The role of education in the health transition: Evidence from the Belgian census

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1. Ageing, health and mortality

In the face of unprecedented population ageing, the narrow link between ageing, health and disability has become a crucial research question with important policy implications. It is unclear for instance, to what extent increasing longevity is likely to entail an increase of the time spent in morbidity or disability[1-7]. Given the importance of factors related to education in accounting for past gains in life expectancy[8-14] – among which the economic opportunities that result from increased educational attainment as well as the diffusion of medical knowledge through education – the analysis of the relation between education, health and mortality in developed countries can shed further light on likely future developments of human longevity and morbidity at the end of life. The aim of this paper is to explore the consequences of increasing longevity on healthy life expectancy using data from the 2001 Census in Belgium where educational attainment and a limited set of health questions have been linked to data from the mortality register allowing a 39 month follow-up period. The resulting dataset (with N = 6.807.936) offers a rare opportunity to analyse the interplay between educational attainment, morbidity, disability and mortality at the individual level. The data have the important advantage of consistency (one source of information at one moment in time over the whole age range of the overall population) and the follow-up of survivorship with matched register data avoids the classical numerator-denominator bias[15,16].

2. Measuring health, morbidity and disability

Apart from 'standard' information on household composition, educational attainment, professional status and housing characteristics, the 2001 Census also includes a limited number of health questions. Three health questions have been used in the analysis:

1) A general question on self-reported health with 5 response possibilities: 'How is your health in general?' (very good / good / fair / bad / very bad)

2) A question on chronic morbidity: 'Are you suffering from one or several long-term illnesses, health problems or handicaps?' (Yes / No)

3) A question on disability for those respondents answering affirmatively to the second question: 'If you are suffering from long-term illnesses, health problems or handicaps, do they limit your daily activities?' (Continuously / once in while / seldom or never).

Using the answers for questions 2 and 3 a distinction has been made between moderate disability (limited once in a while) and severe disability (limited continuously). All persons between 25 and 99 with information on education (2.9% missing) and a valid answer on self-assessed health (3.1% missing) have been included in the analysis. Respondents with missing values for the questions on morbidity and disability have been maintained in the analysis as a separate category.

Table 1 illustrates the well established distributions of bas self-assessed health (SAH), chronic morbidity and disability related to both age and sex. However, the increase of the proportion declaring poor SAH is not parallel for men and women: women report poorer health in old age than men but not in younger ages, putting into perspective the often observed or assumed worse SAH and disability for women. Figures 1 and 2 explore the relationship between age, sex, chronic morbidity and disability respectively. In figure 1 the proportion of a diagnosed or observed chronic condition by level of SAH for men and women is plotted by age. The figure confirms the internal consistency of the data, illustrates the remarkable parallelism in age patterns by sex and shows an interesting shift in the meaning of fair health over age.

3. Education, health and mortality

The relation between educational attainment and self-reported health is explored in figure 3. The proportion of respondents who report being in less than good health by age follows an almost parallel trajectory for al educational levels, but higher educated have a time lag of several years before the proportion in bad health is similar to that of the lower educated. One in five persons with primary education declares to be in less than good health at age 25. Persons with lower secondary education are 39 when crossing the 20% threshold. For respondents with higher secondary education the proportion having less than good health is beneath 20 per cent until the age of 46 and until the age of 53 among those with tertiary education. The increase in the proportion having bad health starts to level of over the age of 80 mainly due to the concurrent risk of mortality. The levelling off appears to start for all

educational groups around the same age resulting in a relative constant difference in the proportion in less than good health among the oldest old.

Semi-parametric survival models were used to further explore the effect of covariates measured in the 2001 census on the hazard of dying in the 39-month follow-up period. The results in table 2 indicate that SAH, chronic morbidity and disability all have considerable negative effects on the hazard of surviving during the 39-month follow-up period. Moreover, the results indicate that the relationship between educational attainment and the hazard of mortality is considerably weakened controlling for differentials in SAH, morbidity and disability. The effect of educational attainment grows increasingly weaker for the older age groups. The results of Cox proportional hazards models thus suggest that differential SAH, morbidity and disability are important factors mediating the relationship between educational attainment and mortality.

4. Education and healthy life expectancy

The results of the survival analysis confirm the well-documented finding that higher educational attainment is negatively related to the hazard of mortality, resulting in a higher life expectancy for the higher educated groups[17]. In addition, the health data in the 2001 census indicate that the proportions reporting poor health at any given age are also consistently lower among higher educated than among lower levels of educational attainment. As a result, higher educated combine increased longevity with a compression of the time spent in morbidity at the end of life. A visual representation of the compression effect is provided in figure 4 where the proportions reporting good health, chronic morbidity and disability have been applied to the estimated survivor functions for 4 groups of respondents (men with primary versus tertiary education and women with primary versus tertiary education). The results clearly suggest that the rectangularisation of the survivor function for the higher educated is associated with an increase of time spent in good health and a compression of disability. An important exception to this overall observation is the pattern among the oldest old women (age 90-95) where the data point to an expansion of morbidity.
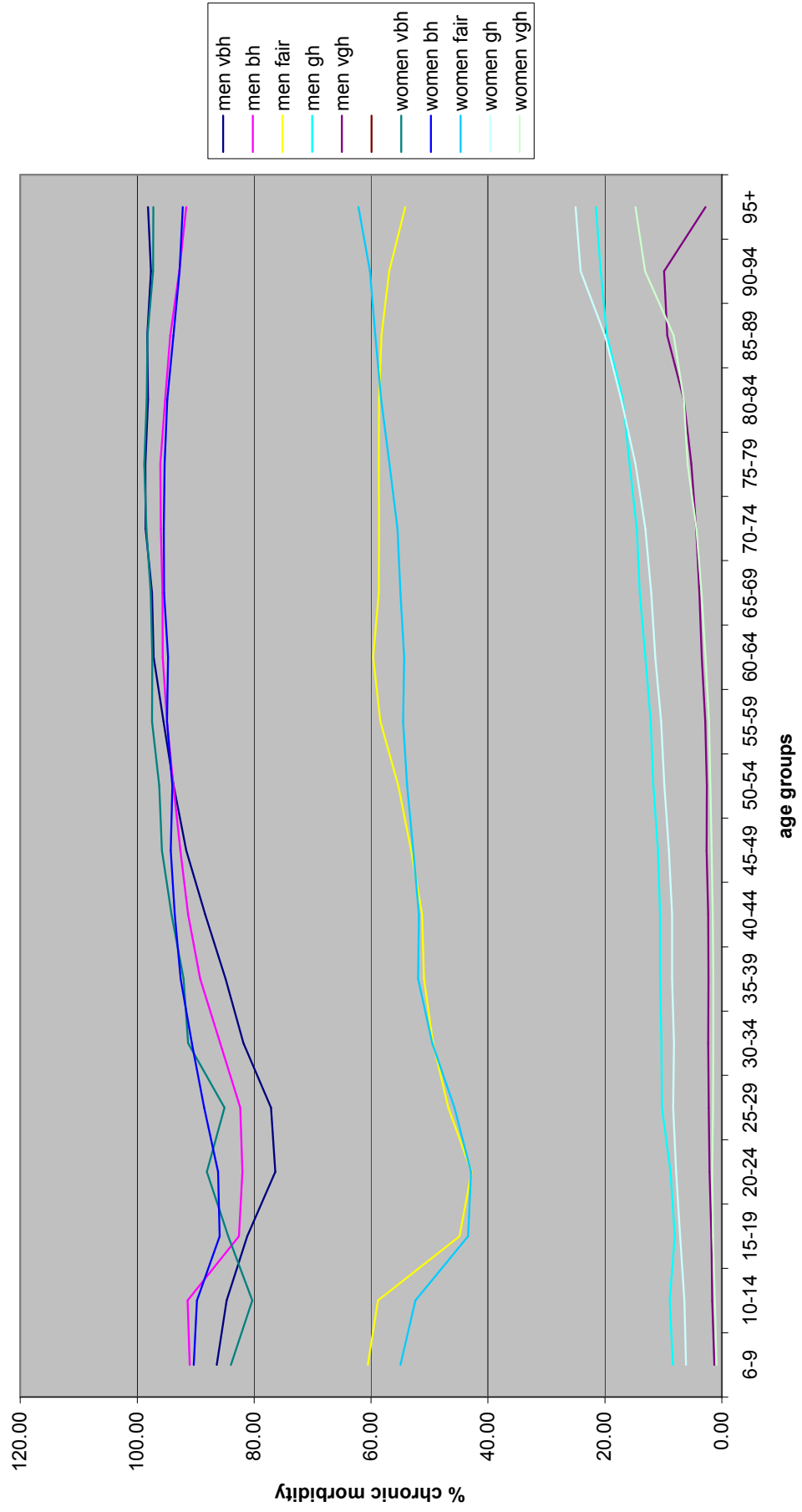
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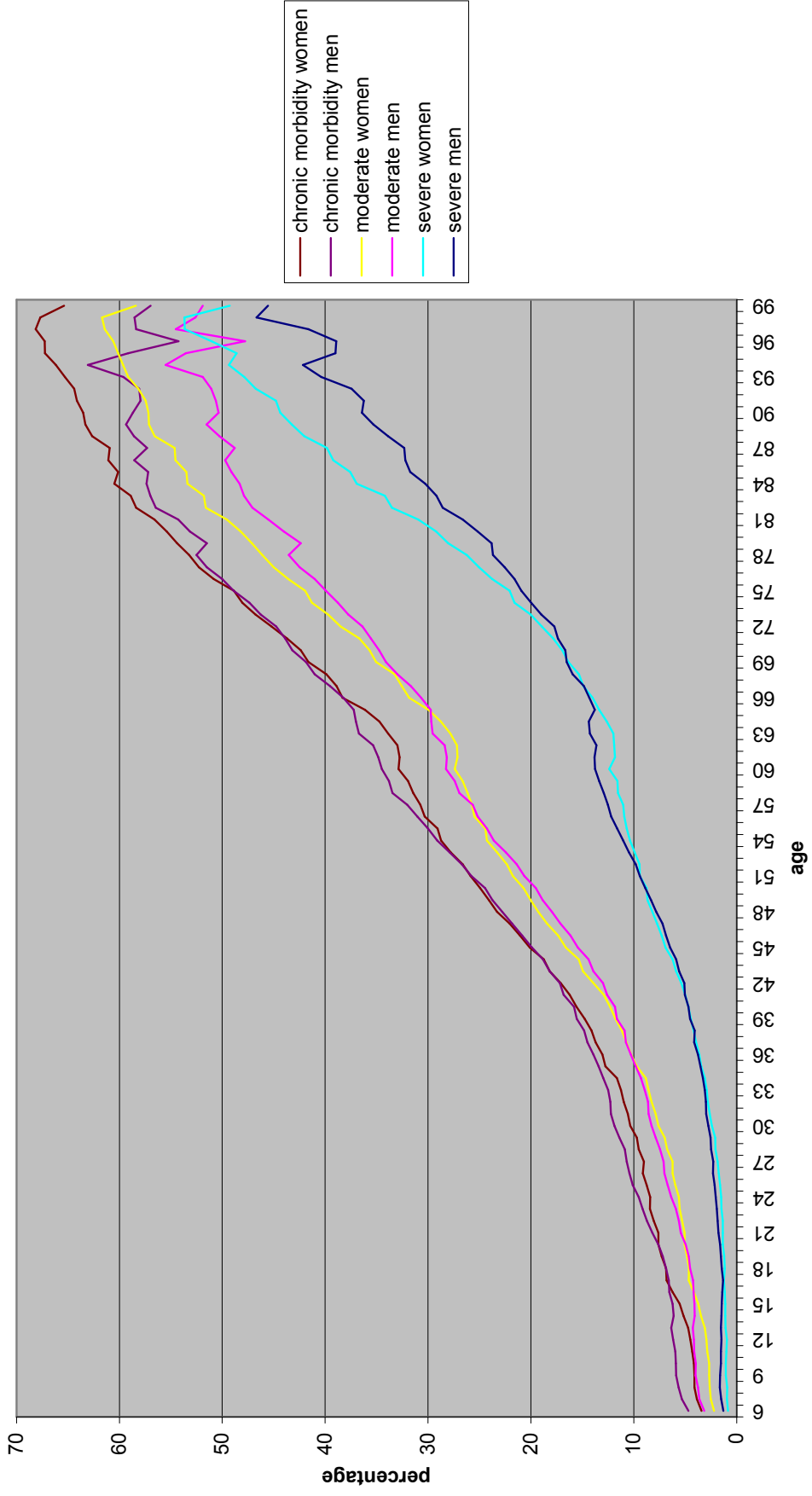17. Mackenbach JP. Health Inequalities: Europe in Profile. Rotterdam: Erasmus MC Rotterdam, 2005: 44.

Table 1 Distribution of highest educational level, self assessed health, chronic morbidity and disability in the 2001 census for the population 25+

age group — men	highest educational level						self assessed health						chronic morbidity			
	no formal	primary	lower sec	higher sec	tertiary	Total	very bad	bad	fair	good	very good	Total	no	yes	missing	Total
25-29	12741	8406	50074	122803	123816	317840	1512	3864	22966	144739	138449	311530	268584	32243	17013	317840
30-34	17683	12569	69133	132380	126710	358475	2051	6091	30866	170437	141874	351319	298479	42120	17876	358475
35-39	23480	22277	97078	128173	122714	393722	2897	8973	41275	193881	137771	384797	318619	53817	21286	393722
40-44	27178	31936	105495	110587	109279	384475	3646	12388	51627	199076	108632	375369	299659	62906	21910	384475
45-49	28927	39000	102848	92700	94460	357935	4294	16869	62632	186919	78208	348922	263120	73289	21526	357935
50-54	30739	50741	94000	77550	85104	338134	4830	21250	75231	168915	58824	329050	231747	84852	21535	338134
55-59	29491	54528	73256	53398	64412	275085	4574	20855	73866	130906	37031	267232	174379	81675	19031	275085
60-64	36478	64980	58610	36519	44119	240706	4476	19457	73303	110123	25614	232973	141699	78726	20281	240706
65-69	43731	71455	53784	31194	32169	232333	5150	19853	82700	98964	17113	223780	126583	82858	22892	232333
70-74	40809	69239	43356	25632	23888	202924	5975	21547	82179	74355	10524	194580	99814	81545	21565	202924
75-79	31083	53562	30298	19338	16989	151270	5739	20083	67656	45622	5435	144535	66406	68501	16363	151270
80-84	15450	25993	14313	8199	8161	72116	3411	11447	33294	18347	2000	68499	29126	35461	7529	72116
85-89	7671	13050	5556	3097	3270	32644	1856	5789	15102	7074	776	30597	12131	16813	3700	32644
90-94	2573	3788	1547	820	916	9644	623	1753	4304	1914	200	8794	3475	4977	1192	9644
95-99	464	593	178	117	167	1519	116	282	640	299	33	1370	551	747	221	1519
	348498	522117	799526	842507	856174	3368822	51150	190501	717641	1551571	762484	3273347	2334372	800530	233920	3368822

age group — women	highest educational level						self assessed health						chronic morbidity			
	no formal	primary	lower sec	higher sec	tertiary	Total	very bad	bad	fair	good	very good	Total	no	yes	missing	Total
25-29	10962	6978	36584	103779	156236	314539	900	3562	22841	143293	137905	308501	270416	27533	16590	314539
30-34	15367	11065	55461	121738	149609	353240	1510	6174	30706	163624	144048	346062	297507	36636	19097	353240
35-39	21741	21035	80876	125566	138013	387231	2279	9751	42759	186319	137137	378245	313828	49746	23657	387231
40-44	26459	32448	95534	113178	113792	381411	3120	13918	55717	192716	106078	371549	294712	60968	25731	381411
45-49	28967	40171	102676	93800	90309	355923	4059	18211	69654	178989	75064	345977	257188	72924	25811	355923
50-54	31430	56078	100885	73726	74194	336313	4434	21042	83438	162561	54454	325929	226596	82924	26793	336313
55-59	32689	65037	82161	49580	49800	279267	4022	19737	80652	130160	34698	269269	175261	77268	26738	279267
60-64	41477	77484	69855	35391	33218	257425	4251	18465	83192	117042	24032	246982	151772	76309	29344	257425
65-69	51571	89900	67834	32587	23223	265115	5589	22522	101789	106327	16583	252810	141493	90484	33138	265115
70-74	55164	100531	60076	26986	16228	258985	7293	28364	112376	86894	11137	246064	123639	101690	33656	258985
75-79	50024	92939	46992	21459	13710	225124	8653	31868	105002	60590	6611	212724	94739	101966	28419	225124
80-84	31276	56625	25300	10613	7573	131387	6517	22546	61814	28824	2900	122601	49234	66094	16059	131387
85-89	22105	36167	13253	5402	3531	80458	5060	15603	36244	14463	1388	72758	26791	42798	10869	80458
90-94	11225	14350	4827	2062	1335	33799	2607	6791	14018	5300	533	29249	9995	18079	5725	33799
95-99	2832	2843	818	437	257	7187	624	1401	2797	969	78	5869	1857	3824	1506	7187
	433289	703651	843132	816304	871028	3667404	60918	239955	902999	1578071	752646	3534589	2435028	909243	323133	3667404

men and women SAH and chronic morbidity

Legend:
- men vbh
- men bh
- men fair
- men gh
- men vgh
- women vbh
- women bh
- women fair
- women gh
- women vgh

X-axis: **age groups** (6-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90-94, 95+)

Y-axis: **% chronic morbidity** (0.00, 20.00, 40.00, 60.00, 80.00, 100.00, 120.00)

Proportion men and women with chronic morbidity, moderate and severe disability by age

Legend:
- chronic morbidity women
- chronic morbidity men
- moderate women
- moderate men
- severe women
- severe men

Self assessed health by educational level Belgian population census 2001

- primary
- lower secundary
- higher secundary
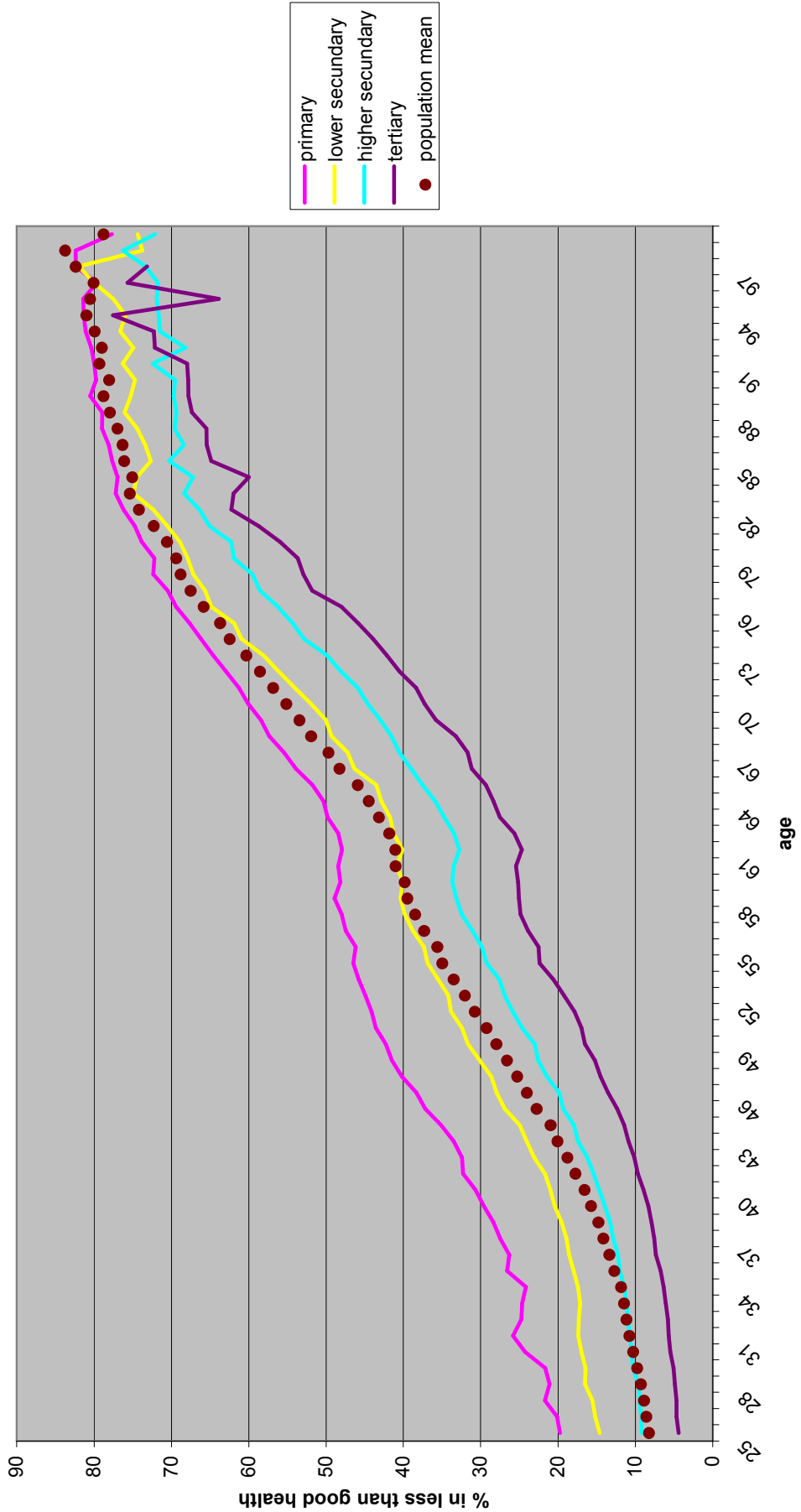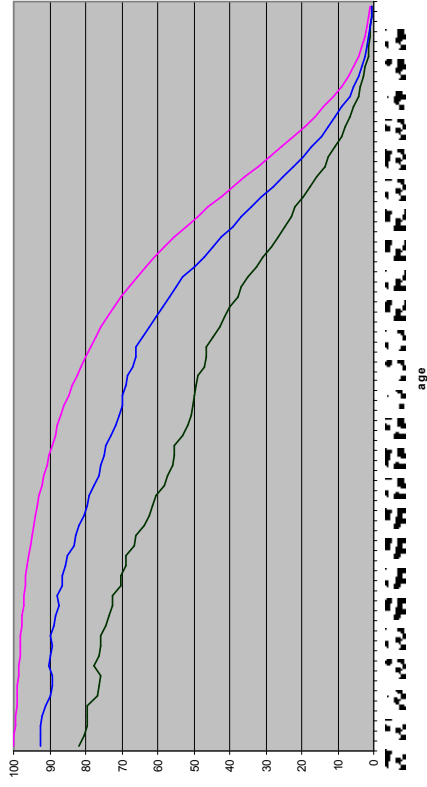- tertiary
- population mean

Table 2 Cox Regression: Relative Risk (Exp(B)) for mortality: census population 2001 - mortality follow-up 2001-2004

25-39

		N	Exp(B)	(95,0% CI)		Exp(B)	(95,0% CI)		Exp(B)	(95,0% CI)	
Age			**1.04**	1.04	1.05	**1.04**	1.03	1.05	**1.04**	1.03	1.04
Sex	men	1047646	**2.00**	1.89	2.11	**2.00**	1.90	2.12	**1.95**	1.84	2.06
	women	1032808	**1.00**			**1.00**			**1.00**		
SAH	very bad	11149	**20.99**	18.70	23.55	**11.11**	9.64	12.80	**9.83**	8.52	11.34
	bad	38415	**10.94**	9.95	12.04	**5.87**	5.19	6.63	**5.19**	4.59	5.87
	fair	191413	**4.06**	3.75	4.40	**2.96**	2.70	3.25	**2.66**	2.42	2.92
	good	1002293	**1.49**	1.39	1.60	**1.42**	1.33	1.53	**1.35**	1.26	1.45
	very good	837184	**1.00**			**1.00**			**1.00**		
Disability	severe	59323				**1.03**	0.86	1.22	**1.02**	0.86	1.21
	moderate	113938				**0.81**	0.68	0.96	**0.83**	0.69	0.99
	no	48443				**0.57**	0.46	0.71	**0.62**	0.50	0.78
	NA	1858750				**1.00**			**1.00**		
chronic morbidity	yes	236868				**2.17**	1.83	2.58	**2.07**	1.74	2.46
	missing	91180				**1.29**	1.14	1.46	**1.20**	1.06	1.36
	no	1752406				**1.00**			**1.00**		
highest educational level	no formal education	87752							**1.69**	1.51	1.88
	primary	80437							**1.88**	1.68	2.11
	lower secundary	382026							**1.70**	1.58	1.84
	higher secundary	723301							**1.52**	1.41	1.63
	tertiary	806938							**1.00**		

40-59

		N	Exp(B)	(95,0% CI)		Exp(B)	(95,0% CI)		Exp(B)	(95,0% CI)	
Age			**1.07**	1.07	1.07	**1.07**	1.07	1.07	**1.07**	1.07	1.07
Sex	men	1320573	**1.85**	1.81	1.89	**1.85**	1.81	1.89	**1.85**	1.81	1.89
	women	1312724	**1.00**			**1.00**			**1.00**		
SAH	very bad	32979	**20.67**	19.64	21.75	**11.70**	11.02	12.42	**11.22**	10.56	11.92
	bad	144270	**9.20**	8.79	9.63	**5.38**	5.10	5.68	**5.18**	4.91	5.48
	fair	552817	**3.60**	3.45	3.76	**2.73**	2.60	2.86	**2.64**	2.52	2.77
	good	1350242	**1.46**	1.40	1.53	**1.40**	1.34	1.46	**1.38**	1.32	1.44
	very good	552989	**1.00**			**1.00**			**1.00**		
Disability	severe	203659				**0.89**	0.84	0.94	**0.89**	0.84	0.94
	moderate	268234				**0.72**	0.68	0.77	**0.73**	0.69	0.77
	no	75035				**0.64**	0.59	0.69	**0.65**	0.60	0.71
	NA	2086369				**1.00**			**1.00**		

Variable	Category	N	Model 1 OR	M1 low	M1 high	Model 2 OR	M2 low	M2 high	Model 3 OR	M3 low	M3 high
chronic morbidity	yes	582466				**2.17**	2.04	2.30	**2.15**	2.03	2.28
	missing	151164				**1.31**	1.25	1.38	**1.28**	1.22	1.35
	no	1899667				**1.00**			**1.00**		
highest educational level	no formal education	213108							**1.23**	1.18	1.28
	primary	359941							**1.15**	1.11	1.20
	lower secundary	739731							**1.14**	1.10	1.17
	higher secundary	651165							**1.14**	1.10	1.18
	tertiary	669352									
60-79											
Age											
Sex	men	795868	**1.10**	1.09	1.10	**1.09**	1.09	1.10	**1.09**	1.09	1.09
	women	958580	**2.01**	1.99	2.04	**2.01**	1.99	2.03	**2.02**	2.00	2.05
			1.00			**1.00**			**1.00**		
SAH	very bad	47126	**12.64**	12.15	13.15	**7.31**	7.00	7.62	**7.07**	6.77	7.37
	bad	182159	**6.32**	6.08	6.56	**3.91**	3.76	4.07	**3.80**	3.64	3.95
	fair	708197	**2.63**	2.53	2.73	**2.14**	2.06	2.23	**2.09**	2.01	2.17
	good	699917	**1.32**	1.27	1.37	**1.28**	1.23	1.33	**1.27**	1.22	1.32
	very good	117049	**1.00**			**1.00**			**1.00**		
Disability	severe	270009				**1.04**	1.01	1.07	**1.04**	1.02	1.07
	moderate	278673				**0.73**	0.71	0.75	**0.73**	0.71	0.75
	no	67720				**0.65**	0.62	0.67	**0.66**	0.64	0.69
	NA	1138046				**1.00**			**1.00**		
chronic morbidity	yes	660798				**1.80**	1.75	1.85	**1.80**	1.75	1.85
	missing	165238				**1.16**	1.14	1.19	**1.14**	1.12	1.17
	no	928412				**1.00**			**1.00**		
highest educational level	no formal education	316976							**1.19**	1.16	1.21
	primary	599089							**1.18**	1.15	1.20
	lower secundary	417694							**1.11**	1.08	1.13
	higher secundary	222375							**1.13**	1.10	1.15
	tertiary	198314							**1.00**		
80-99											
Age											
Sex	men	109260	**1.11**	1.11	1.11	**1.11**	1.10	1.11	**1.10**	1.10	1.11
	women	230477	**1.60**	1.58	1.62	**1.62**	1.60	1.64	**1.63**	1.61	1.65
			1.00			**1.00**			**1.00**		
SAH	very bad	20814	**5.20**	4.91	5.50	**3.81**	3.60	4.04	**3.72**	3.51	3.95
	bad	65612	**3.40**	3.21	3.59	**2.59**	2.44	2.74	**2.54**	2.40	2.68
	fair	168213	**1.96**	1.85	2.07	**1.75**	1.65	1.85	**1.72**	1.63	1.82
	good	77190	**1.23**	1.16	1.30	**1.20**	1.14	1.27	**1.20**	1.13	1.27
	very good	7908	**1.00**			**1.00**			**1.00**		
Disability	severe	107768				**1.02**	0.99	1.05	**1.02**	0.99	1.05

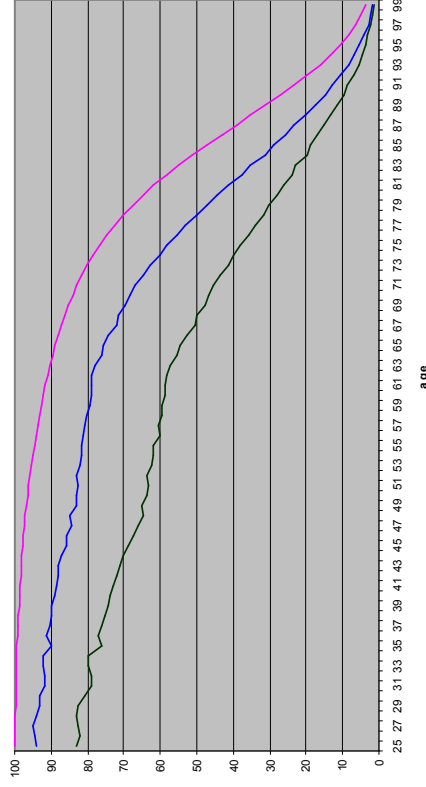|	n	Model 1			Model 2		
moderate	52150	**0.76**	0.74	0.79	**0.76**	0.74	0.79
no	9076	**0.70**	0.66	0.73	**0.71**	0.67	0.74
NA	170743	**1.00**			**1.00**		
chronic morbidity							
yes	182628	**1.42**	1.38	1.46	**1.42**	1.38	1.46
missing	26299	**1.08**	1.05	1.10	**1.06**	1.03	1.09
no	130810	**1.00**			**1.00**		
highest educational level							
no formal education	73344				**1.17**	1.14	1.21
primary	148492				**1.14**	1.11	1.17
lower secundary	63764				**1.08**	1.05	1.11
higher secundary	29748				**1.08**	1.05	1.12
tertiary	24389				**1.00**		

Men primary education

Men tertiary education
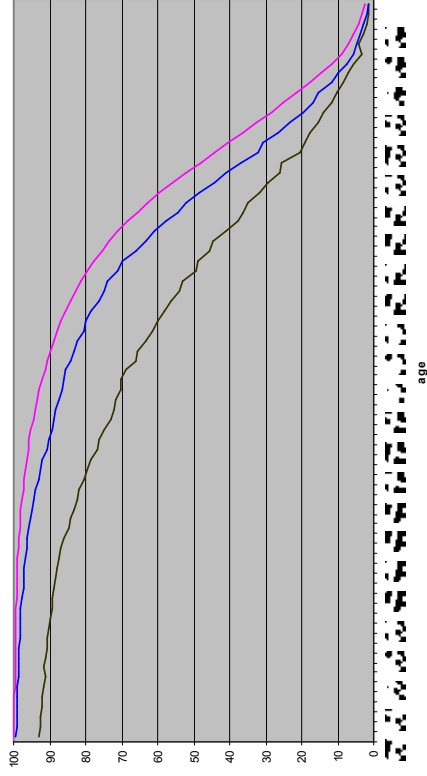
Women primary education

Women tertiary education

age

age