Predictors of decline in self-reported health in older populations

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Motivation

- SHARE
- Dropout
  - due to health problems?
  - health outcome of interest

- Non-ignorable dropout: simple method to deal with it

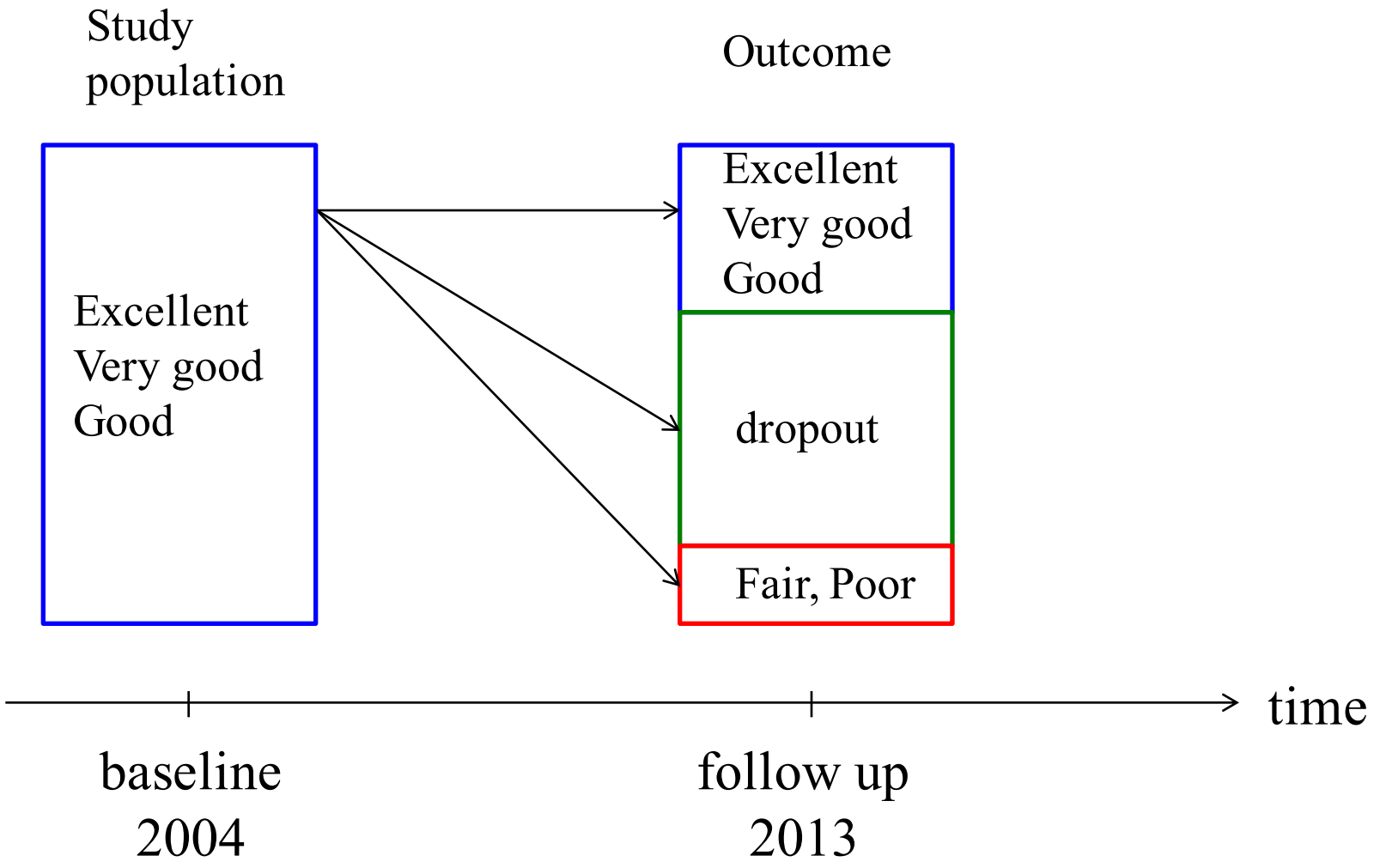
Study of ageing: decline in self-rated health

- **Study aim**: Find predictors of decline in SRH in Italy, the Netherlands and Sweden

- **Data: SHARE – Survey of Health, Ageing and Retirement in Europe**
  - Survey/interviews of 50+ in 20 European countries
  - Panel with 5 waves of follow up (with refresher samples): 2004-2013
  - Dropout increasing through the waves

Outcome:

Would you say your health is: Excellent, Very good, Good, Fair, Poor?



Predictors at baseline

	Age
	Responded to SRH question at the beginning or at the end
Socioeconomy	Education level (high/low)
	Lived in an apartment building or free standing house
Cognition	Good score in a mathematical test
	Good time and date orientation
Health	Body mass index
	Number of chronic diseases
	Number of mobility problems
	Depression
	Maximum grip strength
	Limitation in normal activities due to health problems
Life-style	Smoking (Current smokers, stopped smoking ,never smoked)
	High alcohol use
	Physical inactivity

Predictors at baseline

Socioeconomy

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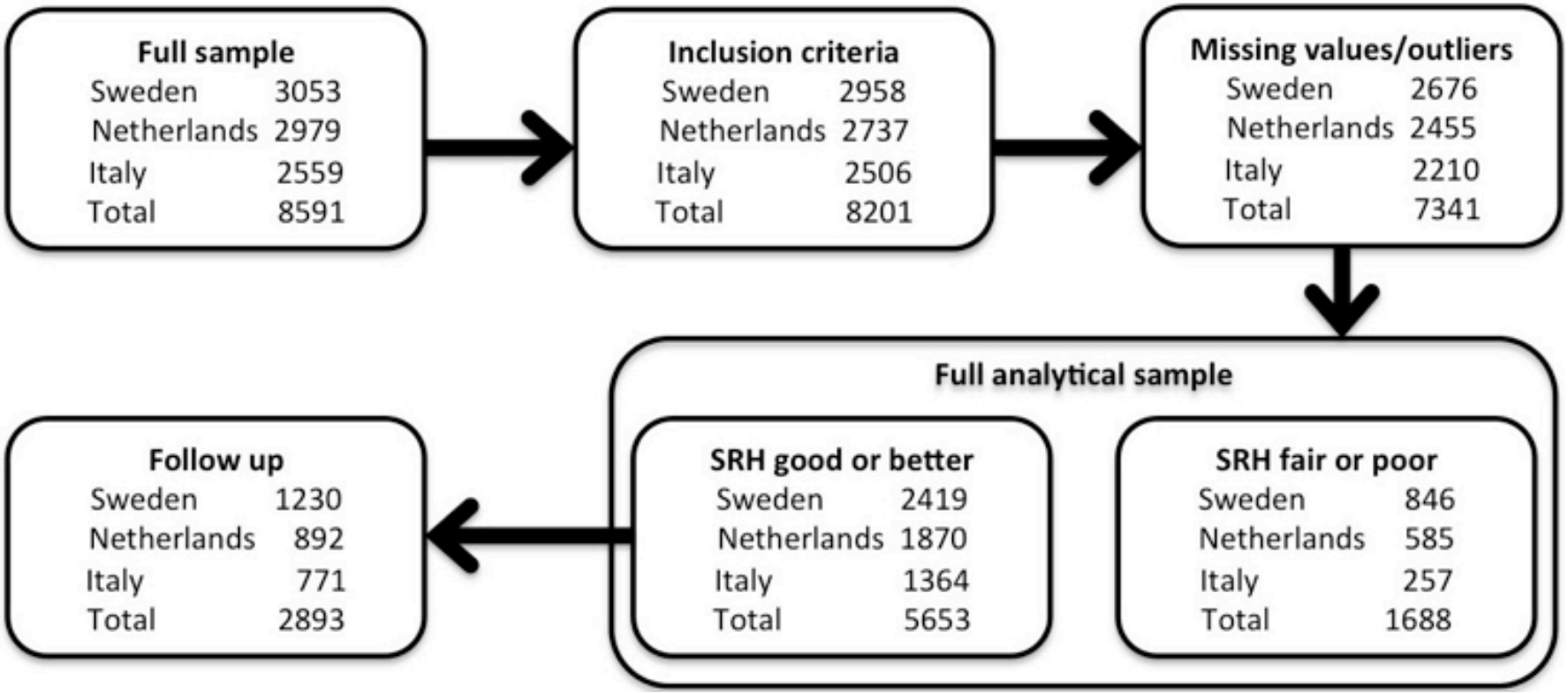
Study population



Descriptive statistics for the female respondents

Variables	Sweden (N = 1240)		Netherlands (N = 975)		Italy (N = 684)	
	Value	(95% CI)	Value	(95% CI)	Value	(95% CI)
Mean age in years	63.8	(63.3, 64.4)	61.8	(61.2, 62.3)	61.9	(61.3, 62.6)
% with SRH question in the beginning	47%	(44%, 50%)	52%	(49%, 55%)	48%	(44%, 52%)
% with high education level	52%	(49%, 55%)	40%	(37%, 43%)	28%	(25%, 32%)
% who lived in an apartment building	33%	(30%, 36%)	17%	(15%, 20%)	36%	(33%, 40%)
% with good mathematical test	51%	(48%, 53%)	50%	(47%, 53%)	25%	(22%, 29%)
% with good date orientation	93%	(92%, 95%)	88%	(85%, 90%)	90%	(87%, 92%)
Mean body mass index	25.3	(25.1, 25.5)	25.7	(25.4, 25.9)	25.7	(25.4, 26.0)
Mean number of chronic diseases	1.33	(1.26, 1.41)	0.98	(0.90, 1.05)	1.15	(1.06, 1.24)
Mean number of mobility problems	0.97	(0.88, 1.05)	0.68	(0.61, 0.76)	0.92	(0.81, 1.03)
% with depression	35%	(33%, 38%)	29%	(26%, 32%)	42%	(38%, 45%)
Mean maximum grip in kg	27.6	(27.3, 28.0)	29.8	(29.4, 30.2)	26.1	(25.6, 26.6)
% with limitation in normal activities	38%	(35%, 41%)	35%	(32%, 38%)	21%	(18%, 24%)
% who stopped smoking	32%	(29%, 34%)	30%	(27%, 33%)	16%	(14%, 19%)
% current smokers	19%	(16%, 21%)	21%	(19%, 24%)	16%	(14%, 19%)
% high alcohol use	1.0%	(0.5%, 1.6%)	14%	(12%, 16%)	13%	(10%, 15%)
% with physical inactivity	3.3%	(2.3%, 4.3%)	4.3%	(3.0%, 5.6%)	17%	(14%, 20%)
% with declined health at follow-up	24%	(48% dropout)	23%	(50% dropout)	42%	(43% dropout)

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Descriptive statistics for the male respondents

	Sweden (N = 1179)		Netherlands (N = 895)		Italy (N = 680)	
Variables	**Value**	**(95% CI)**	**Value**	**(95% CI)**	**Value**	**(95% CI)**
Mean age in years	64.7	(64.1, 65.2)	62.6	(62.0, 63.2)	63.3	(62.7, 64.0)
% with SRH question in the beginning	49%	(46%, 52%)	48%	(45%, 52%)	45%	(42%, 49%)
% with high education level	48%	(45%, 51%)	58%	(55%, 61%)	30%	(26%, 33%)
% who lived in an apartment building	28%	(25%, 31%)	14%	(12%, 17%)	38%	(34%, 42%)
% with good mathematical test	63%	(60%, 66%)	72%	(69%, 75%)	36%	(32%, 40%)
% with good date orientation	88%	(86%, 90%)	86%	(83%, 88%)	87%	(84%, 89%)
Mean body mass index	26.2	(26.0, 26.4)	26.1	(25.9, 26.3)	26.8	(26.5, 27.0)
Mean number of chronic diseases	1.32	(1.25, 1.39)	0.88	(0.81, 0.95)	1.07	(0.99, 1.16)
Mean number of mobility problems	0.54	(0.48, 0.61)	0.30	(0.25, 0.36)	0.45	(0.38, 0.53)
% with depression	17%	(15%, 19%)	17%	(14%, 19%)	25%	(22%, 29%)
Mean maximum grip in kg	45.6	(45.0, 46.1)	47.1	(46.5, 47.7)	42.1	(41.3, 42.9)
% with limitation in normal activities	34%	(31%, 36%)	25%	(22%, 28%)	15%	(12%, 17%)
% who stopped smoking	46%	(43%, 48%)	50%	(47%, 53%)	38%	(34%, 42%)
% current smokers	14%	(12%, 16%)	26%	(23%, 29%)	24%	(21%, 27%)
% high alcohol use	3.0%	(2.0%, 4.0%)	25%	(22%, 28%)	44%	(40%, 48%)
% with physical inactivity	3.3%	(2.3%, 4.3%)	4.6%	(3.2%, 6.0%)	14%	(11%, 16%)
% with declined health at follow-up	22%	(51% dropout)	24%	(55% dropout)	36%	(44% dropout)

Descriptive statistics for the female respondents

Variables	Sweden (N = 1240)		Netherlands (N = 975)		Italy (N = 684)	
	Value	(95% CI)	Value	(95% CI)	Value	(95% CI)
Mean age in years	63.8	(63.3, 64.4)	61.8	(61.2, 62.3)	61.9	(61.3, 62.6)
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% who lived in an apartment building	33%	(30%, 36%)	17%	(15%, 20%)	36%	(33%, 40%)
% with good mathematical test	51%	(48%, 53%)	50%	(47%, 53%)	25%	(22%, 29%)
% with good date orientation	93%	(92%, 95%)	88%	(85%, 90%)	90%	(87%, 92%)
Mean body mass index	25.3	(25.1, 25.5)	25.7	(25.4, 25.9)	25.7	(25.4, 26.0)
Mean number of chronic diseases	1.33	(1.26, 1.41)	0.98	(0.90, 1.05)	1.15	(1.06, 1.24)
Mean number of mobility problems	0.97	(0.88, 1.05)	0.68	(0.61, 0.76)	0.92	(0.81, 1.03)
% with depression	35%	(33%, 38%)	29%	(26%, 32%)	42%	(38%, 45%)
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Descriptive statistics for the male respondents

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	Value	(95% CI)	Value	(95% CI)	Value	(95% CI)
Mean age in years	64.7	(64.1, 65.2)	62.6	(62.0, 63.2)	63.3	(62.7, 64.0)
% with SRH question in the beginning	49%	(46%, 52%)	48%	(45%, 52%)	45%	(42%, 49%)
% with high education level	48%	(45%, 51%)	58%	(55%, 61%)	30%	(26%, 33%)
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Mean body mass index	26.2	(26.0, 26.4)	26.1	(25.9, 26.3)	26.8	(26.5, 27.0)
Mean number of chronic diseases	1.32	(1.25, 1.39)	0.88	(0.81, 0.95)	1.07	(0.99, 1.16)
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% with declined health at follow-up	22%	(51% dropout)	24%	(55% dropout)	36%	(44% dropout)

Women: complete cases results

Logistic regression:
SRH decline (0/1) ← predictors

	Sweden	Netherlands	Italy
Age (years older than 50)	1.08 (1.03, 1.12)	1.06 (1.02, 1.10)	1.05 (1.01, 1.09)
Responded to SRH question at the beginning (Ref: at the end)	0.77 (0.51, 1.17)	0.95 (0.60, 1.51)	0.50 (0.31, 0.78)
High education level (Ref: low education)	0.69 (0.45, 1.06)	1.00 (0.60, 1.66)	0.59 (0.34, 1.03)
Lived in an apartment building (Ref: lived in a freestanding house)	0.96 (0.61, 1.51)	1.09 (0.58, 2.05)	0.92 (0.57, 1.49)
Good mathematical test (Ref: poor test)	0.86 (0.56, 1.31)	0.77 (0.48, 1.25)	1.05 (0.61, 1.82)
Good date orientation (Ref: poor orientation)	1.16 (0.47, 2.88)	1.40 (0.65, 3.04)	1.18 (0.56, 2.49)
Body mass index	1.10 (1.04, 1.16)	1.05 (0.99, 1.11)	1.06 (1.00, 1.13)
Number of chronic diseases	1.22 (1.02, 1.45)	1.31 (1.05, 1.63)	1.25 (1.01, 1.54)
Number of mobility problems	1.32 (1.11, 1.58)	1.05 (0.86, 1.28)	0.98 (0.82, 1.17)
With depression (Ref: without depression)	0.93 (0.60, 1.44)	2.25 (1.40, 3.60)	1.08 (0.68, 1.74)
Maximum grip in kg	0.96 (0.93, 0.99)	0.98 (0.94, 1.02)	0.95 (0.92, 0.99)
Limitation in normal activities (Ref: no limitation)	5.03 (2.11, 11.98)	1.58 (0.95, 2.64)	1.49 (0.85, 2.61)
Stopped smoking (Ref: never smoked)	0.89 (0.55, 1.45)	1.06 (0.60, 1.86)	0.67 (0.35, 1.31)
Current smokers (Ref: never smoked)	1.31 (0.71, 2.44)	1.99 (1.07, 3.69)	1.16 (0.62, 2.17)
high alcohol use (Ref: non-high alcohol use)	2.09 (0.32, 13.84)	1.57 (0.81, 3.04)	0.93 (0.45, 1.90)
Physical inactivity (Ref: active)	1.32 (0.37, 4.68)	0.90 (0.25, 3.22)	0.42 (0.22, 0.81)
Age × Limitation in normal activities	0.94 (0.89, 0.98)		

	Sweden	Netherlands	Italy
Age (years older than 50)	1.08 (1.03, 1.12)	1.06 (1.02, 1.10)	1.05 (1.01, 1.09)
Body mass index	1.10 (1.04, 1.16)	1.05 (0.99, 1.11)	1.06 (1.00, 1.13)
Number of chronic diseases	1.22 (1.02, 1.45)	1.31 (1.05, 1.63)	1.25 (1.01, 1.54)
Maximum grip in kg	0.96 (0.93, 0.99)	0.98 (0.94, 1.02)	0.95 (0.92, 0.99)
Limitation in normal activities (Ref: no limitation)	5.03 (2.11, 11.98)	1.58 (0.95, 2.64)	1.49 (0.85, 2.61)
Physical inactivity (Ref: active)	1.32 (0.37, 4.68)	0.90 (0.25, 3.22)	0.42 (0.22, 0.81)

Men: complete cases results

Logistic regression:
SRH decline (0/1) ← predictors

	Sweden	Netherlands	Italy
Age (years older than 50)	1.36 (1.12, 1.65)	1.53 (1.12, 2.09)	1.02 (0.99, 1.06)
Responded to SRH question at the beginning (Ref: at the end)	0.84 (0.53, 1.32)	0.69 (0.42, 1.15)	1.46 (0.92, 2.31)
High education level (Ref: low education)	0.74 (0.46, 1.18)	0.81 (0.47, 1.41)	0.73 (0.43, 1.24)
Lived in an apartment building (Ref: lived in a freestanding house)	1.04 (0.63, 1.70)	0.71 (0.30, 1.66)	1.53 (0.94, 2.49)
Good mathematical test (Ref: poor test)	0.94 (0.58, 1.54)	0.45 (0.24, 0.82)	1.02 (0.62, 1.68)
Good date orientation (Ref: poor orientation)	0.62 (0.32, 1.21)	0.63 (0.31, 1.25)	0.75 (0.39, 1.43)
Body mass index	1.28 (1.13, 1.45)	1.16 (1.01, 1.33)	1.04 (0.97, 1.12)
Number of chronic diseases	1.49 (1.23, 1.81)	1.87 (1.43, 2.43)	1.36 (1.08, 1.71)
Number of mobility problems	1.18 (0.92, 1.52)	1.44 (0.98, 2.11)	1.07 (0.83, 1.36)
With depression (Ref: without depression)	0.56 (0.29, 1.10)	1.13 (0.58, 2.23)	0.67 (0.39, 1.12)
Maximum grip in kg	0.94 (0.91, 0.97)	1.01 (0.98, 1.05)	0.97 (0.94, 1.00)
Limitation in normal activities (Ref: no limitation)	2.47 (1.49, 4.10)	0.85 (0.44, 1.62)	1.27 (0.67, 2.40)
Stopped smoking (Ref: never smoked)	1.02 (0.62, 1.67)	0.73 (0.39, 1.39)	0.95 (0.56, 1.62)
Current smokers (Ref: never smoked)	1.59 (0.76, 3.34)	1.18 (0.55, 2.51)	1.39 (0.74, 2.61)
high alcohol use (Ref: non-high alcohol use)	1.25 (0.25, 6.17)	0.30 (0.09, 1.07)	0.92 (0.58, 1.46)
Physical inactivity (Ref: active)	1.45 (0.39, 5.39)	1.28 (0.34, 4.82)	0.43 (0.19, 0.95)
Age × Body Mass Index	0.99 (0.98, 1.00)	0.98 (0.97, 1.00)	
Age × high alcohol use		1.12 (1.02, 1.23)	

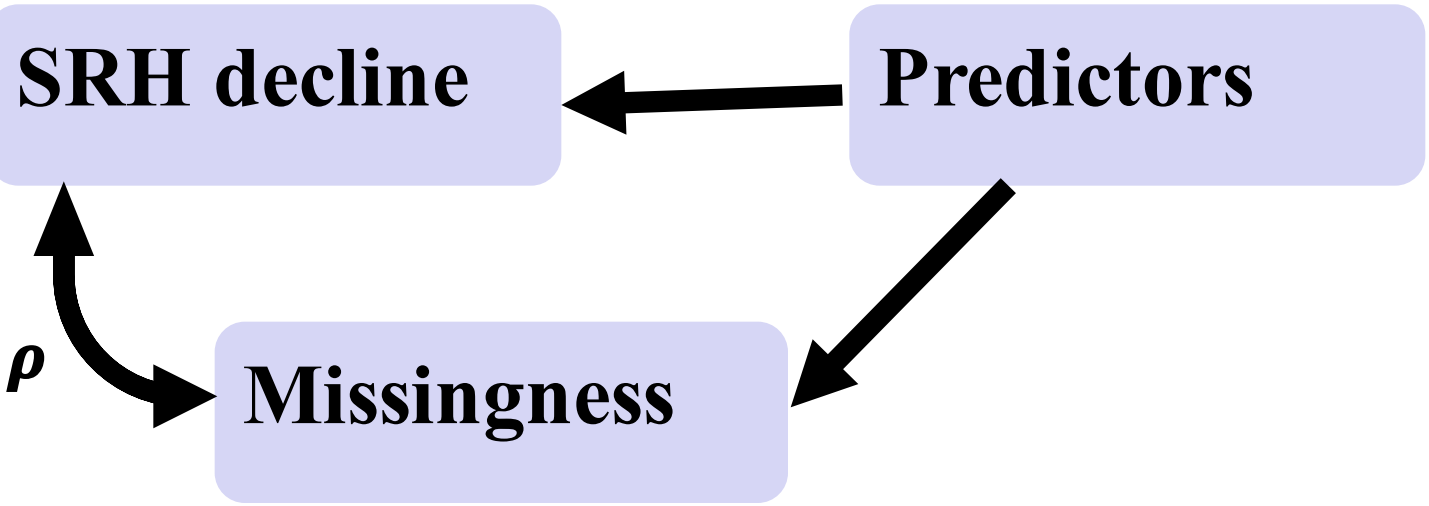
	Sweden	Netherlands	Italy
Age (years older than 50)	1.36	1.53	1.02
	(1.12, 1.65)	(1.12, 2.09)	(0.99, 1.06)
Body mass index	1.28	1.16	1.04
	(1.13, 1.45)	(1.01, 1.33)	(0.97, 1.12)
Number of chronic diseases	1.49	1.87	1.36
	(1.23, 1.81)	(1.43, 2.43)	(1.08, 1.71)
Maximum grip in kg	0.94	1.01	0.97
	(0.91, 0.97)	(0.98, 1.05)	(0.94, 1.00)
Limitation in normal activities (Ref: no limitation)	2.47	0.85	1.27
	(1.49, 4.10)	(0.44, 1.62)	(0.67, 2.40)
Physical inactivity (Ref: active)	1.45	1.28	0.43
	(0.39, 5.39)	(0.34, 4.82)	(0.19, 0.95)

Non-ignorable dropout

- If dropout independent of outcome given the covariates dropout is ignorable / MAR.
  - Complete case, OK.
- If dropout is in part due to bad health dropout is non-ignorable / MNAR, when health is the outcome.
  - Complete case, biased.

Non-ignorable dropout, $\rho \neq 0$

- Sensitivity parameter, correlation coefficient ρ
  - dropout mechanism
  - outcome



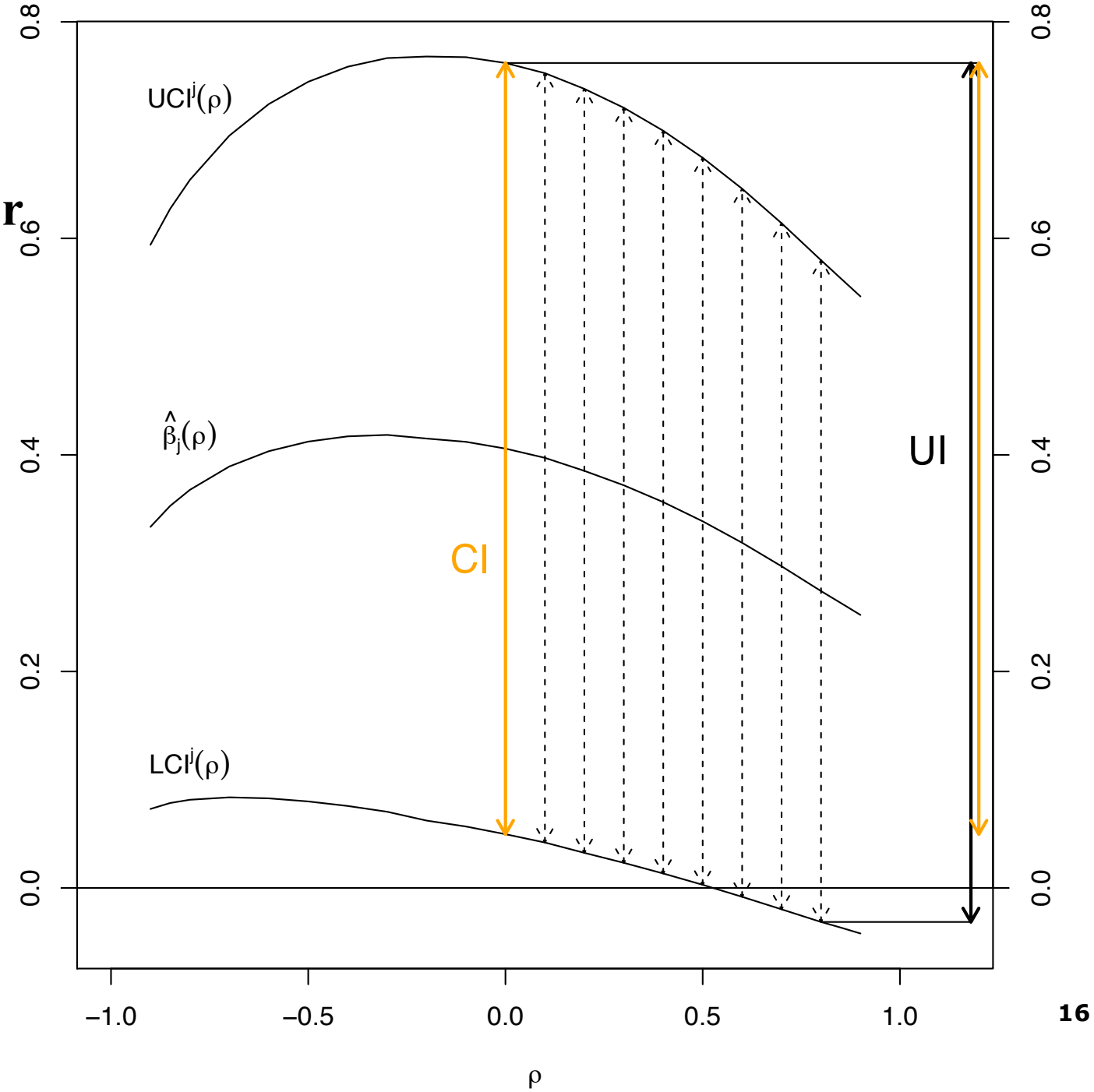
How to proceed with inference?

- Likelihood for joint model can be computed if distributions are assumed.
- No real information in data on ρ from data.
- Hence: Fix ρ and perform inference on β using maximum likelihood.

Example: Women, current smoker

	Sweden	Netherlands	Italy
Current smokers (Ref: never smoked)	1.31 (0.71, 2.44)	1.99 (1.07, 3.69)	1.16 (0.62, 2.17)

Netherlands
Women
current smoker

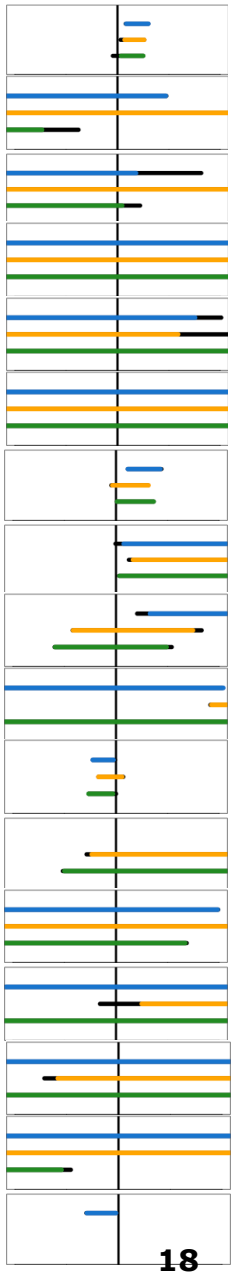


Example: Women, current smoker

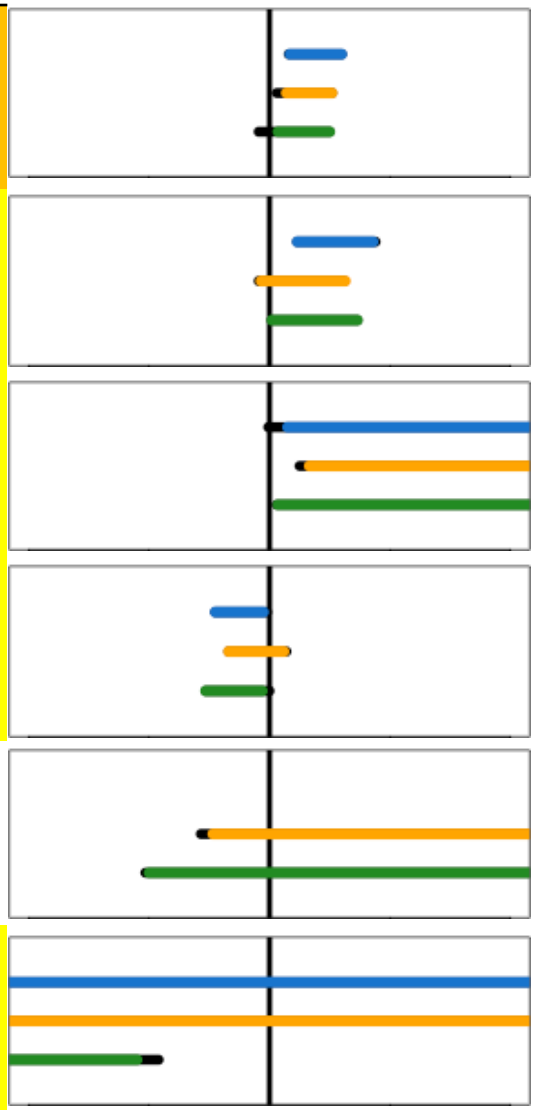
	Sweden	Netherlands	Italy
Current smokers (Ref: never smoked)	1.31 (0.71, 2.44)	1.99 (1.07, 3.69)	1.16 (0.62, 2.17)

Women

	Sweden	Netherlands	Italy
Age (years older than 50)	1.08 (1.03, 1.12)	1.06 (1.02, 1.10)	1.05 (1.01, 1.09)
Responded to SRH question at the beginning (Ref: at the end)	0.77 (0.51, 1.17)	0.95 (0.60, 1.51)	0.50 (0.31, 0.78)
High education level (Ref: low education)	0.69 (0.45, 1.06)	1.00 (0.60, 1.66)	0.59 (0.34, 1.03)
Lived in an apartment building (Ref: lived in a freestanding house)	0.96 (0.61, 1.51)	1.09 (0.58, 2.05)	0.92 (0.57, 1.49)
Good mathematical test (Ref: poor test)	0.86 (0.56, 1.31)	0.77 (0.48, 1.25)	1.05 (0.61, 1.82)
Good date orientation (Ref: poor orientation)	1.16 (0.47, 2.88)	1.40 (0.65, 3.04)	1.18 (0.56, 2.49)
Body mass index	1.10 (1.04, 1.16)	1.05 (0.99, 1.11)	1.06 (1.00, 1.13)
Number of chronic diseases	1.22 (1.02, 1.45)	1.31 (1.05, 1.63)	1.25 (1.01, 1.54)
Number of mobility problems	1.32 (1.11, 1.58)	1.05 (0.86, 1.28)	0.98 (0.82, 1.17)
With depression (Ref: without depression)	0.93 (0.60, 1.44)	2.25 (1.40, 3.60)	1.08 (0.68, 1.74)
Maximum grip in kg	0.96 (0.93, 0.99)	0.98 (0.94, 1.02)	0.95 (0.92, 0.99)
Limitation in normal activities (Ref: no limitation)	5.03 (2.11, 11.98)	1.58 (0.95, 2.64)	1.49 (0.85, 2.61)
Stopped smoking (Ref: never smoked)	0.89 (0.55, 1.45)	1.06 (0.60, 1.86)	0.67 (0.35, 1.31)
Current smokers (Ref: never smoked)	1.31 (0.71, 2.44)	1.99 (1.07, 3.69)	1.16 (0.62, 2.17)
high alcohol use (Ref: non-high alcohol use)	2.09 (0.32, 13.84)	1.57 (0.81, 3.04)	0.93 (0.45, 1.90)
Physical inactivity (Ref: active)	1.32 (0.37, 4.68)	0.90 (0.25, 3.22)	0.42 (0.22, 0.81)
Age × Limitation in normal activities	0.94 (0.89, 0.98)		



	Sweden	Netherlands	Italy
Age (years older than 50)	1.08 (1.03, 1.12)	1.06 (1.02, 1.10)	1.05 (1.01, 1.09)
Body mass index	1.10 (1.04, 1.16)	1.05 (0.99, 1.11)	1.06 (1.00, 1.13)
Number of chronic diseases	1.22 (1.02, 1.45)	1.31 (1.05, 1.63)	1.25 (1.01, 1.54)
Maximum grip in kg	0.96 (0.93, 0.99)	0.98 (0.94, 1.02)	0.95 (0.92, 0.99)
Limitation in normal activities (Ref: no limitation)	5.03 (2.11, 11.98)	1.58 (0.95, 2.64)	1.49 (0.85, 2.61)
Physical inactivity (Ref: active)	1.32 (0.37, 4.68)	0.90 (0.25, 3.22)	0.42 (0.22, 0.81)



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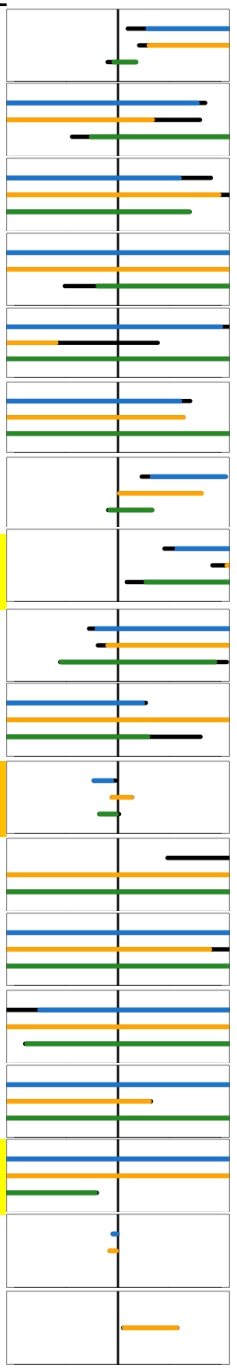
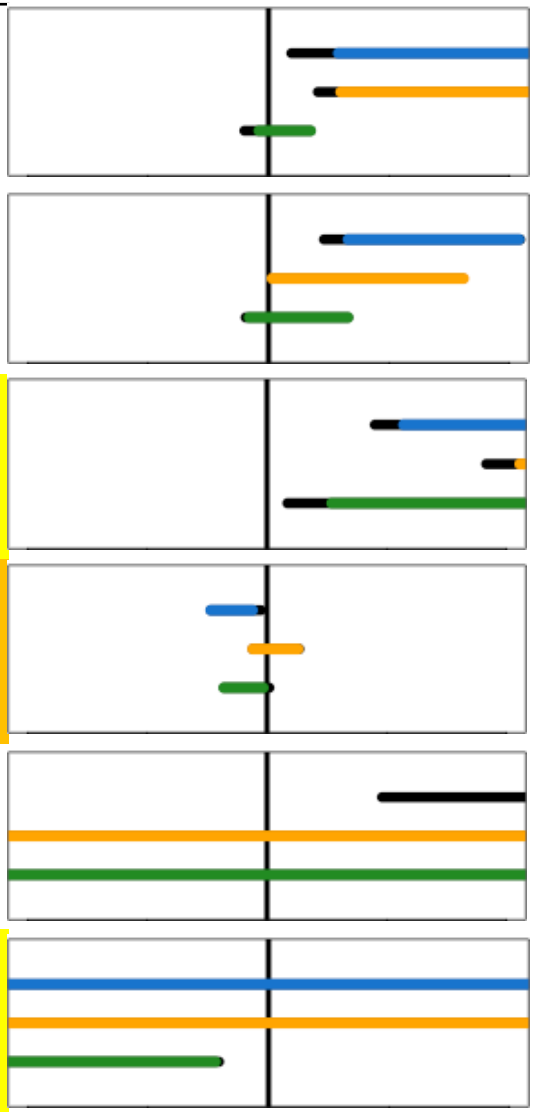
Men

	Sweden	Netherlands	Italy
Age (years older than 50)	1.36 (1.12, 1.65)	1.53 (1.12, 2.09)	1.02 (0.99, 1.06)
Responded to SRH question at the beginning (Ref: at the end)	0.84 (0.53, 1.32)	0.69 (0.42, 1.15)	1.46 (0.92, 2.31)
High education level (Ref: low education)	0.74 (0.46, 1.18)	0.81 (0.47, 1.41)	0.73 (0.43, 1.24)
Lived in an apartment building (Ref: lived in a freestanding house)	1.04 (0.63, 1.70)	0.71 (0.30, 1.66)	1.53 (0.94, 2.49)
Good mathematical test (Ref: poor test)	0.94 (0.58, 1.54)	0.45 (0.24, 0.82)	1.02 (0.62, 1.68)
Good date orientation (Ref: poor orientation)	0.62 (0.32, 1.21)	0.63 (0.31, 1.25)	0.75 (0.39, 1.43)
Body mass index	1.28 (1.13, 1.45)	1.16 (1.01, 1.33)	1.04 (0.97, 1.12)
Number of chronic diseases	1.49 (1.23, 1.81)	1.87 (1.43, 2.43)	1.36 (1.08, 1.71)
Number of mobility problems	1.18 (0.92, 1.52)	1.44 (0.98, 2.11)	1.07 (0.83, 1.36)
With depression (Ref: without depression)	0.56 (0.29, 1.10)	1.13 (0.58, 2.23)	0.67 (0.39, 1.12)
Maximum grip in kg	0.94 (0.91, 0.97)	1.01 (0.98, 1.05)	0.97 (0.94, 1.00)
Limitation in normal activities (Ref: no limitation)	2.47 (1.49, 4.10)	0.85 (0.44, 1.62)	1.27 (0.67, 2.40)
Stopped smoking (Ref: never smoked)	1.02 (0.62, 1.67)	0.73 (0.39, 1.39)	0.95 (0.56, 1.62)
Current smokers (Ref: never smoked)	1.59 (0.76, 3.34)	1.18 (0.55, 2.51)	1.39 (0.74, 2.61)
high alcohol use (Ref: non-high alcohol use)	1.25 (0.25, 6.17)	0.30 (0.09, 1.07)	0.92 (0.58, 1.46)
Physical inactivity (Ref: active)	1.45 (0.39, 5.39)	1.28 (0.34, 4.82)	0.43 (0.19, 0.95)
Age × Body Mass Index	0.99 (0.98, 1.00)	0.98 (0.97, 1.00)	
Age × high alcohol use		1.12 (1.02, 1.23)	



	Sweden	Netherlands	Italy
Age (years older than 50)	1.36 (1.12, 1.65)	1.53 (1.12, 2.09)	1.02 (0.99, 1.06)
Body mass index	1.28 (1.13, 1.45)	1.16 (1.01, 1.33)	1.04 (0.97, 1.12)
Number of chronic diseases	1.49 (1.23, 1.81)	1.87 (1.43, 2.43)	1.36 (1.08, 1.71)
Maximum grip in kg	0.94 (0.91, 0.97)	1.01 (0.98, 1.05)	0.97 (0.94, 1.00)
Limitation in normal activities (Ref: no limitation)	2.47 (1.49, 4.10)	0.85 (0.44, 1.62)	1.27 (0.67, 2.40)
Physical inactivity (Ref: active)	1.45 (0.39, 5.39)	1.28 (0.34, 4.82)	0.43 (0.19, 0.95)



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Concluding

- Longitudinal studies of ageing often have dropout

- Complete case analysis based on missing at random assumptions should always be presented with a sensitivity analysis: what would be the results if missing is not at random!

Concluding

- We introduce a method to present a sensitivity analysis when regression is used (OLS, logistic/probit). We are happy to provide R functions (R package is planned).

- Performing studies on different countries is another way to investigate robustness of results

Concluding

- BMI and number of chronic diseases associated with decline in SRH in all countries
- Maximum grip strength associated with decline in SRH in Sweden and Italy

Contact, references

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References:

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