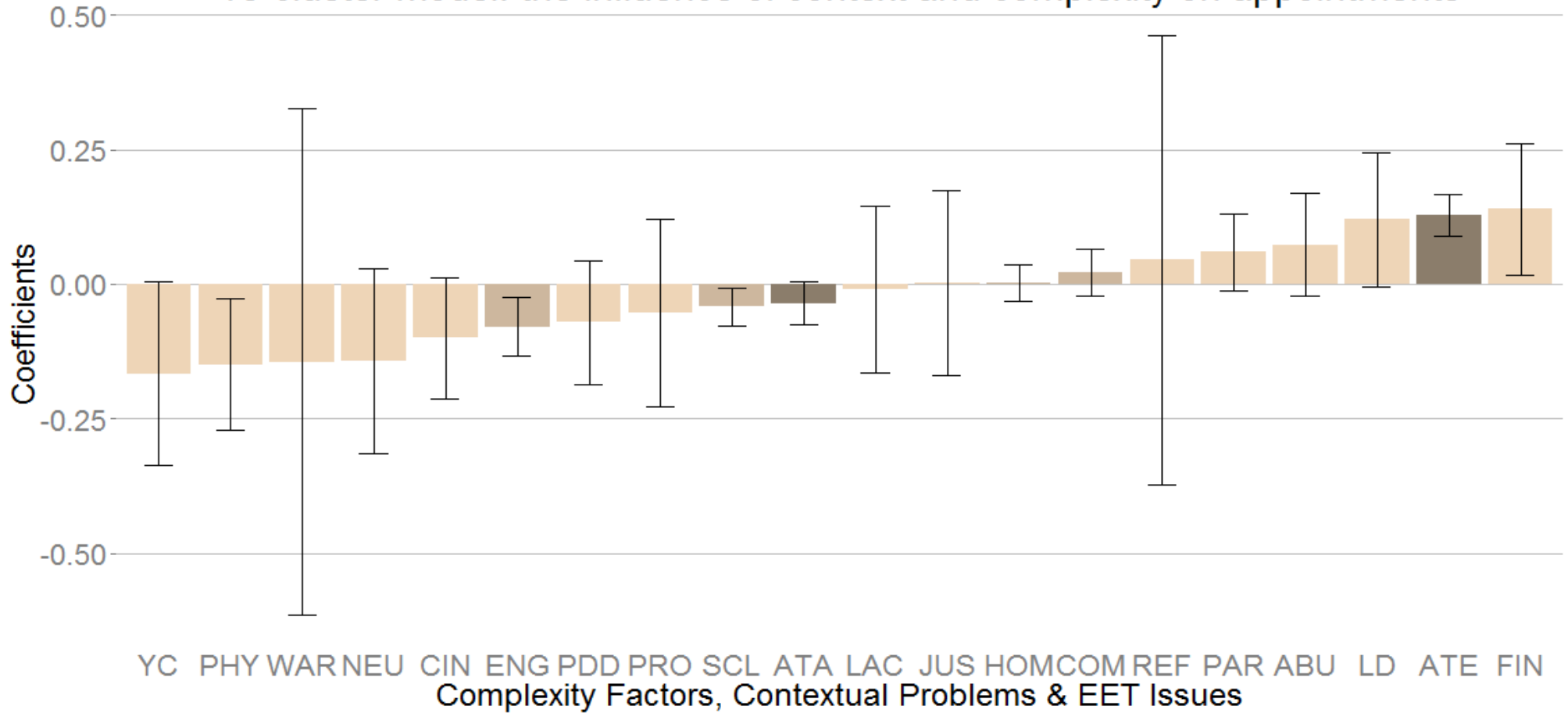
Note: This plot is based on a model predicting the "number of appointments" using 16 clusters and 20 complexity, context and EET factors as predictors. Coloured bars show estimates the effect of having the associated risk factor, compared to the risk factor being absent. A bar reaching 'up' indicates that the associated risk factor is predicted to increase the number of appointments; a bar reaching 'down' indicates that the associated risk factor is predicted to decrease the number of appointments. Error bars around the coloured bars show 95 % confidence intervals. If error bars span the value "0", then there is no strong evidence for the influence of the associated risk factor. See appendix for a legend to labels, and for the model specification.

16-cluster model: comparing clusters and other factors: influence on appointments

Complexity Factors, Contextual Problems, EET Issues & Clusters
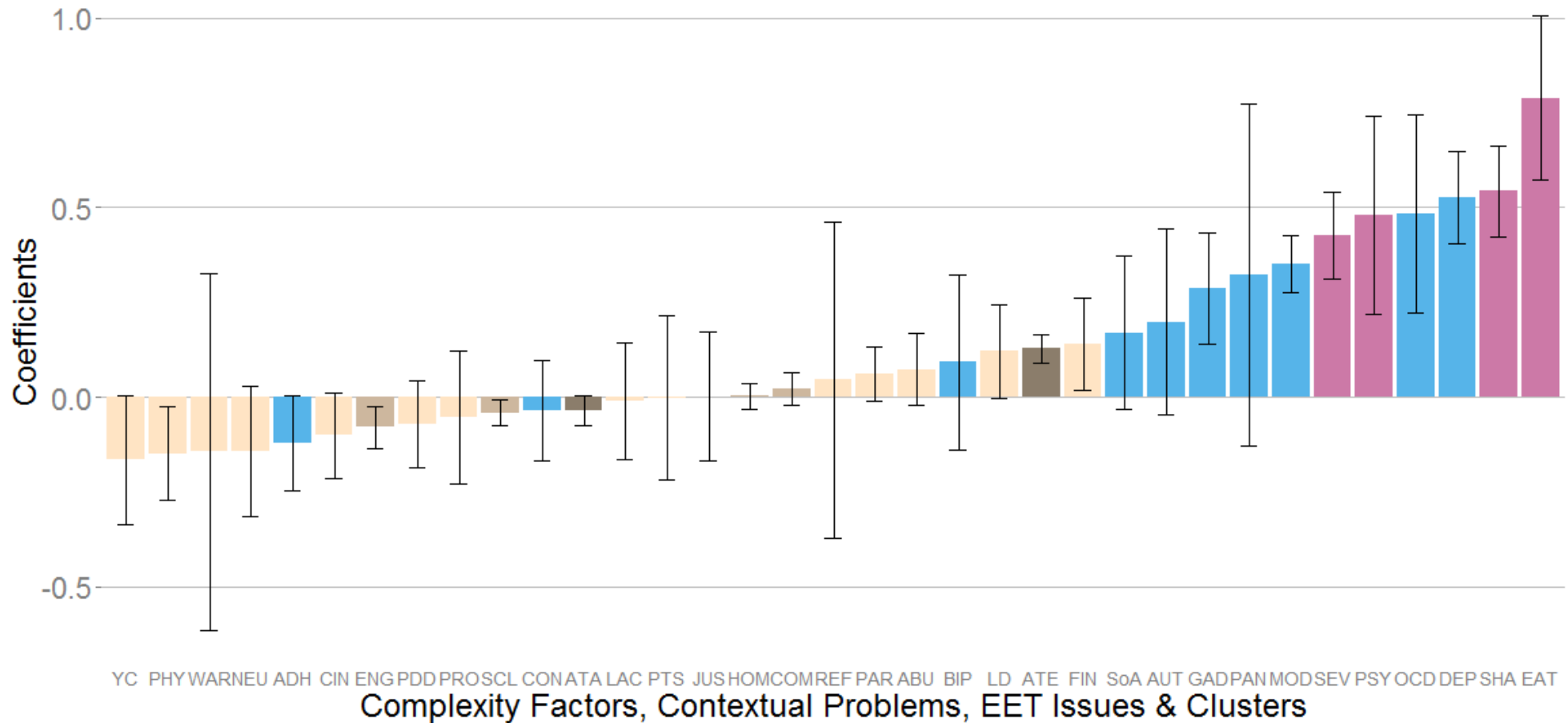
Note: This plot shows the same model as the previous plot, but this time the estimated effects of the 16 clusters are shown alongside the effects for complexity, context and EET factors. Clusters are identified by colour only: blue bars show clusters belonging to "Getting Help", purple bars show clusters belonging to "Getting More Help". The influence of each cluster or risk factor is shown compared to a POC in the "Coping" cluster without any risk factors. It can be seen that Cluster Membership is a more important predictor of "number of appointments" than any of the associated risk factors. See appendix for a legend to labels and for the model specification.

Summary

Summary

- Presence of Psychosis or Eating Disorder predicts the highest resource use
- Next high for:
  - Multiple Severe Problems
  - Self-harm
- Children with depression or anxiety currently tend to have more appointments than children with conduct problems, autism or ADHD
- There is a large group of children that does not appear to fit neatly into any NICE guidance category, and this group varies widely with respect to resource use
- No evidence <u>from these data</u> for a strong influence of context or complexity factors
  - Only "EET Attendance Issues" and "Family Financial Difficulties" appear to predict higher number of appointments
  - Some factors appear to predict smaller number of appointments (Physical Health Complexity, Service Engagement Problems, School Context Problems)

Summary (2)

- Three theoretical models were being compared, using 3, 5, and 16 clusters respectively
- Using statistical criteria (AIC and BIC), the 16-cluster model provided the best prediction of "number of appointments"
- However, the model that best predicts current resource use may not be the most useful in practice
- All models result in classifications that have large within-cluster variation compared to between-cluster variation
  - That means that children within the same cluster may vary widely in their resource use

Appendix: Legend to Slides 33 & 34

Complexity Factors
ABU: Experience of Abuse or Neglect
CIN: Child in Need
FIN: Living in financial difficulty
JUS: Contact with Youth Justice System
LAC: Looked after Child
LD: Learning Disability
NEU: Neurological Issues
PAR: Parental Health Issues
PDD: Pervasive Developmental Disorders
PHY: Physical Health Problems
PRO: Current Protection Plan
REF: Refugee or asylum seeker
WAR: Experience of War, Torture or Trafficking
YC: Young Carer

Contextual Problems
ENG: Service Engagement
COM: Community Issues
HOM: Home
SCL: School, Work or Training

Education/Employment/Training
ATA: Attainment Difficulties
ATE: Attendance Difficulties

Clusters: Getting Help
ADH: ADHD
AUT: Autism
BIP: Bipolar Disorder (moderate)
CON: Conduct Problems
DEP: Depression
GAD: Generalized Anxiety Disorder
MOD: Multiple Moderate Problems
OCD: Obsessive Compulsive Disorder
PAN: Panics
PTS: PTSD
SoA: Social Anxiety

Clusters: Getting More Help
EAT: Eating Disorder
PSY: Psychosis
SHA: Self Harm
SEV: Multiple Severe Problems

Appendix: Model Specification

A mixed-effects zero-truncated negative binomial regression approach was used to compare the three classifications with respect to how well they predict the number of appointments, and to explore the effect of contextual problems and complexity factors. The model includes a random effect for "CAMH service" in order to take into account the nested data structure.

$$\log(\mu_{ij}) = \beta_0 + \sum_{k=1}^{p} \beta_k x_{ijk} + u_i \,,$$

where:

- $Y_{ij} \sim NB(\mu_{ij}, \alpha)$ is the number of appointments for the jth child treated by the ith service, with mean μ_{ij} and dispersion parameter α;
- β_0 is an intercept term;
- β_k, $k = 1, \dots, p$, is a vector of slope coefficients corresponding to the p predictor variables $x_1, \dots, x_p$;
- $u_i \sim N(0, \sigma_u^{\,2})$ is the random intercept term for the ith service, $i = 1, \dots, 11$;
- The variance function is defined as: $V(\alpha) = \mu + \alpha\mu^2$. (This is called the "NB2 parameterization".)