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# Loss to follow-up was used to estimate bias in a longitudinal study: A new approach

# Author names and affiliations:

Jennifer Powers a

Meredith Tavener a

Anna Graves a

Deborah Loxton a

a Research Centre for Gender, Health and Ageing,

University of Newcastle

Callaghan NSW 2308, Australia

#### Email addresses

Jenny.powers@newcastle.edu.au

Meredith.tavener@newcastle.edu.au

Anna.graves@newcastle.edu.au

Deb.loxton@newcastle.edu.au

# **Corresponding author:**

Jennifer Powers,

Research Centre for Gender, Health and Ageing,

HMRI building, University of Newcastle,

Callaghan NSW 2308, Australia

Email: jenny.powers@newcastle.edu.au

Telephone: +61-2-40420677

#### Using loss to follow-up to estimate bias in a longitudinal study: A new approach

#### Abstract

**Objectives:** To examine bias arising from loss to follow-up due to lack of contact. **Study Design/Setting** The 1973-78 cohort of Australian Longitudinal Study on Women's Health was first surveyed in 1996, and followed-up in 2000, 2003, 2006 and 2009. At the 2000 survey, 9688 women responded (Responders), 2972 could not be contacted, of whom 1515 responded subsequently (Temporary No-contact) and 1457 did not (Permanent No-contact). Characteristics were compared for these groups at baseline and follow-up in 2003, 2006 or 2009. Relative risk ratios were used to estimate bias

**Results** No-contacts were younger, more likely to live in cities, to be less educated and stressed about money than Responders. No-contacts were more likely to be in de-facto relationships, separated, divorced or widowed, to have experienced partner violence and be smokers. Compared with Temporary No-contact, Permanent No-contact were less educated, less likely to be studying or employed. Despite differences in prevalence estimates, relative odds ratios were close to one and had confidence intervals that included one, indicating little effect of bias.

**Conclusions**. Although various characteristics were related to loss to follow-up, the relative risks estimates did not indicate serious bias due to loss to follow-up in this cohort of young women.

**Keywords:** longitudinal study; loss to follow-up; no contact; bias; cohort; non-response **Running title:** A new approach to estimating bias from loss to follow-up **Word count**: 2726

# What is new?

# **Key findings**

Characteristics of those loss to follow-up due to lack of contact (Temporary or Permanent No-contact) differed from those of Responders resulting in differences in prevalence estimates e.g. for smoking.

Relative odds ratios (e.g. between self-rated health and smoking) were close to one and had confidence intervals that included one, indicating little effect of bias at baseline or at follow-up.

# What this adds to what is known?

Bias, particularly in prevalence estimates, is reduced when No-contacts are re-engaged. The inclusion of re-engaged No-contacts in these analyses was a novel approach.

# What is the implication?

Loss to follow-up due to lack of contact does not seriously bias estimates of association in a cohort of young women.

#### Introduction

Non-response is a major problem that has increased over recent years in health and social science surveys [1, 2]. Non-response or attrition may occur due to death, refusal or no contact. In some studies attrition is also referred to as loss to follow-up [3-5]. In this and other studies, loss to follow-up refers to inability to locate individuals or no contact [6, 7]. There is evidence that in longitudinal studies, non-response is increasingly due to the inability to locate individuals rather than refusal to continue participation [8, 9].

In longitudinal studies non-response due to death, refusal to complete the survey as well as no contact are often lumped together rather than investigated separately [10, 11]. However, the potential biases attributable to different attrition groups may differ [12-14]. The issue of loss to follow-up due to inability to locate individuals (no-contact) in longitudinal studies presents a potential source of bias that has been under-investigated. Furthermore strategies to prevent and mitigate the impact of loss to follow-up will necessarily differ from those that are employed to encourage potential refusers to take part. It is therefore important to identify the profile of those most at risk of loss to follow-up. Possible bias should be investigated to evaluate the effects of loss to follow-up on results.

Most studies have examined factors related to attrition using variables collected at baseline [5, 6, 15]. One exception was a study of French workers that used responses to annual surveys to examine factors related to permanent or temporary withdrawal [7]. In the 1973-78 cohort of the Australian Longitudinal Study on Women's Health (ALSWH), much of the non-response at surveys has been temporary, mainly due to inability to locate participants (no-contact), rather than permanent [16]. The present study examines factors related to

permanent or temporary loss to follow-up using ALSWH data collected at baseline and at subsequent surveys, after those participants who were lost to follow-up were re-engaged.

This study aims to describe differences between continuing respondents and those participants permanently or temporarily not contactable. Based on previous findings [14, 17, 18], we hypothesised that factors such as lower socioeconomic status, instability in relationships (divorce, separation, widowhood, living alone, experiences of partner violence), poor health behaviours and health would be associated with loss to follow-up. To build on past research we will determine whether differences between responders and those lost to follow-up are likely to result in biases.

## Methods

#### Sample

Recruitment for, and construction of, the cohort has been described in detail elsewhere [19]. Briefly, women born between 1973 and 1978 (ALSWH 1973-78 cohort) were randomly selected from the Medicare (national health insurance) database, which covers all permanent residents of Australia. Women living in rural and remote areas of Australia were intentionally oversampled. The ALSWH 1973-78 cohort was recruited by mailed survey in 1996 and had an estimated response rate of 41-42% (n=14247). Names and addresses of the selected women were not available until the women responded to the mailed survey so that participation could not be encouraged using personalised contact. However comparison with the 1996 Census showed the women were broadly representative of women of the same age with some over-representation of tertiary educated women [20]. Participants were resurveyed by mail in 2000, 2003, 2006 and 2009. Participants provided informed consent and the study

is approved by the Human Research Ethics Committees of the Universities of Newcastle and Queensland [19].

The sample included Responders: 9688 women who responded to the 2000 survey and Nocontacts: 2972 women who could not be contacted at the 2000 survey despite every effort to locate them [21]. No-contacts were split into two groups: 1) Temporary No-contact (n=1515) - those who could not be contacted at the 2000 survey but responded at one or more subsequent surveys in 2003, 2006 or 2009; 2) Permanent No-contact (n=1457) - those who could not be contacted at the 2000 survey and did not respond to subsequent surveys. Women who were deceased or had withdrawn from the study by the 2000 survey (n=255), or were contacted but did not return the 2000 survey (n=1332) were excluded. The current analysis included 12660 of the 14247 women who responded to the baseline survey in 1996 (Figure 1).

For this paper, No-contact refers to those women who had not responded after a minimum of 11 contact attempts consisting of a mailed survey, two mailed targeted reminders and eight attempted contacts by telephone. Telephone calls were made at different times, on different days of the week, and over a month or more. In addition, further attempts were made to contact women using supplied contacts, electronic telephone directories and extracts from the electoral roll.

#### Measures

Survey variables were included if they were potentially related to ease of contact. Women were classified as younger (18-20 years of age in 1996) or older (21-23 years of age in 1996). Area of residence was categorised as living in a major city or living in a regional or remote

area. Socioeconomic factors included highest level of education achieved (up to 11 years school; 12 years school; trade, apprenticeship, certificate or diploma; university), and three dichotomous variables: currently studying, employed, and feeling very or extremely stressed about money. Relationship status had four categories: married; living in a de facto relationship; separated, divorced or widowed; single. Women also recorded whether they lived alone, lived with children and whether they had ever been in a violent relationship with a partner or spouse.

Health behaviours included smoking (non-smoker, ex-smoker, current smoker) and drinking (non-drinker, up to 14 drinks a week, 15 or more drinks a week). Self-rated health was defined as good if a woman reported her health as 'excellent', 'very good' or 'good' and poor if she answered 'fair' or 'poor'. The mental health subscale of the Medical Outcomes Studies Short-From (SF-36) measures self-rated mental health with scores ranging from 0 to 100, with higher scores indicating better mental health [22]. A score of less than 53 on the mental health subscale of the SF-36 was used to indicate poor mental health [23].

#### Statistical analyses

All variables were collected at the first survey in 1996 and again, at subsequent surveys in 2003, 2006 and 2009. The 2000 survey was the point of No-contact. Data collected at the 1996 survey were used for comparisons of Responders and Temporary and Permanent No-contacts before non-contact. Responders and Temporary No-contacts were also compared after the 2000 survey using data from the first survey that was answered post non-contact. To make the data for Responders comparable, respondents were randomly selected in approximately the same proportions from the 2003, 2006 and 2009 surveys using a computer generated list (Figure 1).

The effects of Temporary and Permanent No-contact were investigated on well-known associations: 1) monetary stress and self-rated health[24] 2) experience of violence and self-rated health[25] 3) smoking and self-rated health [26] 4) mental health and self-rated health [27]. Logistic regression was used to estimate odds ratios for each association in the baseline sample and the follow-up sample (Figure 1). Odds ratios were adjusted for all other social, demographic and other health-related factors. To examine the potential bias effect of No-contact on estimates of association, the relative odds ratios were computed as the ratio of the odds ratio among Responders to the odds ratio among Responders and No-contacts [28]. Ninety-five percent confidence intervals were calculated for the relative odds ratios using the approximate estimation described and validated by Nohr et alia [28]. All analyses were conducted in SAS version 9.3.

#### Results

#### Responders compared to No-contacts using data collected at baseline

The 1996 characteristics of the 1996 cohort, Responders, Temporary No-contact and Permanent No-contact are shown in Table 1. Temporary and Permanent No-contact were younger, more likely to live in major cities, to be less educated and to be stressed about money than Responders. Both No-contact groups were also more likely to be living in a de facto relationship, to be separated, divorced or widowed, to have children living with them, to have experienced partner violence and be current smokers. Compared with Temporary Nocontact , Permanent No-contact were less educated, less likely to be studying or employed, were more likely to have children living with them, were more likely to live in a major city and be non-drinkers (Table 1).

*Responders compared to Temporary No-contact using data collected at a 2003, 2006 or 2009 survey* 

Compared with Responders, Temporary No-contact were more likely to be less educated, stressed about money, separated, divorced or widowed, to have experienced violence, and to be a smoker (Table 2). These differences were also observed at baseline. Although participants in the Temporary No-contact group were more likely to be studying at a subsequent survey than Responders (Table 2), this was not the case at baseline (Table 1).

#### Potential for bias

The bias estimates related to No-contact using information collected at baseline and at follow-up are shown in Table 3. Compared with Responders and No-contacts, the effect of monetary stress on self-rated health was higher at baseline for Responders (relative odds ratio 1.13) but not at follow-up. All other relative odds ratios were close to 1 and had confidence intervals that included 1, indicating no effect of bias.

# Discussion

As expected, socio-economic factors and relationships were associated with No-contact[17, 18]. Specifically, less education, monetary stress, relationships (de facto, separated, divorced or widowed), experience of partner violence and smoking related to loss to follow-up, as has been found by other studies[15, 18, 25, 29]}. Furthermore, we were able to demonstrate that these differences remained stable over time, participants who were Temporary No-contact were most similar to women who were Permanently No-contact. These findings are encouraging since they imply that strategies used by the ALSWH to locate and re-engage

participants lost to follow-up are actually effective in returning some of those at risk of permanent loss to follow-up to the cohort. Logically, the results can be used to inform strategies to prevent loss to follow-up in the first place, as well as to more effectively reengage lost participants by targeting strategies to those most at risk of permanent loss to follow-up.

In the current study a large investment of time and resources has gone into tracking participants, and yet 21% of the 14247 young women could not be contacted four years after the initial survey. It is also worth noting that among those participants who remained with the study, over 6,000 changes of address were recorded in between the first two surveys, indicating the high rate of mobility among this age group.

The question remains as to whether or not bias was reduced as a result of extensive contact attempts. This depends on several factors: first the extent to which people who were lost to follow-up differed from responders, second whether those who were re-engaged were similar to those who remained lost to follow-up, and whether enough variation in responses is maintained so that valid associations between variables can be estimated.

There appear to be no other studies that compare Temporary and Permanent No-contacts, or their characteristics using data collected at baseline and follow-up. The characteristics of the Permanent No-contact group were remarkably similar to those who were re-engaged, although different to the responders. The women who were re-engaged still had less education and monetary stress (lower socioeconomic status), unstable relationships and experience of a violent partner, suggesting that making the effort to relocate these women is likely to reduce the bias resulting from loss to follow-up. The magnitude and direction of associations between variables remained remarkably similar whether the No-contact groups were included or not, and the relative odds ratios suggested that lack of contact had minimal effects on estimates of association. However, despite these positive findings, it must be noted that the losses to follow-up reported above are likely to influence prevalence estimates for these variables. In addition, if losses to follow-up were to continue without intervention, the end result could be inadequate subgroup sample sizes among those who are most mobile.

A three part approach could help to prevent and mitigate these issues. Firstly, those most at risk of loss to follow-up could be oversampled at the outset of a cohort study. Past research and results from the current study would indicate that for young women, those who are younger, less educated, experiencing financial stress and who have unstable relationships and poor health behaviours should be oversampled. Secondly, interventions in the form of intensive tracking as conducted by ALSWH [21] as well as novel approaches to keeping in touch with participants as described by Fumagalli [30], have been found to successfully reengage participants lost to follow-up. The current results suggest further ways that might assist in this process, whereby contacts with those most at risk of loss to follow-up are increased - presenting more opportunities to prevent loss. For example, newsletters can be tailored to characteristics of those participants most at risk of loss to follow-up, a strategy that has been previously reported as being successful in re-engaging young people and busy people [30]. Finally, the impact of loss to follow-up on estimates of association between variables should be calculated and reported by longitudinal studies as a matter of course, so that any biases present can be taken into account.

As with any study, there are strengths and limitations. Strengths include the large sample size, younger age group and the breadth and representativeness of the study. For these

reasons, the results are likely to be generalizable to other studies of young women, but not young men. As women were enrolled into the ALSWH via Medicare and the survey team could only contact participants at the time of enrolment, the size and effect of lack of contact at the initial survey in 1996 could not be estimated [20]. The consistency of results using data collected at baseline and at follow-up suggests the findings are likely to be applicable to the initial enrolment. In other words, it is likely that loss to follow-up will result in under-representation of those who are less educated, stressed about money, not in stable relationships, and those who have experienced partner violence or who smoke.

#### Conclusion

Knowledge about loss to follow-up or lack of contact is important as non-response is increasing, primarily due to lack of contact with participants [9, 18]. This research used a large nationally representative sample of young women to show that those most at risk of loss to follow-up were less educated, more stressed about money, less likely to be in stable relationships, and more likely to have experienced partner violence and have poor health behaviours than those who continued to respond to the surveys. While some bias in prevalence estimates may persist, estimates of relative associations between risk factors and health outcomes showed loss to follow-up due to lack of contact had minimal effects on estimates of association. While these results are context specific they suggest that loss to follow-up due to lack of contact does not seriously bias results in a cohort of young women.

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	1996 cohort		Responders <sup>a</sup>		Temporary		Permanent	
					No-contact <sup>b</sup>		No-contact <sup>c</sup>	
	n=14247 n=9688		n=1515		n=1457			
	Ν	%	Ν	%	Ν	%	Ν	%
Aged 18-20 years	7780	54.6	5176	53.4	816	53.9	842	57.8
Living in a major city	7375	51.8	4964	51.3	791	52.2	795	54.6
Education								
11 years school	2427	17.1	1364	14.2	304	20.2	445	30.8
12 years school	7600	53.6	5383	55.8	752	49.9	653	45.2
Trade / certificate / diploma	2563	18.1	1706	17.7	289	19.2	256	17.7
University	1576	11.1	1188	12.3	163	10.8	91	6.3
Studying	6513	45.9	4648	48.1	638	42.3	527	36.3
Employed	7329	52.3	5070	53.1	777	52.1	626	44.2
Stressed about money	3640	25.7	2325	24.1	469	31.2	467	32.3
Relationship status								
Married	1265	8.9	888	9.2	123	8.1	138	9.6
De facto	1928	13.6	1212	12.6	270	17.9	291	20.2
Separated, divorced,	134	1.0	58	0.6	27	1.8	38	2.6
widowed								
Single	10850	76.5	7484	77.6	1091	72.2	976	67.6
Living alone	852	6.1	562	5.9	111	7.4	89	6.2
Living with children	1244	8.8	674	7.0	170	11.2	269	18.7
Experienced violence	1703	12.0	971	10.1	247	16.4	297	20.5
Smoker								
Non-smoker	7437	53.3	5410	56.7	661	44.7	584	41.8
Ex-smoker	2085	15.0	1405	14.7	242	16.3	220	15.8
Current smoker	4422	31.7	2729	28.6	577	39.0	591	42.4
Alcohol consumption per week								
Non-drinker	1254	9.0	798	8.4	115	7.8	183	12.8
Up to 14 drinks	11923	85.4	8183	86.2	1287	86.7	1153	80.9
15 or more drinks	782	5.6	517	5.4	82	5.5	89	6.2
Fair or poor self-rated health	1716	12.1	1087	11.3	210	13.9	223	15.4
Poor mental health	3090	21.7	1982	20.5	361	23.9	403	27.8

Table 1. Baseline characteristics in 1996 for 14247 women in the Australian Longitudinal Study on Women's Health 1973-78 cohort, by subsequent response status

a Responders: women who responded at the 2000 survey

b Temporary No-contact: women who could not be contacted at the 2000 survey but responded at a subsequent survey

c Permanent No-contact: women who could not be contacted at the 2000 survey and did not respond at a subsequent survey

	Responders <sup>b</sup> (n=8813)		Tempo No-con (n=15	rary tact <sup>c</sup> 15)
	N	%	N	%
Aged 18-20 years	4682	53.1	816	53.9
Living in a major city	4938	56.1	859	56.7
Education				
11 years school	830	9.5	229	15.3
12 years school	1549	17.7	289	19.3
Trade / certificate / diploma	2334	26.7	433	29.0
University	4039	46.1	544	36.4
Studying	1937	22.4	381	25.6
Employed	6680	76.4	1072	71.3
Stressed about money	2006	22.9	445	29.5
Relationship status				
Married	4208	47.9	627	41.6
De facto	1665	19.0	318	21.1
Separated, divorced, widowed	335	3.8	114	7.6
Single	2569	29.3	447	29.7
Living alone	711	8.1	126	8.4
Living with children	3577	40.6	669	44.3
Experienced violence	1054	12.2	291	19.6
Smoker				
Non-smoker	4369	49.6	571	37.7
Ex-smoker	2577	29.3	501	33.1
Current smoker	1856	21.1	442	29.2
Alcohol consumption per week				
Non-drinker	829	9.5	150	10.0
Up to 14 drinks	7603	87.0	1266	84.2
15 or more drinks	305	3.5	88	5.8
Fair or poor self-rated health	804	9.1	171	11.3
Poor mental health	1431	16.3	289	19.1

Table 2. Characteristics in 2003, 2006 or 2009<sup>a</sup> for 10328 women who either responded or were lost to follow-up at the 2000 survey of the Australian Longitudinal Study on Women's Health

a Earliest subsequent survey that data were available was used for comparison; equal proportions of data from each survey were randomly selected for the Responders. b Responders: women who responded at the 2000 survey

c Temporary No-contact: women who could not be contacted at the 2000 survey but responded at a subsequent survey

Table 3. Relative odds ratios based on adjusted odds ratios for poor self-rated health using
information collected at baseline and using information collected at follow-up after the 2000
survey of the Australian Longitudinal Study on Women's Health

· ·	Responders and		Re	sponders	Adjusted relative odds			
	No-contacts			ratios				
	Adj.		Adj.		Adj.			
	OR	(95% CI)	OR	(95% CI)	ROR	(95% CI)		
Odds ratios for poor self-rated health using information collected at baseline (1996)								
Self-rated health and	N = 12660		Ν	N=9688				
Stressed about money	1.62	(1.43-1.84)	1.84	(1.59-2.14)	1.13	(1.05-1.22)		
Experienced violence	1.36	(1.15-1.60)	1.20	(0.97-1.47)	0.88	(0.78-1.00)		
Current smoker	1.47	(1.28-1.69)	1.51	(1.29-1.78)	1.03	(0.95-1.12)		
Ex-smoker	1.12	(0.94-1.34)	1.06	(0.86-1.32)	0.95	(0.85-1.06)		
Poor mental health	2.99	(2.65-3.38)	2.80	(2.42-3.24)	0.94	(0.87-1.01)		
Odds ratios for poor self-rated health using information collected at follow-up								
(2003, 2006 or 2009) <sup>b</sup>								
Self-rated health and	N=10328		N=8813					
Stressed about money	1.74	(1.49-2.04)	1.75	(1.47 - 2.08)	1.00	(0.93-1.08)		
Experienced violence	1.23	(1.01 - 1.49)	1.14	(0.92 - 1.42)	0.93	(0.84-1.03)		
Current smoker	1.43	(1.18-1.73)	1.38	(1.12 - 1.70)	0.96	(0.88 - 1.05)		
Ex-smoker	1.22	(1.02-1.46)	1.18	(0.97-1.44)	0.97	(0.90-1.05)		
Poor mental health	3.99	(3.41-4.66)	4.19	(3.53-4.98)	1.05	(0.98-1.13)		

<sup>a</sup>Adjusted for all social, demographic and other health-related factors <sup>b</sup>Earliest subsequent survey that data were available was used for comparison; equal proportions of data from each survey were randomly selected for Responders (see Figure 1).

Figure 1. Flowchart for Responders and loss to follow-up (No-contact)



<sup>1</sup> Sample for comparison of 1996 characteristics (prior to No-contact)

<sup>2</sup> Sample for comparison of characteristics after Temporary No-contact, and their distribution across subsequent surveys (<sup>2a</sup> and <sup>2b</sup>)

<sup>2a</sup> randomly sampled so same proportion of 2003, 2006 and 2009 responses as for <sup>2b</sup>