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Technical report

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

Weighting for the Pathways of Care Longitudinal Study

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

Technical Report No. 7

Weighting for the Pathways of Care Longitudinal Study

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About the information in this report
All the analyses presented in this report are based on the February 2018 version of the Wave 1-3 unweighted data collected in face-to-face interviews with children, young people and caregivers; and FACS administrative data.

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

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Preface

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
- 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 over an 18 month period between May 2010 and October 2011 (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.facs.nsw.gov.au/resources/research/pathways-of-care.

The POCLS acknowledges and honours Aboriginal people as our First Peoples of NSW and is committed to working with the FACS Aboriginal Outcomes team to ensure that Aboriginal children, young people, families and communities are supported and empowered to improve their life outcomes. The POCLS data asset will be used to improve how services and supports are designed and delivered in partnership with Aboriginal people and communities.

FACS recognises the importance of Indigenous Data Sovereignty (IDS) and Indigenous Data Governance (IDG) in the design, collection, analysis, dissemination and management of all data related to Aboriginal Australians. The POCLS is subject to ethics approval, including from the Aboriginal Health & Medical Research Council of NSW. FACS is currently in the process of scoping the development of IDS and IDG principles that will apply to future Aboriginal data creation, development, stewardship, analysis, dissemination and infrastructure. The POCLS will continue to collaborate with Aboriginal Peoples and will apply the FACS research governance principles once developed.

1 Introduction

The Pathways of Care Longitudinal Study (POCLS) is a study that follows people aged 0 to 17 entering out-of-home care (OOHC) for the first time within an 18-month period between May 2010 and October 2011. Data collection for the study started in May 2011. Study participants are enumerated over waves, with Wave 4 (W4) 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 and Watson (2014).

The study is designed as a complete collection or census 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 or provide information for various reasons, or not provide sufficient information for use in producing estimates. Non-response occurs at Wave 1 (W1) and each following wave, which reduces the sample size. Unless people are Missing Completely at Random (MCAR), non-respondents and respondents may differ in key characteristics so that estimates obtained from the sample of respondents may differ from the characteristics of the population, leading to biased estimates (Rubin and 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 and 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 additional information that can potentially be exploited in weighting subsequent waves, due to the availability of additional variables collected at the first and subsequent waves to use in the modelling of the response probabilities.

A previous report by Steel and Navin Cristina (2018) describes the development and implementation of weights for the initial wave of the POCLS and complements Wulczyn *et al.* (2017). This current report describes the development and implementation of weights for subsequent waves up to Wave 3 (W3) and also for longitudinal estimation and analysis.

2 Initial waves weighting

The population has two components: those who were in OOHC, who were included in Wave 1 and those restored to parents (restored) who were not included in Wave 1, and were first included in Wave 2 (W2). These two components were treated separately as described in Steel and Navin Cristina (2018).

The general approach to non-response adjustment for the initial waves (i.e. Wave 1 for in-OOHC and Wave 2 for restored cases) is:

- Each population unit, *i*, has a Response Probability (RP), ϕ_i
- The RP is estimated 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 the Wave 1 in-OOHC and the Wave 2 restored component of the population the variables available for the RP modelling are auxiliary variables available from the population frame, which are listed in Table 1.

Issues examined in the RP modelling for the initial waves were:

- 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, $\hat{\phi}_{1i}$ obtained from a logistic regression of Wave 1 response using auxiliary variables, which are available for all members of the population.

A main effects model with all auxiliary variables treated as categorical was recommended. This model has 13 parameters or degrees of freedom (d.f.) and will provide useful weights that adjust for the main factors affecting non-response and are well behaved. The coefficient of variation (CV) of the weights is acceptable at 0.18 implying a design effect due to weighting (*deff)* of 1.03 and the maximum weight is 4.91, which is 2.79 times larger than the median weight.

For the restored cases a similar approach was used for the first wave in which they were included, that is Wave 2. The CV of the resulting weights is acceptable at 0.44, giving a *deff* of 1.19 and the maximum weight is 14.93, which is 3.05 times larger than median weight.[1]

Table 1: Auxiliary Variables

Care type
Foster care
Relative/kinship care
Other (includes residential care, supported accommodation)
Age at first entry to OOHC
<1 year
1 to 5 years
6 years and older
Aboriginal status
Non-Aboriginal
Aboriginal
Gender
Female
Male
Maltreatment type
No issue specified
Neglect only
Abuse only
Mixed
Number of Risk of Significant Harm (ROSH) reports
None
1 to 2
3 to 6
7 to 15
16 or more

[1] The summary statistics for the weights are slightly different from those in Steel and Navin Cristina (2018) due to updates in the survey data.

3 Overview of cross-sectional and longitudinal weighting for later waves

Any analysis that involves respondents from more than one wave can be regarded as a longitudinal analysis. For this report we consider the first three waves. Weights are needed for cross-sectional estimation and analysis for:

- In-OOHC Wave 1, Wave 2, Wave 3
- Restored Wave 2, Wave 3.

For longitudinal analysis weights are needed for:

- In-OOHC, those responding in Wave 1 and Wave 2, denoted by Waves 1-2, and those responding in all three waves, i.e. Waves 1-3
- Restored those responding in Wave 2 and Wave 3, i.e. Waves 2-3.

We will use the general notation ϕ^A for the RP relevant to population component A=in-OOHC and B=restored. Subscripts are used to indicate the wave(s) to which the RP refers, so ϕ_a^A refers to wave *a*, ϕ_{ab}^A to waves *a* and *b*, and $\phi_{b.a}^A$ to wave *b* given wave *a*.

The RPs that are relevant can be summarised in Table 2.

Table 2: Summary of Relevant Response Probabilities

Wave	In OOHC	Restored
Wave 1 Cross-sectional	ϕ_1^A	*N/A*
Wave 2 Cross-sectional	ϕ_2^A	ϕ_2^B
Wave 3 Cross-sectional	ϕ_3^A	ϕ_3^B
Waves 1-2 Longitudinal	ϕ_{12}^A	*N/A*
Waves 2-3 Longitudinal	*N/A*	ϕ_{23}^B
Waves 1-3 Longitudinal	ϕ_{123}^A	*N/A*

For subsequent waves the variables collected in the previous wave are also available for use in RP modelling.

The usual approach in weighting for longitudinal analysis is to multiply the relevant probabilities of appearing in the relevant sequence of waves. This *direct attrition* approach assumes that the sample at each wave is a subsample of the preceding wave.

Cross-sectional weights

- Cross-sectional weights for Wave 2 would be based on ϕ_2^A=$\phi_1^A\phi_{2.1}^A$ and for Wave 3 ϕ_3^A=$\phi_1^A\phi_{2.1}^A.\,\phi_{3.21}^A$.

Longitudinal weights

- For estimation or analysis that involves two or more consecutive waves the sample used will be those who respond to each wave. In this case the direct attrition approach can be used.
- For example for an estimate obtained from respondents at Wave 1 and Wave 2 the relevant RP is ϕ_{12}^A=$\phi_1^A\phi_{2.1}^A$.
- For analyses based on people who respond to Wave 1, Wave 2 and Wave 3, the relevant RP is ϕ_{123}^A=$\phi_1^A\phi_{2.1}^A.\,\phi_{3.21}^A$

So the longitudinal weights equal the cross-sectional weights in this case. However, the assumption that the sample at each wave is a subsample of the sample at the previous wave does not hold for the POCLS, since non-respondents to a wave may be included in later waves. This means that alternatives to the direct attrition approach need to be considered and these are discussed in the next Section.

4 Options for cross-sectional and longitudinal weights

4.1 Introduction

A complication in the POCLS is the inclusion of cases in a wave that were non-respondents in one or more previous waves, so the usual direct attrition approach is not necessarily the most appropriate for cross-sectional estimation.

There are four approaches that can be considered for calculation of cross-sectional weights for the POCLS, which are described in this Section. All methods are based on obtaining an estimate of the response probability (RP) for the *i*th person in the relevant sample and setting that person's weight to the inverse of this probability. These methods are:

- Current Sample Approach (Section 4.2)
- Attrition Sample Approach (Section 4.3)
- Stratified Approach (Section 4.4)
- Pseudo Attrition Sample Approach (Section 4.5).

For Wave 1 estimation of the response probabilities auxiliary variables that are available for all people in the population can be used. For subsequent waves the survey variables collected in the previous wave can also be used to estimate the RP for that wave.

Weights for the restored and in-OOHC components of the survey will be calculated separately. As discussed in Steel and Navina Cristina (2018) this is because they are considered different groups and for the restored cases no data were collected at Wave 1.

4. 2. Current sample approach

In this approach for any sample the RP is estimated by fitting a logistic regression model with the dependent variable being an indicator of whether the person is a respondent in the sample and the explanatory variables are the auxiliary variables. The model is estimated using the data set of the whole population.

This is the method used in Wave 1 for in-OOHC and Wave 2 for restored cases. It can be applied at any wave. It can also be applied to any longitudinal sample.

The advantage of this approach is that it very simple and direct. The disadvantage is that is does not use the survey variables that may explain response after Wave 1.

4.3. Attrition sample approach

This is the standard approach used in longitudinal surveys and is based on not allowing any new entrants to the survey at each wave. So at Wk+1 only those who responded at Wk are considered, so that the sample at Wk+1 is a subsample of the sample at Wk.

The RP for the cross-sectional sample at Wk+1 is built from the estimated RP for responding at a wave given that the person responded at the previous wave. Let the estimated RP be $\hat{\phi}^{A}\ _{1.}$, which is estimated using the data set of respondents at Wk with the dependent variable being response at Wk+1.

For a person to be a respondent at Wk+1 they must have responded at all previous waves and so the overall RP is the product of the estimated transition probabilities, $\hat{\phi}^{A}\ _{1} = \hat{\phi}_{1}^{A}\hat{\phi}_{2.1}^{A}\cdots\hat{\phi}^{A}\ _{1.}$.

The corresponding weight can be used for cross-sectional analysis of Wk+1 and longitudinal analysis that ends at Wk+1.

The estimation of the transition response probabilities $\hat{\phi}^{A}\ _{1.}$ can use the auxiliary variable and the survey variables from previous waves.

The approach for Wave 2 is to obtain an estimate of RP to Wave 2 for those who responded to Wave 1, $\hat{\phi}_{2.1i}$ usually using variables collected in Wave 1 and relevant auxiliary variables. The cross-sectional weight is then determined by $\hat{\phi}_{1i}\ \hat{\phi}_{2.1i}=\hat{\phi}_{2i}$. Any case that was a non-respondent at Wave 1 who responded at Wave 2 would be ignored. This will be called the *attrition sample* approach as we create a subsample for which the direct attrition approach to weighting can be applied.

The disadvantage of this approach is that it does not use data for people who respond for the first time after Wave 1 or, more generally have data missing for any wave before Wk.

Two further approaches were considered that enable the use of respondents who did not respond at one or more previous waves and survey variables.

4.4 Stratified approach

In this approach at each wave we form strata of respondents and non-respondents within the strata formed at the previous wave. At each wave there will be several strata of respondents. For each stratum of respondents an RP model is estimated using the data set for the stratum in the previous wave that contains the current stratum and the dependent variable indicating response at the current wave.

In strata consisting of non-respondents at a previous wave the proportion of respondents in the current wave would be small, leading to high weights compared to the other strata. Also, as the number of waves grows the number of strata also grows and many will have small samples, affecting the reliability of the estimation of the RPs and leading to very high and variable weights.

More details of this approach are given in Appendix.

4.5. Pseudo attrition sample approach

This approach allows the use of the direct attrition approach but includes people who joined the sample after Wave 1. This is done by creating pseudo samples of respondents to the current wave and previous waves (see Taylor et al. 2010, page A5-9).

Considering Wave 3, the pseudo sample at Wave 2 consists of those that responded at Wave 3 or Wave 2. The pseudo sample at Wave 1 consists of those that responded at Wave 3 or Wave 2 or Wave 1. For any people who did not respond at Wave 1 the survey variables to be used in the weighting after Wave 1 are imputed from their values in the first wave in which they do respond.

The RP modelling then proceeds using the direct attrition approach described in Section 2 applied to the pseudo attrition sample.

Note that as each wave is added the pseudo samples and the associated estimated RPs have to be recalculated. For example, at Wave 4 the pseudo sample for Wave 3, Wave 2 and Wave 1 has to add respondents to Wave 4 that have not previously responded.

This approach is somewhat complicated but enables the direct attrition approach to be used for cross-sectional and longitudinal samples and includes people who did not respond for any of the previous waves while avoiding the high weights that can arise with the stratified approach.

4.6. Discussion of options for cross-sectional weights

The stratified approach is likely to lead to some very high weights and also strata with very small numbers, leading to instability in the estimated RPs. For this reason, it is not a preferred method.

The attrition sample approach can be considered if the number of responding people that would be deleted from the study is small, but at least for Wave 2 the number joining the survey is such that we would like to include them.

The current sample approach has the appeal of simplicity. The remaining alternative is the pseudo attrition approach. The main difference between the two approaches is that the former uses only the auxiliary variables whereas the latter uses the auxiliary variables and potentially the survey variables collected at Wave 1 and later waves that are associated with response at later waves.

The key issue is therefore the additional value of including these survey variables.

Analysis of Wave 1 and auxiliary variables in RP model for Wave 2 in-OOHC

This analysis was conducted to see if there were gains from using key Wave 1 variables in addition to the auxiliary variables in the RP model for going from Wave 1 to Wave 2. This is a key issue in longitudinal survey weighting. The analysis was based on Wave 1 in-OOHC respondents.

Table 3 gives the results of initial chi-squared testing of the response status in Wave 2 cross classified by the candidate Wave 1 variables and shows the following were statistically significant ($p<0.1$): Socio-emotional wellbeing, verbal ability, non-verbal reasoning, physical health, K10 score (categorical), placement change between Wave 1 and Wave 2 (dichotomous), number of placement changes between Wave 1 and Wave 2 (grouped), number of ROSH reports between Wave 1 and Wave 2 (grouped), ROSH reports between Wave 1 and Wave 2 (dichotomous), and K10 numerical. Throughout this report statistical significance will be assessed using $p<0.1$ as the aim is not to determine substantively important effects but to build effective RP models for weighting.

Table 3: Chi-squared test association between Wave 2 response Wave 1 Variables, in-OOHC Children, p-value

Wave 1 Variable	p value
Socio-Emotional wellbeing (Inside/Outside normal range)	0.0315
Verbal ability (Inside/Outside normal range)	0.0002
Non-verbal reasoning (Inside/Outside normal range)	0.0033
Physical health (Very poor to fair/Good to excellent)	0.0311
Satisfaction with being able to reach caseworkers when needed	0.5373
Satisfaction with assistance from caseworkers	0.9826
K10 Score grouped	0.0681
Placement change between Wave 1 and Wave 2 (yes/no)	<0.0001
Number of Placement changes between Wave 1 and Wave 2 (1,2,3, or 4+)	<0.0001
ROSH report between Wave 1 and Wave 2 (yes/no)	<0.0001
Number of ROSH reports between Wave 1 and Wave 2 (1,2,3, or 4+)	<0.0001
K10 score (t-test)	0.0450
Satisfaction with Foster Parenting Inventory (t-test)	0.3855

RP models were fitted for response at Wave 2 for those that responded at Wave 1 using only auxiliary variables, only Wave 1 variables, and both auxiliary and Wave 1 variables (Table 4). The Wave 1 variables included in the analysis were: socio-emotional wellbeing, verbal ability, non-verbal reasoning, physical health, number of placement changes between Wave 1 and Wave 2 grouped, and the number of ROSH reports grouped. These correspond to the statistically significant associations in Table 3. For the placement changes and ROSH report variables the grouped versions were used as it was considered this provided more scope for reflecting the RP than just treating them as dichotomous variables.

Table 4: Summary of models for predicting of Wave 2 response for in-OOHC children

	Variables Included		
	Auxiliary	Wave 1	Both
Akaike information criterion (AIC)	1266.5	995.6	1003.3
-2logL	1238.5, 13 d.f.	967.6, 13 d.f.	949.307 26 d.f.
Overall effect sig p=0.05	Age group	Number of placement changes between Wave 1 and Wave 2 grouped Number of ROSH reports grouped	Number of placement changes grouped Number of ROSH reports grouped Non-verbal ability
Overall effect sig p=0.010		Non-verbal reasoning	Aboriginal status
Parameter sig p=0.05	Age 6 years +	0, 2 placement changes 0, 1 ROSH reports	0, 2 placement changes 0,1 ROSH reports Non-verbal reasoning: normal
Parameter sig p=0.10	Maltreatment Type: Mixed issues	Verbal ability: normal range 2 ROSH reports	3 placement changes Aboriginal Maltreatment Type: Abuse only

The Akaike Information Criterion (AIC) suggested that the model using Wave 1 variables was better than the model using only the auxiliary variables, and slightly better than the model using both the Wave 1 and auxiliary variables. In this model the overall effect for the auxiliary variable age group and the Wave 1 variables number of placement changes grouped, number of ROSH reports grouped, non-verbal reasoning and verbal ability were statistically significant ($p<0.1$). This shows that the use of Wave 1 variables is needed and rules out using the current sample approach and therefore suggests use of the pseudo attrition approach.

In examining changes in response between Wave 1 and Wave 2 the number of placement changes and number of ROSH reports refers to those occurring between waves. It was considered that these would be directly relevant to the probability of response at Wave 2.

All the methods discussed can be considered for application to the population component consisting of those children restored to parents as well as the in-OOHC component. However, as the restored cases were excluded from Wave 1, the Wave 2 plays the role of the first wave. The smaller sample size will limit the complexity of the RP models that can be applied.

Table 5 gives the results of initial chi-squared testing of the response status in Wave 3 cross-classified by the candidate Wave 2 variables for restored children and shows the following were statistically significant (p<0.1): K10 grouped, ROSH report between Wave 2 and Wave 3 (yes/no), number of ROSH reports, and K10 numerical.

Table 5: Chi-squared test association between Wave 3 response and Wave 2 variables, restored children, p-value

Wave 2 Variable	p value
Socio-Emotional wellbeing (Inside/Outside normal range)	0.4603
Verbal ability (Inside/Outside normal range)	0.6572
Non-verbal reasoning (Inside/Outside normal range)	0.1066
Physical health (Very poor to fair/Good to excellent)	0.8509
Satisfaction with being able to reach caseworkers when needed	0.4057
Satisfaction with assistance from caseworkers	0.4057
K10 Score grouped	0.0821
Placement change between Wave 2 and Wave 3 (yes/no)	0.1798
Number of Placement changes between Wave 2 and Wave 3 (1,2,3, or 4+)	0.2067
ROSH report between Wave 2 and Wave 3 (yes/no)	0.0245
Number of ROSH reports between Wave 2 and Wave 3 (1,2,3, or 4+)	0.0016
K10 score (t-test)	0.0674
Satisfaction with Foster Parenting Inventory (t-test)	0.3216

4.7. Discussion of options for longitudinal weights

Longitudinal analyses will only use cases that are respondents for all the relevant waves. So the sample at each wave will be a subsample of the respondents at the previous wave and the direct attrition approach can be used. There is no need to create pseudo attrition samples or adopt a stratified approach that would lead to very high and variable weights.

5 Analysis for producing weights

5.1 Introduction

Based on the considerations in Section 4, the approach to determining the weights are as follows:

- Cross-sectional weights in Wave 1 for the in-OOHC component and the Wave 2 returned component, the RP model will be estimated using the logistic regression using auxiliary variables, giving $\hat{\phi}_1^A$ and $\hat{\phi}_2$.
- Cross-sectional weights in Wave 2 and Wave 3 in-OOHC and Wave 3 returned will use the pseudo attrition approach. To make this clear we will use $\tilde{\phi}_2^A, \tilde{\phi}_3^A$ and $\tilde{\phi}_3$ to indicate the respective estimated RPs obtained using the pseudo attrition approach.
- Longitudinal weights for Waves 1-2 and Waves 1-3 for in-OOHC and Waves 2-3 for returned cases, will use the direct attrition approach, using $\hat{\phi}_{12}^A, \hat{\phi}_{123}^A$ and $\hat{\phi}_{23}$ respectively.

The RPs that are relevant are summarised in Table 6.

Table 6: Summary of Relevant Estimated Response Probabilities

Wave	in OOHC	Restored
Wave 1 Cross-sectional	$\hat{\phi}_1^A$	*N/A*
Wave 2 Cross-sectional	$\tilde{\phi}_2^A=\tilde{\phi}_1^A\tilde{\phi}_{2.1}^A$	$\hat{\phi}_2^B$
Wave 3 Cross-sectional	$\tilde{\phi}_3^A=\tilde{\phi}_1^A\tilde{\phi}_{2.1}^A\tilde{\phi}_{3.21}^A$	$\tilde{\phi}_3^B=\tilde{\phi}_3^B\tilde{\phi}_{3.2}^B$
Waves 1-2 Longitudinal	$\hat{\phi}_{12}^A=\hat{\phi}_1^A\hat{\phi}_{2.1}^A$	*N/A*
Waves 2-3 Longitudinal	*N/A*	$\hat{\phi}_{23}^B=\hat{\phi}_2^B\hat{\phi}_{3.2}^B$
Waves 1-3	$\hat{\phi}_{123}^A=\hat{\phi}_1^A\hat{\phi}_{2.1}^A\hat{\phi}_{3.2}^A$	*N/A*

5.2 Practical considerations

Large variation in weights can lead to considerable inefficiencies in analysis which are reflected in increased standard errors on estimates. Hence, part of the diagnostics applied to any method used to calculate weights is examination of the distribution of the resulting weights. The coefficient of variation of the weights is also a useful summary measure of variation and if this exceeds say 0.7, corresponding to a design effect due to weighting of 1.5, the weights should be examined more closely. The ratio of the maximum weight to the median weight is another useful indicator of possibly large weights and in general should be less than 6. Large variation may be due to high weights associated with relatively low estimated RPs. There is an intrinsic conflict in the RP modelling. The better the model performs in finding combination of variables that explain low response rates in some subgroups of the population the larger the variation in the weights. This is classic example of balancing potential bias reduction with increase in standard errors. One approach to moderating the effect of a small number of large weights is to trim the weights by truncating them at some upper limit (see Valliant, et al., 2013)

For a variable to be used in the estimation of the RP it has to be available for all people in the data set used to estimate the RP. If a variable is missing for an appreciable percentage, say more than 10%, then that calls into question the use of that variable. This comment applies to potential auxiliary variables and Wave 1 survey variables.

Even if a variable is missing for less than 10% of people the estimation of the RP and its application has to cope with missing values. In some cases imputation of the values from later waves may be feasible. Another option is to treat the missing category as a value in the model.

Even if the set of variables being considered for use in the RP model all have a missing rate of less than 10%, the percentage of people for which all of these variables are available may be much less than 90%.

In the following subsections we will summarise the models used in examining the RPs and the characteristics of the resulting weights.

5.3 Weights for in-OOHC component

5.3.1 Cross-sectional weight Wave 1 in-OOHC

Analysis was based on 2,309 cases of which 1,285 were respondents in Wave 1. The RP model used all the auxiliary variables, corresponding to a model with 13 degrees of freedom (d.f.). Statistically significant effects were obtained for age group and number of ROSH reports before entry to OOHC (grouped). Statistically significant parameter estimates were obtained for aged 6 and above, 3-6 ROSH reports, 7-15 ROSH reports and 16+ ROSH reports.

For the distribution of the resulting weights the median was 1.74, the CV was 0.18 and the ratio of the maximum to median weight was 2.80. These all indicate that the variation in the weights is satisfactory.

5.3.2 Pseudo attrition weights Wave 2 in-OOHC

The Wave 1 analysis was modified to include cases that had responded in Wave 2 but not in Wave 1 and so was based on 2,309 cases of which 1,357 were respondents in Wave 1 or Wave 2. The RP model used all the auxiliary variables, corresponding to a model with 13 d.f. Statistically significant effects were age group and number of ROSH reports before entry to OOHC (grouped). Statistically significant parameter estimates were obtained for the variable categories aged 6 and above, 3-6 ROSH reports, 7-15 ROSH reports and 16+ ROSH reports. These results are the same as the original Wave 1 analysis in Section 5.3.1.

For the analysis of response at Wave 2 for those that responded at Wave 1 or Wave 2 the analysis was based on 1,357 cases of which 1,104 were respondents in Wave 2. The model was based on 15 d.f. and included the auxiliary variables age and gender and the Wave 1 variables, non-verbal reasoning, number of placement changes between Wave 1 and Wave 2 and number of ROSH reports between Wave 1 and Wave 2. The variables were chosen by including all the statistical significant variables in Table 3 and the auxiliary variables whose association with Wave 2 response was statistically significant and then using backward elimination to select statistically significant variables. All effects included in the final model were statistically significant except gender.

For the distribution of the resulting weights: the median was 1.95, the CV was 0.27 and the ratio of the maximum to median weight was 4.07. These all indicate that the variation in the weights is satisfactory.

5.3.3 Pseudo attrition weights Wave 3 in-OOHC

The Wave 1 analysis was modified to include cases that had responded in Wave 1, Wave 2 or Wave 3 and so was based on 2,309 cases of which 1,380 were respondents in Wave 1, Wave 2 or Wave 3. The RP model used all the auxiliary variables, corresponding to a model with 13 d.f. Statistically significant effects were age group and number of ROSH reports before entry to OOHC (grouped). These results are the same as the original Wave 1 analysis.

For the analysis of response at Wave 2 for those that responded at Wave 1 or Wave 2 or Wave 3 the analysis was based on 1,380 cases of which 1,151 were respondents in Wave 2. The model was based on 15 d.f. and included the auxiliary variables age and gender and the Wave 1 variables, non-verbal reasoning, number of placement changes between Wave 1 and Wave 2 and number of ROSH reports between Wave 1 and Wave 2. These are the same variables as used in the Wave 2 pseudo attrition approach in Section 5.3.2. All effects were statistically significant.

For the analysis of response at Wave 3 for those that responded at Wave 1 or Wave 2 or Wave 3 the analysis was based on 1,151 cases of which 973 were respondents in Wave 3. The model was based on 8 d.f. and included the auxiliary variables age and gender and the Wave 1 variables~~,~~ number of placement changes between Wave 2 and Wave 3 and Wave 2 K10 score. These are the same variables as used in the Wave 2 pseudo attrition approach, except the measure of placement changes and number of ROSH report are related to those occurring between Wave 2 and Wave 3 (rather than occurring before Wave 2). Statistically significant effects were obtained for the number of placement changes and statistically significant parameter estimates were obtained for those aged 6 and above, whether there was a placement change and 2 ROSH reports.

For the distribution of the resulting weights: the median was 2.14, the CV was 0.36 and the ratio of the maximum to median weight was 5.52. These all indicate that the variation in the weights is satisfactory.

5.3.4 Longitudinal weights Waves 1-2 in-OOHC

The Wave 1 weighting is as in Section 5.3.1. For the analysis of response at Wave 2 for those that responded at Wave 1 the analysis was based on 1,285 cases of which 1,032 were respondents in Wave 2. The model was based on 13 d.f. and included the auxiliary variables age and gender and the Wave 1 variables~~,~~ non-verbal reasoning, number of placement changes between Wave 1 and Wave 2 and number of ROSH reports between Wave 1 and Wave 2. Statistically significant effects were obtained for age group, non-verbal reasoning, number of ROSH reports between Wave 1 and Wave 2 grouped, and number of placement changes between Wave 1 and Wave 2. Statistically significant parameter estimates were obtained for missing and normal range non-verbal reasoning, number of ROSH reports equal to 0,1 or 2, and number of placement changes equal to 0,1,2 or 3.

For the distribution of the resulting weights: the median was 2.04, the CV was 0.32 and the ratio of the maximum to median weight was 5.98. These all indicate that the variation in the weights is satisfactory.

5.3.5 Longitudinal weights Waves 1-3 in-OOHC

The Wave 1 weighting is as in Section 5.3.1 and the weights reflecting transition from Wave 1 to Wave 2 are as in Section 5.3.4. For the analysis of response at Wave 3 for those that responded at Wave 1 and Wave 2 the analysis was based on 1,032 cases of which 882 were respondents in Wave 3. The model was based on 8 d.f. and included the auxiliary variables age and gender and the Wave 1 variables, number of placement changes between Wave 1 and Wave 2 and K10 score at Wave 2.

For the distribution of the resulting weights: the median was 2.28, the CV was 0.47 and the ratio of the maximum to median weight was 8.31.

While the CV of the weights is reasonable the ratio of the maximum to median weight is a bit high. The high weights correspond to cases that the RP modelling has successfully identified as having a low RP. This is showing that the modelling is working well but the variation in the weights can lead to some instability and high standard errors of estimates. Trimming the weights so that the maximum is 6 times the median results in the truncation of 2 cases and the following distribution of the resulting weights: the median was 2.29, the CV was 0.45 and the ratio of the maximum to the median weight was 6.00.

Truncating weights to be no more than 6 times the median effectively restricts the estimated RP from being less than 17% of the median RP.

5.4 Weights for restored component

5.4.1 Cross-sectional weight Wave 2

Analysis was based on 519 cases of which 96 were respondents in Wave 2. This is a small sample and corresponds to a response rate of only 18.5% and so any estimates and analyses must be treated with caution, even after the use of weights that have attempted to reduce biases due to non-response. The size of the responding sample will restrict the level of detail of estimates and analyses that can be carried out and estimated standard errors on estimates should be examined.

The RP model used all the auxiliary variables, corresponding to a model with 8 d.f. Statistically significant effects were obtained for type of first placement. Statistically significant parameter estimates were obtained for 1-2 ROSH reports, foster care and abuse only.

For the distribution of the resulting weights: the median was 4.89, the CV was 0.44 and the ratio of the maximum to median weight was 3.05. These all indicate that the variation in the weights is satisfactory.

5.4.2 Pseudo attrition weights Wave 3 returned

The Wave 2 analysis was modified to include cases that had responded in Wave 3 but not in Wave 2 and so was based on 519 cases of which 99 were respondents in Wave 2. The RP model included age, gender, and placement type, corresponding to a model with 4 d.f. Statistically significant effects were obtained for placement type. Statistically significant parameter estimates were obtained for foster care and kinship care.

For the analysis of response at Wave 3 for those that responded at Wave 2 or Wave 3 the analysis was based on 99 cases of which 60 were respondents in Wave 3. The model was based on 11 d.f. and included the auxiliary variables age group, gender, the number of ROSH reports before entry to OOHC and maltreatment issue (all categorical), and the Wave 2 variable number of reports between Wave 2 and Wave 3 (K10 was not statistically significant in the model).

For the distribution of the resulting weights: the median was 6.73, the CV was 1.14 and the ratio of the maximum to median weight was 9.76. Both the CV and the ratio of the maximum to median weight are very high.

Trimming the weights so that the maximum is 6 times the median results in the truncation of 3 cases and the following distribution of weights: the median was 7.21, the CV was 0.91 and the ratio of the maximum to median weight was 6.00.

5.4.3 Longitudinal weights Waves 2-3 returned

The Wave 2 weights are the same as in Section 5.4.1. For the analysis of response at Wave 3 for those that responded at Wave 2 the analysis was based on 96 cases of which 57 were respondents in Wave 3. The model was based on 12 d.f. and included the variables age group and gender, report between Wave 2 and Wave 3 (yes/no), number of ROSH reports before entry to OOHC, and maltreatment issue (all categorical).

For the distribution of the resulting weights: the median was 6.35, the CV was 1.45 and the ratio of the maximum to median weight was 13.57. Both the CV and the ratio of the maximum to median weight are very high.

Trimming the weights so that the maximum is 6 times the median results in the truncation of 3 cases and the following distribution of the resulting weights: the median was 7.47, the CV was 0.90 and the ratio of the maximum to median weight was 6.00.

6 Summary

These analyse have produced:

- Cross-sectional weights for in-OOHC for Wave 1, and restored for Wave 2 using the direct attrition approach
- Cross-sectional weights for in-OOHC for Wave 2, Wave 3 and restored for Wave 3 using the pseudo attrition sample approach
- Longitudinal weights for in-OOHC for Waves 1-2, Waves 1-3 estimation and analysis using the direct attrition approach
- Longitudinal weights for restored for Waves 2-3 estimation and analysis using the direct attrition approach.

The RPs modelling has produced weights with the following summary characteristics.

Table 7: Summary of Distribution of Weights

Wave	in OOHC (med, CV, max/med)	Restored (med, CV, max/med)
Wave 1 Cross-sectional	1.74, 0.18, 2.80	N/A
Wave 2 Cross-sectional	1.95, 0.27, 4.07	4.89. 0.44. 3.05
Wave 3 Cross-sectional	2.18. 0.38. 4.15	6.73. 1.45. 9.76 7.21, 0.91, 6.00 trimmed
Waves 1-2 Longitudinal	2.04, 0.32. 5.98	N/A
Waves 2-3 Longitudinal	N/A	6.25, 1.45, 13.57 7.47, 0.90, 6.00 trimmed
Waves 1-3 Longitudinal	2.28, 0.47, 8.31 2.29. 0.45. 6.00 trimmed	N/A

The sum of the weights obtained from the RP approach does not necessarily equal the population size, although the difference is often small. As a final step the weights were adjusted by a constant factor so that their sum over the sample equals the relevant overall population size.

Appendix: Stratified Approach

As an example consider Wave 3, where there are four strata of respondents.

1. Let S_{123} denote people who responded at each wave, which is a subsample of S_{12}, the people who responded at Wave 1 and Wave 2. A RP models is estimated using S_{12} as the data set and response to W_3 as the dependent variables. This results in weights that weight from S_{123} to S_{12}.
2. Let S_{103} denote people who responded at Wave 1 and Wave 3 but not Wave 2, which is a subsample of S_{10}, the people who responded at W_1 and not at W_2. A RP models is estimated using S_{10} as the data set and response to W_3 as the dependent variable. This results in weights that weight from S_{103} to S_{10}.
3. Let S_{023} denote people who responded at Wave 2 and Wave 3 but not Wave 1, which is a subsample of S_{02}, the people who did not respond at W_1 and did respond at Wave 2. A RP models is estimated using S_{02} as the data set and response to Wave 3 as the dependent variable. This results in weights that weight from S_{023} to S_{02}.
4. Let S_{003} denote people who responded only at Wave 3, which is a subsample of S_{00}, the people who did not respond at Wave 1 or Wave 2. A RP models is estimated using S_{00} as the data set and response to Wave 3 as the dependent variable. This results in which weights that weight from S_{003} to S_{00}.

In stratum 4 only auxiliary variables can be used in the estimation of the RP, whereas for the other three strata both auxiliary variable and Wave 1 variables can be used, with some imputation for S_{02} in case 3.

This approach uses respondents at Wave 3 within the strata of non-respondents in Wave 2. For example, S_{103} is used to weight up to S_{10} and S_{003} is used to weight up to $S_{00.}$ In both cases the proportion of respondents in Wave 3 would be small leading to high weights compared to the other two strata.

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