Systematic handling of missing data in complex study designs – Experiences from the Health 2000 and 2011 Surveys

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Sampling designs Cluster sampling, nested case-control, varying sampling probabilities, etc.

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How to communicate assumptions of steps above to other researchers?

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Causal model with design

A graphical model

Causal node X Variables of scientific interest in the population, possibly unobserved.

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Common nodes are

sampling r corresponding to sampling design and

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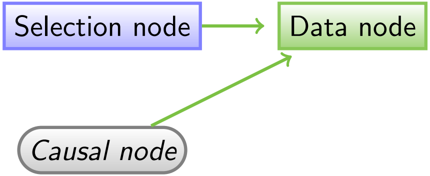

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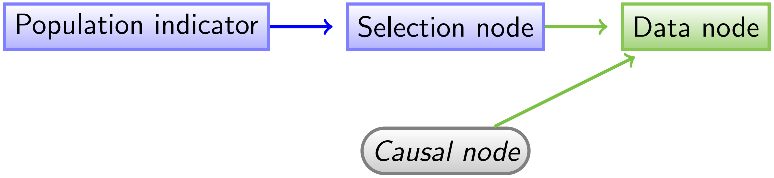
Population indicator $r_\Omega \equiv 1$.



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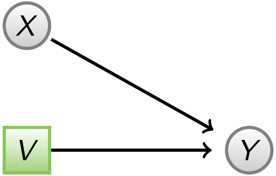
Population distribution of outcome Y

Different probabilities:

Distribution of outcome Causal model $\mathbb{P}\{\, Y \mid V, X\,\}$.



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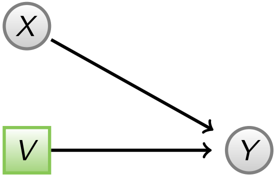

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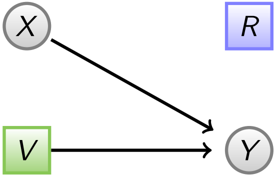

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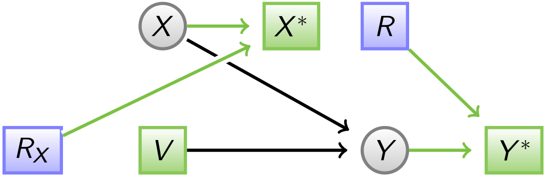

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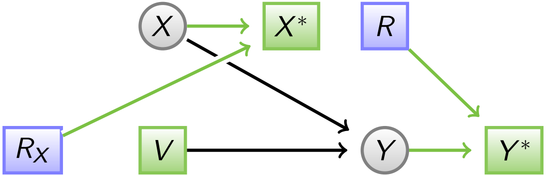

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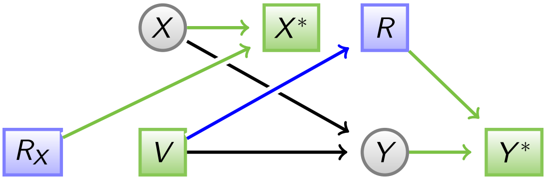

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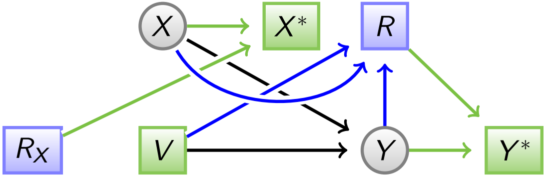

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Health 2000 Survey data (aged 29 or older)

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New sample of 1,994 young adults (aged 18 to 28)

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Missing data in the Health 2000 and 2011 Surveys

Participation rates (%) in age group 30 years and above:

Section of the survey	2000	2011	Difference
Health examination	85	59	**-26**
Any part of the survey	93	73	**-20**

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- Low social activity, low education
- Oldest age groups: Illnesses, disabilities, weak functional capacity
- Young age groups: Male

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Available administrative register data

Linking of the survey sample using the personal ID numbers to several administrative registers with a good coverage

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Reimbursement of medical expenses from which medication in 2011.

Disability benefits and services from which disability pension in 2009.

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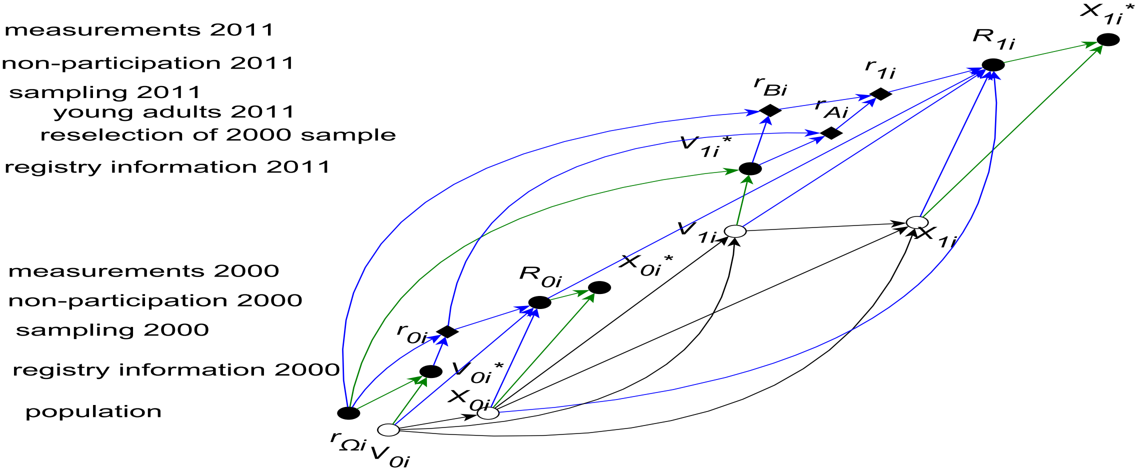

	......Observed......			Unobserved		
	Symbol	2000	2011	Symbol	2000	2011
Selection status	♦	r_{0i}	r_{1i}			
Participation status	•	R_{0i}	R_{1i}			
Empirical data	•	X_{0i}^*	X_{1i}^*	○	X_{0i}	X_{1i}
Register data	•	V_{0i}^*	V_{1i}^*	○	V_{0i}	V_{1i}

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Different methods to handle nonparticipation in 2011

Inverse probability weights (IPW)

Separate models for participation

Participants of Health 2000 Register data and observed Health 2000 Survey data were used. Weighting model was selected using the Bayesian Information Criterion: self-reported health and work ability, and participation frequency in clubs or associations.

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Multiple imputation

Imputation model 1 (MI1) contained categorical age, gender, language and education

Imputation model 3 (MI3) In addition to MI1 and IPW, also body mass index (BMI), systolic blood pressure and smoking measured in 2000.

Results in the Health 2011 Survey

Variable	Clustering	Missing data method	Prev. (%)	SE
Disability pension	SRS	Complete case analysis	8.8	0.4
	Complex	IPW weights	9.3	0.4
	Complex	Doubly Robust	9.3	0.5
	Complex	MI1	9.4	0.5
	Complex	MI3	**9.5**	0.4
	Complex	Full sample prevalence	**9.5**	0.4
Hospitalization	SRS	Complete case analysis	16.6	0.5
	Complex	IPW weights	16.9	0.5
	Complex	Doubly Robust	17.2	0.6
	Complex	MI1	**17.4**	0.9
	Complex	MI3	17.2	0.5
	Complex	Full sample prevalence	**17.6**	0.5
Medication	SRS	Complete case analysis	40.2	0.7
	Complex	IPW weights	40.8	0.8
	Complex	Doubly Robust	41.4	0.7
	Complex	MI1	41.0	0.9
	Complex	MI3	**41.8**	0.7
	Complex	Full sample prevalence	**41.9**	0.6

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Conclusion

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provide a useful tool to describe complex statistical (causal) models involving a sampling design and non-response.

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Statistical methods to handle missing data

Our empirical analyses suggest that the multiple imputation methods managed to remove most bias caused by the non-response.

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