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Technical report

Pathways of Care Longitudinal Study: Outcomes of Children and Young People in Out-of-Home Care

Initial Wave Weighting for the Pathways of Care Longitudinal Study

Pathways of Care Longitudinal Study

Technical Report No. 6

Initial Wave Weighting for the Pathways of Care Longitudinal Study[1]

[1] This publication is to be read in conjunction with Wulczyn, F., Collins, L., Chen, L. & Huhr, S. (2017). Statistical Power, Selection Bias, and Non-response Correction. Pathways of Care Longitudinal Study: Outcomes of Children and Young People in Out-of-Home Care. Technical Report Number 5. Sydney. NSW Department of Family and Community Services.

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Pathways of Care Longitudinal Study Clearinghouse All study publications including research reports, technical reports and briefs can be found on the study webpage www.community.nsw.gov.au/pathways

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Preface

The Pathways of Care Longitudinal Study (POCLS) is funded and managed by the New South Wales Department of Family and Community Services (FACS). It is the first large-scale prospective longitudinal study of children and young people in out-of-home care (OOHC) in Australia. Information on safety, permanency and wellbeing is being collected from various sources. The child developmental domains of interest are physical health, socio-emotional wellbeing and cognitive/learning ability.

The overall aim of this study is to collect detailed information about the life course development of children who enter OOHC for the first time and the factors that influence their development. The POCLS objectives are to:

describe the characteristics, child protection history, development and wellbeing of children and young people at the time they enter OOHC for the first time;

describe the services, interventions and pathways for children and young people in OOHC, post restoration, post adoption and on leaving care at 18 years;

describe children's and young people's experiences while growing up in OOHC, post restoration, post adoption and on leaving care at 18 years;

understand the factors that influence the outcomes for children and young people who grow up in OOHC, are restored home, are adopted or leave care at 18 years; and

inform policy and practice to strengthen the OOHC service system in NSW to improve the outcomes for children and young people in OOHC.

The POCLS is the first study to link data on children's child protection backgrounds, OOHC placements, health, education and offending held by multiple government agencies; and match it to first hand accounts from children, caregivers, caseworkers and teachers. The POCLS database will allow researchers to track children's trajectories and experiences from birth.

The population cohort is a census of all children and young people who entered OOHC for the first time in NSW between May 2010 and October 2011 (18 months) (n=4,126). A subset of those children and young people who went on to receive final Children's Court care and protection orders by April 2013 (2,828) were eligible to participate in the study. For more information about the study, please visit the study webpage www.community.nsw.gov.au/pathways.

1 Introduction

The Pathways of Care Longitudinal Study (POCLS) follows a population cohort of 4,126 children aged 0 to 17 years entering out-of-home care for the first time in an 18-month period between May 2010 and October 2011. Data collection for the study started in May 2011. The final orders cohort is children who received Children's Court care and protection final orders by April 2013 (n=2,828). Children in the no final orders cohort were assessed to be safe to return to their parents care (n=1,298). Children and their caregivers in the final orders cohort are invited to participate in face-to-face interviews every 18-24 months for five waves.

The final orders cohort study participants were enumerated in five waves, with Wave 4 commencing in 2017. The POCLS is a longitudinal study, which enables cross sectional estimation and analysis, estimation and analysis of changes between waves, and longitudinal data analysis involving several waves. Further details of the study can be found in Paxman, Tully, Burke & Watson (2014).

The study is designed as a complete collection in which all eligible people are approached and there is no explicit sampling process. However, at each wave a proportion of the population will not respond and provide information for various reasons, or not provide sufficient information for use in producing estimates. Non-response occurs at Wave 1 and each following wave, which reduces the sample size. Also, unless people are Missing Completely at Random (MCAR), non-respondents and respondents may differ in key characteristics so that estimates obtained for the sample of respondents may differ from the characteristics of the population leading to biased estimates (Rubin & Little, 2002).

Adjustments can be made to the estimates calculated from the responding sample that may reduce biases due to non-response. One general approach to adjustment is weighting and there are various ways that this can be done (see Valliant, Dever & Kreuter, 2013; Brick & Montaquila, 2009, for example).

Previous work on Wave 1 has suggested the use of a response propensity model (see Wulczyn, Collins, Chen &Huhr, 2017). Here the process of responding is assumed to have response probabilities or propensities for each person in the population. These probabilities are estimated through statistical analysis. Weights are then calculated as the inverse of these estimated probabilities and applied to the responding sample to produce estimates. Other approaches are also available, some of which are discussed in Wulczyn et al., (2017). The use of response probabilities to create weights is discussed in Valliant et al., (2013, section 13.5.2 and Brick & Montaquila, 2009 section 4.3).

Weighting based on estimated response probabilities can be used at the first wave where the study is treated as a cross-sectional survey. It can also be applied for subsequent waves. In the case of a longitudinal survey there are added complications and also additional information that can potentially be exploited in weighting subsequent waves, due to the availability of additional variables collected at the first wave to use in the modelling for the response probabilities.

This report describes the development and implementation of weights for the initial wave of the POCLS and complements Wulczyn et al., (2017). A further report will describe the development and implementation of weights for subsequent waves and also for longitudinal estimation and analysis.

2 Previous analysis and approach

The approach to weighting for the POCLS Wave 1 was considered by Wulczyn et al., (2017). They recommended an approach in which the weights are calculated as the inverse of the estimated response probabilities (RP). The RPs were estimated by a logistic regression with response status as the dependent variable and care type, age at admission, Indigenous status, gender, maltreatment type, and number of Risk of Significant Harm (ROSH) reports as the explanatory variables. These explanatory variables are auxiliary variables that are available for all members of the population. In a main effects model the statistically significant variables ($p<0.1$) were age at admission and number of ROSH reports. The auxiliary variables are listed in Table 7.1. A model with full interactions was recommended by Wulczyn et al., (2017).

Provided the probability of response is fully accounted for by the variables included in the RP model, so that the non-respondents are Missing at Random (MAR) conditional on these variables, then unbiased estimate can be obtained by using weights that are the inverse of RPs. In practice it is unlikely that the MAR condition is completely fulfilled and weighted estimates may still have some bias, but the use of the weights should reduce the bias.

While the use of weights may reduce the bias in estimates due to non-response, the variation of the weights can increase the variances of estimates and their sensitivity to observation with very high weights. So it is useful to check that the variation in the weights is reasonable. The increase in variance of estimates of totals and means that arise due to weighting is often assessed using the design effect (*deff*) due to weighting, also known as the unequal weighting effect (Kish, 1965, Valliant et al., 2017, section 14.4.1), which is given by $1+C^2$, where C is the coefficient of variation (SD divided by mean) of the weights. While there is no strict rule, in practice values of C less than 0.7, corresponding to a *deff* of 1.5 are often regarded as acceptable. A check of the resulting weights derived by Wulczyn et al., (2017) showed a coefficient of variation of 0.31, which is reasonable. Estimates can be sensitive to cases with relatively high weight and so it is also desirable that the ratio of the maximum weight to the median weight is not excessive.

Weights were normalised to the responding sample size. Normalised weights can be used to produce estimates of means and proportions and used in statistical analysis procedures, but are not suitable for estimation of population totals. Normalisation of weights is not required for valid statistical inference, provided the appropriate survey estimation options are used in the analysis for example, the SVY approach in STATA (Valliant & Dever, 2018, section 7.1).

In seeking to apply the approach developed by Wulczyn et al., (2017) several issues arose:

- different enumeration strategy of different components of the population, those that were restored and those that were in out-of-home care (in-OOHC);
- the inclusion of interaction terms; and
- treatment of some variables as numerical or categorical.

3 Two sub-populations

The population has two components: restored, who were not included in Wave 1, and those in OOHC, who were included in Wave 1. The population consisted of 2,305 in-OOHC cases of which 1,281 were fully responding in Wave 1, a response rate of 55.6%. There were 521 restored cases in the population, none of which were included in Wave 1 and 96 which responded in Wave 2, giving a response rate of 18.4% in Wave 2.

In Wave 1, 521 study eligible children and young people had been restored to their birth parents before FACS attempted to contact the caregiver. In these cases, FACS attempted to recruit the birth parent(s). A total of 192 birth parents agreed to have their contact details passed on to the data collection agency. However, these children were not included in Wave 1 data collection for practical (e.g. recruitment) and ethical reasons (e.g. sensitivity). Birth parents and their children took part in the interview from Wave 2.

Therefore, the status of ‘restored to parents’ is defined as cases where children were restored in the process of recruitment and before the Wave 1 interview was scheduled. In other words, restoration needed to occur before the Wave 1 interview in order for the case to be classified as a ‘restored’ care. If a child took part in the Wave 1 interview and restoration occurred after that, then the case is classified to be in the ‘in-OOHC’ component (i.e. the child was in OOHC at the time of the Wave 1 interview).

In Wave 1, those children who had been restored were excluded from the study as it was felt that this was a very sensitive time. Consequently, the Wave 1 sample of respondents only included in-OOHC cases. The RP modelling performed by Wulczyn et al., (2017) includes all the restored cases as non-respondents. This means that implicitly the restored cases are being represented by the responding in-OOHC cases in Wave 1. If these two components are substantially different then this approach will lead to biases in the Wave 1 estimates and also affect longitudinal analyses. Also, the RP model will be strongly affected by the characteristics of the restored children, who were omitted from Wave 1 by design.

Substantive consideration of the restored cases suggested that they were different in many ways from the in-OOHC children. So using the characteristics of the in-OOHC cases at Wave 1 to account for the non-inclusion of the restored cases is problematic. A comparison of auxiliary variables between the two population components showed statistically significant differences, with the exception of gender, as shown in Table 7.2. The restored cases tended to have a higher incidence of foster care and lower incidence of kinship care, more were aged 6 years or more and fewer were aged less than 1 year old. They also had a lower percentage with Aboriginal status, a lower incidence of neglect only and a higher incidence of abuse only, higher incidence of one to two ROSH reports, and a lower incidence of higher numbers of ROSH reports. It was therefore decided to exclude them from Wave 1 weighting and to weight them separately from Wave 2 onwards.

In general, these two components of the population should be analysed separately, not least for the practical reason that there are no restored cases in Wave 1. If there are analyses that substantively make sense that combine the two components that can be achieved using the weights that have been calculated. For estimation of the variances and standard errors of estimates each component should be treated as a stratum in the statistical software being used. The weights calculated will result in each component being represented in proportion to their relative population size. The weights in each component should not be scaled to the sample size in that component as that will lead to each component being represented in proportion to their relative sample size, which is not appropriate because of the much lower response rate in the restored component

If there are children in the in-OOHC component that are considered similar to the restored children, then they can be treated as different categories in any analysis as long as there is an indicator of their status available. For weighting they will still be included in the in-OOHC component, but the analysis could conceivably break down the in-OOHC into these two groups.

4 Wave 1 final orders cohort component

4.1 General approach and issues examined

The general approach to non-response adjustment:

- each population unit, *i*, has a Response Probability (RP), ϕ_i
- we estimate the RP by modelling response in terms of available explanatory variables, to give $\hat{\phi}_i$
- the weight $w_i = \hat{\phi}_i^{-1}$ is used to adjust for the probability that the unit is a respondent
- for Wave 1 NRTP (and W2 RTP) the variables available for the RP modelling are auxiliary variables available from the population frame
- for subsequent waves the variables collected in the previous wave are also available for use in RP modelling.

Issus examined in RP modelling:

- selection of variables
- inclusion of interaction terms
- treatment of some variables as numerical or categorical
- variation of resulting weights.

For the in-OOHC component in Wave 1 we can use the estimated RP, $\widehat{}_{1i}$ obtained from a logistic regression of Wave 1 respondents using auxiliary variables listed in Table 7.1, which are available for all members of the population.

4.2 Analysis and results

The weights of the Wave 1 in-OOHC cases were recalculated by using the same general approach suggested by Wulczyn et al., (2017) applied only to the non-restored cases. That analysis is based on a population size of 2,205, with 1,281 respondents. To help decide what RP model to use, a number of analyses were undertaken.

Inclusion of interactions

A logistic regression model was fitted using all the six auxiliary variables listed in Table 7.1, with all interactions included, i.e. up to order six. This is a saturated model with 366 parameters and it was important to check the resulting weights are reasonable.

Treatment of numerical variables

The Wulczyn and colleagues (2017) approach treats maltreatment type and number of ROSH reports as numerical values in the final model, although they are treated as categorical in the main effects analysis in Table 7.8 of the Wulczyn et al., (2017) report. While the number of ROSH reports can be considered as numerical, maltreatment type is categorised as no issue specified, neglect only, abuse only and mixed, which does not naturally lend itself to numerical coding. The results in Table 7.8 of Wulczyn et al., (2017) show a general trend of increasing non-response with increasing number of ROSH reports; however, there seems to be no strong reason to treat it as numerical and assume a linear trend (in the log of the odds ratio). Treating it as categorical variable adds only three degrees of freedom in the main effects model and makes no assumptions about the way response varies with the number of ROSH reports, so how it is scored is not an issue. This approach allows for non-linear effects.

4.3 Discussion

To examine these issues, RP models were analysed that included all the main effects and interactions and those that did not include interactions; i.e. main effects only. Models were also analysed that treated both maltreatment type and ROSH reports as numerical, as both categorical, and where maltreatment type was categorical and ROSH reports was numerical.

Models were assessed using the Akaike Information Criterion (Akaike, 1974). Table 7.3 summarises the AIC associated with each option and Table 7.4 summarises the key features of the resulting weights. For the in-OOHC cases; the model with only main effects and treating all variables as categorical gives the lowest AIC. The CV of the weights is acceptable at 0.21 implying a *deff* of 1.044 and the maximum weight is 4.96, which is 2.79 times larger than median weight.

Using the same approach as Wulczyn et al., (2017) the full model including interactions produces weights with a CV of 0.95, implying a *deff* of 1.90 and a maximum weight of 58.63, which is 33.50 times larger than median weight. This large variation is probably due to the use of the full interaction model combined with treating some auxiliary variables as numerical. This is because the full model with some auxiliary numerical variables effectively fits local logistic regression models within the cells defined by the categorical auxiliary variables. Hence the estimated models are based on small sample sizes, with resulting instability of the fitted models. While extreme weights can be truncated, these results suggest the model is over-fitting.

A main effects model with all auxiliary variables treated as categorical is recommended. It has 13 parameters and will provide useful weights that adjust for the main factors affecting non-response and are well behaved.

The estimated main effect model is summarised in Table 7.5, which shows the auxiliary variables that are statistically significant (for $p<0.05$ and $p<0.1$) in the overall effects. Table 7.6 shows the specific categories of the auxiliary variables that are statistically significant. The p-values of the overall effect for each auxiliary variable are shown in Table 7.7.

A main effects model has age group and number of ROSH reports as statistically significant ($p<0.1$). Using $p<0.1$ to assess statistical significance, these results suggest that these are the main auxiliary variables explaining response in the in-OOHC component. The analysis of the parameters of the individual effects is given in Table 7.8. These results suggest that the response rate is lower for cases where the age at admission is 6 and above and higher where there are three or more ROSH reports.

Weights could be calculated using only statistically significant auxiliary variables. However, the purpose of the analysis is not to find substantively important effects but to develop a useful RP model for use in weighting. Since the number of parameters in the main effects model is only 13 and the variation of the weights is acceptable, using all of the auxiliary variables, as done in Wulczyn et al., (2017), is reasonable.

5 Wave 2 restoration cases

For children in the final orders cohort who were restored to their parents by Wave 2, a similar approach was used for the first wave in which they were included. A logistic regression for response was estimated. The sample size was smaller (n=521) so this limits the complexity of the RP model that can be used effectively.

Similar options were evaluated for the restored component of the population. Table 7.3 summarises the AIC associated with each option and Table 7.4 summarises the key feature of the weights. For the restored cases, the model with only main effects and treating the maltreatment types and ROSH variables as numerical gives the lowest AIC. However, the issues associated with treating these variables as numerical remain. The model with only main effects and all variables treated as categorical also has a relatively small AIC – it is smaller than the AIC for the main effects model where only number of ROSH reports is treated as numerical and is recommended. The CV of the resulting weights is acceptable at 0.52, giving a *deff* of 1.27 and the maximum weight is 19.71, which is 3.4 times larger than median weight. Applying the Wulczyn et al., (2017) approach to the restored component for Wave 2 leads to some extremely high weights, and a CV of 17.1.

The estimated model, with no interaction and all variables categorical, is summarised in Tables 5 and 6. More details are given in Table 7.9 and Table 7.10. These results suggest that the main factor explaining response in the restored component is care type, with foster care having a lower response rate. The analysis of the individual effects also suggests that abuse only and one to two ROSH reports also have higher and lower response rates than the other categories, respectively.

Weights could be calculated only using statistically significant auxiliary variables, but to be consistent with the general approach used for the in-OOHC component, using the model with all the variables was considered. That model uses 13 degrees of freedom with a population size of 521, with 96 respondents.

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7 Appendix

Table 7.1 Auxiliary variables

Care Type	
	Foster Family
	Kinship
	Other (includes residential care, supported accommodation)
Age at Admission	
	<1
	1 to 5
	6 and above
Indigenous Status	
	Non-Indigenous
	Indigenous
Gender	
	Female
	Male
Maltreatment Type	
	No issue specified
	Neglect only
	Abuse only
	Mixed
Number of ROSH Reports	
	None
	1 to 2
	3 to 6
	7 to 15
	16 or more

Table 7.2 Chi-squared test of difference between in-OOHC and restored children, p-value

Auxiliary Variable	p-value
Placement group	0.0027*
Age group	0.0029*
Aboriginality	<0.0001*
Gender	0.7753*
Issue group	0.0029*
rcountA-grp	0.0004*

** Statistically Significant 0.10*

Table 7.3 Summary of first wave analysis results, AIC

Model	Treatment of Maltreatment Type and ROSH Reports	In-OOHC W1	Restored W2
Main Effects	Categorical	3,119.1	502.3
Full Model	Categorical	3,412.7	663.5
Main Effects	Type categorical, ROSH numerical	3,123.7	503.1
Main Effects	Numerical	3,126.9	500.8
Full Model	Numerical	3,226.3	554.0

Table 7.4 Summary of first wave weights, median, CV, max

Model	Treatment of Maltreatment Type and ROSH Reports	In-OOHC W1 (Med, CV, Max)	Restored W2
Main Effects	Categorical	1.78, 0.21, 4.96	5.78, 0.52, 19.71
Full Model	Categorical	1.83, 4.75, 10,145	10.00, 1.02, 18,318
Main Effects	Type categorical, ROSH numerical	1.79, 0.21, 4.96	
Main Effects	Numerical	1.78, 0.15, 2.80	5.92, 0.33, 10.93
Full Model	Numerical	1.75, 0.95, 58.63	9.15, 17.1, 6.59E36

Table 7.5 Summary of first wave analysis results, statistically significant overall effects, p=0.05, *p=0.1*

Model	Treatment of Maltreatment Type and ROSH Reports	In-OOHC W1 (Med, CV, Max)	Restored W2
Main Effects	Categorical	Age_Group Recount_grp	Place1_Group
Full Model	Categorical	N/A	N/A
Main Effects	Type categorical, ROSH numerical	Age_Group Recount_grp	-
Main Effects	Numerical	Age_group, rcountA	Place1_Group
Full Model	Numerical	N/A	N/A

Table 7.6 Summary of first wave analysis results, statistically significant parameter estimates, p=0.05, *p=0.1*

Model	Treatment of Maltreatment Type and ROSH Reports	In-OOHC W1	Restored W2
Main Effects	Categorical	6 and above, 3-6 ROSH. 16+ ROSH *7-15 ROSH*	Foster Care 1-2 ROSH *Abuse only*
Full Model	Categorical	N/A	N/A
Main Effects	Type categorical, ROSH numerical	6 and above, 3-6 ROSH. 16+ ROSH *7-15 ROSH*	
Main Effects	Numerical	6 and above, rcountA	Foster Care, Kinship Care
Full Model	Numerical	N/A	N/A

Table 7.7 Summary of overall effect for main effects RP model with auxiliary variables, in-OOHC cases, all auxiliary variables categorical

Auxiliary Variable	Degrees of Freedom	Wald Chi-squared	p-value
Care Type	2	0.8858	0.6422
Age at Admission	2	39.0954	<0.0001*
Indigenous Status	1	2.1537	0.1422
Gender	1	1.9662	0.1609
Maltreatment Type	3	3.0109	0.3900
Number of ROSH Reports	4	15.0759	0.0045*

** Statistically Significant 0.10*

Table 7.8 Details of parameter estimates for main effects RP model for Wave 1 response, in-OOHC cases, all auxiliary variables categorical

Auxiliary Variable	Estimate	Standard Error	p-value	Odds Ratios
Intercept	0.00259	0.0725	0.9714	
Care Type				
Foster Family	0.0528	0.0643	0.4113	1.150
Kinship	0..0341	0.0758	0.6527	1.129
Other	baseline			
Age at Admission				
<1	baseline			
1 to 5	-0.0190	0.0630	0.7625	0.637
6 and above	-0.4123	0.0699	<0.0001*	0.430
Indigenous Status				
Non-Indigenous	baseline			
Indigenous	-0.0660	0.0450	0.1422	0.876
Gender				
Female	0.0599	0.0427	0.1608	
Male	baseline			1.127
Maltreatment Type				
No issue specified	baseline			
Neglect only	0.0902	0.0782	0.2486	1.136
Abuse only	0.0361	0.0787	0.6462	1.076
Mixed	-0.0892	0.0802	0.2660	0.949
Number of ROSH Reports				
None	baseline			
1 to 2	0.0929	0.1037	0.3706	2.536
3 to 6	0.2340	0.0928	0.0117*	2.920
7 to 15	0.1667	0.0988	0.0916*	2.731
16 or more	0.3442	0.1165	0.0031*	3.261

** Statistically Significant 0.10*

Table 7.9 Summary of overall effect for main effects RP model with auxiliary variables, restored cases, all auxiliary variables categorical

Auxiliary Variable	Degrees of Freedom	Wald Chi-squared	p-value
Care Type	2	10.4443	0.0054*
Age at Admission	2	1.3797	0.5017
Indigenous Status	1	0.1624	0.6870
Gender	1	2.3537	0.1250
Maltreatment Type	3	3.6369	0.3034
Number of ROSH Reports	4	6.7716	0.1485

** Statistically Significant 0.10*

Table 7.10 Details of parameter estimates for main effects RP model for Wave 1 response, restored cases, all auxiliary variables categorical

Auxiliary Variable	Estimate	Standard Error	p-value	Odds Ratios
Intercept	-1.2167	0.1917	<0.0001*	
Care Type				
Foster Family	-0.5070	0.1829	0.0056*	0.504
Kinship	0.3281	0.2057	0.1107	1.161
Other	baseline			
Age at Admission				
<1	baseline			
1 to 5	0.1218	0.1721	0.4789	1.047
6 and above	-0.1980	0.1849	0.2848	0.760
Indigenous Status				
Non-Indigenous	baseline			
Indigenous	0.0565	0.1403	0.6870	1.120
Gender				
Female	0.1810	0.1180	0.1250	1.436
Male	baseline			
Maltreatment Type				
No issue specified	baseline			
Neglect only	-0.1428	0.2565	0.5778	1.258
Abuse only	0.3721	0.2094	0.0755*	2.105
Mixed	0.1428	0.2321	0.5382	1.674
Number of ROSH Reports				
None	baseline			
1 to 2	-0.6296	0.2755	0.0229*	0.313
3 to 6	-0.0805	0.2509	0.7485	0.541
7 to 15	0.2507	0.2620	0.3387	0.753
16 or more	-0.0777	0.3379	0.8182	0.542

** Statistically Significant 0.10*