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Descriptive Finding

Is the accuracy of individuals' survival beliefs associated with their knowledge of population life expectancy?

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Contents

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Abstract

BACKGROUND
On average, individuals underestimate their survival chances, which could yield suboptimal long-term decisions.

OBJECTIVE
Is the accuracy of individuals' survival beliefs associated with their knowledge of population life expectancy of people of their age and gender?

METHODS
We use the 1995 and 1996 waves of the Dutch DNB Household Survey (DHS) with data on individuals' survival beliefs and their knowledge of population life expectancy, supplemented with death registry data for the years 1995 to 2018. The accuracy of their survival beliefs is measured by comparing these beliefs with (actual) survival during the years after the survey was conducted. We provide prima facie evidence on the association between individuals' knowledge of population life expectancy and the accuracy of their survival beliefs, and quantify this association using mortality risk models that control for socioeconomic status and health-related characteristics.

RESULTS
Individuals with only some over- or underestimation of population life expectancy had, on average, about a one-third smaller difference between their survival beliefs and survival rate than those who severely underestimated population life expectancy. In line with this prima facie evidence, we find that, after controlling for socioeconomic and health characteristics, 55-year-old individuals with one-year of better knowledge of population life expectancy underestimated their lifetime with, on average, about 0.3 years less (95% CI: 0.09–0.52).

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CONTRIBUTION

We provide empirical evidence in support of the hypothesis that individuals with a better knowledge of population life expectancy have more accurate survival beliefs.

1. Introduction

Individuals' long-term decisions on matters such as human capital investments, savings, the purchase of a life insurance policy, retirement timing, or adopting a healthy lifestyle can be influenced by their beliefs on remaining lifetime (Gan et al. 2004; Hurd 1989; Kutlu Koc, Alessie, and Kalwij 2017; O'Dea and Sturrock 2020; Oster, Shoulson, and Dorsey 2013; Salm 2010; Vanajan, Bültmann, and Henkens 2020). While subjective survival probabilities elicited in household surveys (Manski 2004) have been shown to predict actual survival (Hurd and McGarry 2002), several studies have shown that individuals, on average, underpredict their remaining lifetime (Groneck, Ludwig, and Zimper 2016; Kutlu Koc and Kalwij 2017; Teppa 2012; Bago D'Uva, O'Donnell, and van Doorslaer 2020).

One strand of the literature has studied the underlying reasons for biases in survival beliefs empirically. For example, Grevenbrock et al. (2020) found that cognitive weakness, according to which people cannot distinguish well among respective likelihoods of events, increases with age and explains the underestimation (overestimation) of survival beliefs at age 65 (85). Similarly, Bago D'Uva, O'Donnell, and van Doorslaer (2020) found that both men and women underestimate their subjective probability of living to age 75 compared to survival to that age, and that predictions errors are larger for the low-educated and those with low cognitive skills. Further, studies have shown that women, on average, underestimate their remaining lifetime more than men, and that smokers are too optimistic about their remaining lifetime (Bissonnette, Hurd, and Michaud 2017; Kutlu Koc and Kalwij 2017).

Another strand of the literature has focused on the consequences of survival misperceptions for economic decision-making. According to the research, misperceptions can lead to individuals making suboptimal long-term decisions. For instance, Bissonnette, Hurd, and Michaud (2017) showed that misperceptions of mortality risk can lead to welfare losses, and Groneck, Ludwig, and Zimper (2016) and Heimer, Myrseth, and Schoenle (2019) showed that pessimistic survival beliefs at younger ages and optimistic beliefs at older ages explain, respectively, undersaving before retirement and a slower rate of dissaving after retirement.

We contribute to the first strand of the literature on the sources of inaccurate survival beliefs by providing empirical evidence in support of the hypothesis that individuals with a better knowledge of population life expectancy (PLE) have more accurate survival beliefs. Insights into these sources are important for, e.g., implementing public policy aimed at alleviating potential negative consequences arising from inaccurate survival beliefs. Our findings suggest that informing individuals about population life expectancy could improve their long-term decisions insofar these require knowledge on their survival chances.

Two previous studies suggest that respondents' knowledge of population life expectancy could be associated with their survival beliefs. Elder (2013) found that US respondents' uncertainty in their survival forecasts decreased after having received information on population survival rates. Steffen (2009) combined the elicited beliefs of German respondents on population life expectancy and on their own position relative to it, and his findings suggest that individuals' underprediction of their own remaining lifetime can be related to their underestimation of population life expectancy. Both studies, however, did not provide empirical evidence on the association between individuals' knowledge of population life expectancy and the accuracy of their survival beliefs.

2. Data and descriptive statistics

The raw data of the 1995 and 1996 waves of the DNB Household Survey (DHS) contains information on 9,415 individuals from 3,348 households. The DHS oversampled high-income households, and while this does not invalidate our empirical findings, it warrants caution when extending our conclusions to the general Dutch population. We refer to Alessie, Hochguertel, and van Soest (2002) for a detailed description of the DHS. For respondents who were in both the 1995 and 1996 waves, we have used the 1995 responses to avoid a potential influence of repeated interviewing on response behavior (Lazarsfeld 1940; Sturgis, Allum, and Brunton-Smith 2009). The survey data was supplemented with administrative microdata from the causes of death registry that contains the year of death of Dutch residents who died during the 1995–2018 period (CBS 2020). The largest reduction in sample size was due to the selection of about 20% of respondents who were aged 52–84 in 1995 or aged 53–84 in 1996. Only for these respondents could it be determined whether they died before the target age, for which they provided subjective survival probabilities (see below). Item non-response caused a further sample reduction of about 30%. Our final estimation sample contains information on 1,273 respondents.

Data on the following characteristics displayed in parenthesis (i.e., the sample proportions or means), is available: age at the time of the interview in full years (62.3); marital status (86% married, 6% widowed, 4% divorced, 4% single); level of education

(28% low, 38% medium, 34% high educated)[3]; labor market status (24% employed, 34% not employed, 37% retired, 5% on disability); homeownership (72%); household income tercile; self-reported health (5% in bad health, 37% with chronic illnesses); health behavior (25% smokers, 8% heavy drinkers, 41% with overweight, 4% obese)[4]; and a mood indicator (25% unhappy).

Survival until a certain age is based on mortality information from the death registry that covered the years 1995–2018. Respondents were followed from the year of interview (1995 or 1996) until the end of 2018 or until their death (whichever came first). During the period 1995–2018, 629 (49%) respondents died and their year of death was observed. For our analysis we compared individuals' survival with their survival beliefs to certain ages at the time they were surveyed. These latter beliefs were elicited with subjective survival probabilities (SSPs; Manski 2004) in the DHS using the survey question:

What do you think the chances are that you will live to be T years of age or more?

Here $T \in \{75, 80, 85, 90, 95, 100\}$ is a target age that depends on the respondent's age at the time of the survey. Respondents aged 52–64 reported their SSP to ages 75 and 80; those aged 65–69 reported their SSPs to ages 80 and 85; and those aged 70–74, 75–79, or 80–84, reported their SSPs to ages 85 and 90, 90 and 95, or 95 and 100, respectively. These responses were measured on a 10-point scale, from 0, "no chance at all," to 10, "absolutely certain." Following Hurd and McGarry (1995), we assumed that after having divided these responses by 10, they could be interpreted as survival probabilities, conditional on individuals having reached their current age. Further, following Perozek (2008), we replaced reported the probabilities 0 and 1 by 0.01 and 0.99, respectively, and when equal SSPs were reported, we added 0.05 to the SSP for the lowest target age and subtracted 0.05 from the SSP for the highest target age (about 30% of the cases).[5]

On average, respondents were 62 years of age at the time of the interview and answered the SSP question for a target age of 80 years. Hence, survival beliefs and (actual) survival rate refer, on average, to surviving for at least 18 years. In line with the existing literature, the first three bars from the left of Figure 1 show that respondents, on average, underestimated their survival chances: respondents' survival beliefs were, on average, 22% (16pp) lower than their survival rate (56% vs 72%).

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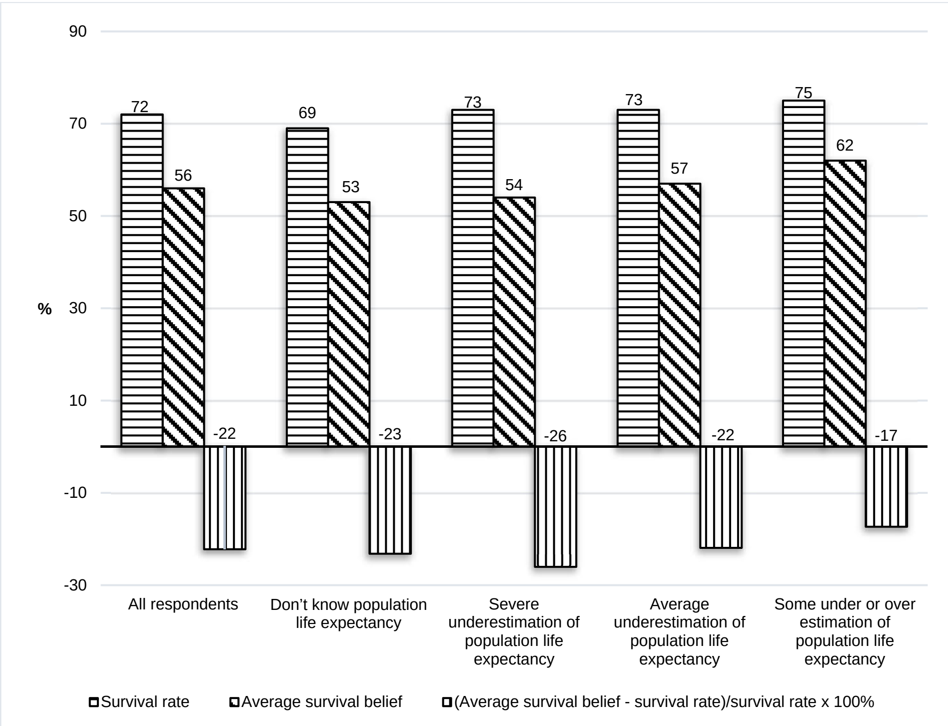
[3] Low educated: at most a lower vocational training; Medium educated: higher secondary or intermediate vocational education; High educated: at least a higher vocational or university degree.

[4] Heavy drinker: four or more glasses of alcohol a day; Overweight: 25≤ BMI<30; Obese: BMI≥30.

[5] Perozek (2008) performed sensitivity checks concerning these assumptions; Kleinjans and Van Soest (2014) showed that accounting for rounding and 50% focal point answers does not affect the coefficient estimates of the determinants of SSPs; and the reliability of SSPs was confirmed by de Bresser (2019).

Figure 1: Respondents' survival beliefs and (actual) survival rate by degree of knowledge of population life expectancy



Notes: Survival belief and survival rate refer, on average, to surviving for at least another 18 years. With PLE=Population life expectancy, DK-PLE= Don't know PLE, and PLE-knowledge= knowledge of PLE (see Section 2), severe underestimation of population life expectancy is defined, for those with DK-PLE=0, as PLE-knowledge<-8, average underestimation as -8 ≤ PLE-knowledge ≤ -6, and some under- or overestimation as PLE-knowledge ≥ -5 (see also Figure 2),. Only about 2% of respondents overestimated population life expectancy and this group is too small for considering it separately. At the top of the bars are the percentages.

The DHS survey also asked two questions about population life expectancy, at a certain age, in the Netherlands. The first question was:

For people of your age and sex there is an average life expectancy. Do you have any idea what age people of your age and sex reach on average?

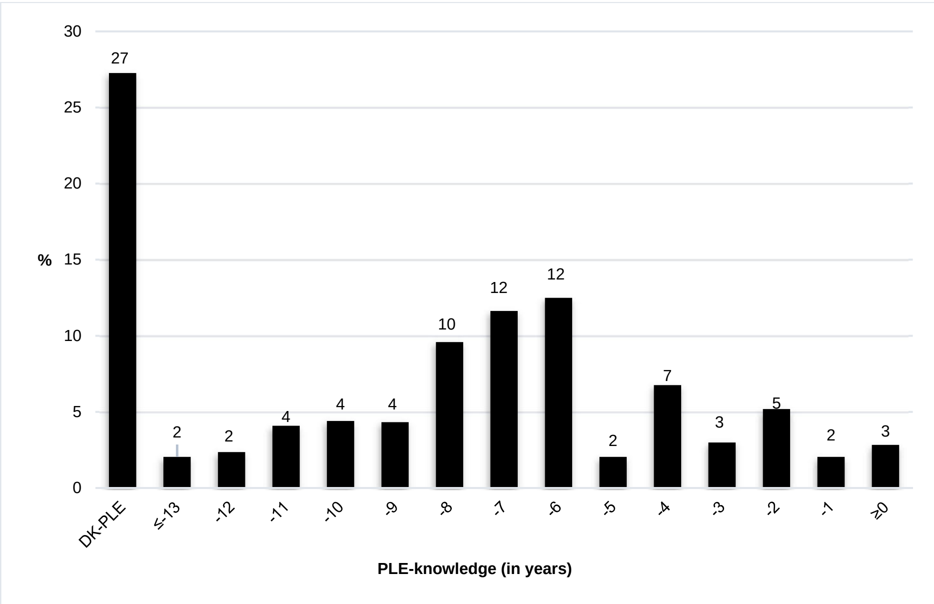
The variable DK–PLE takes the value one if the respondent answered no to this question, and zero otherwise. To 73% of the respondents who answered they know about population life expectancy (DK–PLE = 0), the following question was asked to elicit their knowledge of population life expectancy:

What age do you think people of your age and sex reach on average?

The reported ages in this second question were compared to the corresponding actuarial population life expectancy from age and gender specific cohort life tables (Royal Dutch Actuarial Association 2019). These life tables contain actual mortality rates until 2012 and predicted mortality rates from 2012 until 2062. Based on these tables, all men in our sample were expected to live at least until the age of 81, while only 6% of the men in our sample, in answering the second question, gave 81 years or more as the population life expectancy. This latter percentage equaled 8% when the DKs were excluded (when DK–PLE = 1). Hence, most men believed the population life expectancy for men of their age to be lower than the actuarial one. For women, the finding is similar: based on life tables, all women in our sample were expected to live until the ages 85–90, while only 6% believed this to be the case (8% when excluding the DKs). For the empirical analysis, we used the difference between the reported and actuarial population life expectancy as a measure of respondents' knowledge of population life expectancy for people of their age and gender (variable PLE-knowledge, measured in full years). There is considerable variation in the degree of underestimation of population life expectancy, which is, on average, about 6 years (Figure 2). Not reported in this figure, is that less than 1% of the respondents had this age exactly right (PLE–knowledge = 0 when DK–PLE = 0).

In Figure 1, the three sets of bars from the right present prima facie evidence on the relation between PLE-knowledge and individuals' accuracy regarding their survival beliefs. Only, for this figure we grouped PLE-knowledge into three categories (defined in the figure's footnote). Respondents who answered they have no knowledge of population life expectancy (DK–PLE = 1), on average reported a 23% lower survival belief than their survival rate; an underestimation which is about the same as for respondents with average PLE-knowledge (penultimate set of bars). Compared to those who severely underestimated population life expectancy, respondents with some over- or underestimation of population life expectancy (ultimate set of bars) had, on average, a smaller difference between their survival belief and survival rate (–17% vs –26%). In sum, the main insight Figure 1 represents is that individuals with a better knowledge of population life expectancy have, on average, more accurate survival beliefs.

Figure 2: The variable PLE-knowledge: Respondents' knowledge of population life expectancy minus actuarial population life expectancy



Notes: DK-PLE = Don't know population life expectancy (DK-PLE=1). PLE-knowledge is conditional on DK-PLE=0. At the top of the bars are the percentages. Population life expectancy is conditional on the age at interview and the gender of the respondent.

3. Empirical analysis

The empirical analysis quantifies the positive association suggested in Figure 1 between respondents' knowledge of population life expectancy and the accuracy of their survival beliefs. Following previous empirical studies on individual mortality, we modelled lifetime with a Gompertz distribution (Cox 1972; Gompertz 1825; Olshansky and Carnes 1997; Perozek 2008). Mortality risk models were estimated using data on individuals' survival over the period 1995–2018 and data on SSPs for their survival beliefs. These models control for individual characteristics such as gender, socioeconomic status, and health behavior, which can be correlated with PLE-knowledge and related to survival or survival belief (e.g., Cutler, Deaton, and Lleras-Muney 2006, 2011; Delavande and Rohwedder 2011; Grevenbrock et al. 2020; Hurd and McGarry 2002; Kalwij, Alessie, and Knoef 2013; Kutlu Koc and Kalwij 2017).

The associations between the covariates and annual mortality belief (see Table 1, right columns) are in line with previous findings, especially in terms of health characteristics, such as having bad health, chronic illnesses, smoking and drinking alcohol (e.g., Teppa 2012; Bissonnette, Hurd, and Michaud 2017). Not separately reported, the finding of no associations between socioeconomic status and the annual mortality rate (see Table 1, left columns) − an association usually found to be negative (e.g., Kalwij, Alessie, and Knoef 2013) − emerged once health-related characteristics were controlled for (see also Kutlu Koc and Kalwij 2017). In line with previous findings, the estimated age gradient in the mortality rate was steeper than the one in mortality belief, and the lower mortality rate for women – compared to the one for men – was not matched with, on average, a relatively lower mortality belief by women (Kutlu Koc and Kalwij 2017).

The empirical findings concerning PLE-knowledge are in support of no association with the annual mortality rate (see Table 1, left columns), and a negative association with annual mortality belief (right columns). Individuals who did not know population life expectancy (DK–PLE = 1) had, on average, about a 21% higher annual mortality belief than individuals who knew their population life expectancy exactly (PLE-knowledge = 0 and DK–PLE = 0). Compared to this latter group, individuals who reported a population life expectancy of one-year lower than the correct one, had, on average, a 3% higher annual mortality belief. Hence, the less individuals' underestimated population life expectancy, the higher, on average, were their survival beliefs.

Table 2, Panel A, shows that the predicted lifetime based on survival data – i.e., based on the results in the left columns of Table 1 – is about 88 years for a male reference individual. This predicted lifetime is almost seven years lower, at about 81 years, when based on data on survival beliefs – i.e., the results in the right columns of Table 1. The empirical evidence suggests that the degree of this underprediction does not vary with most individual characteristics, with only a few exceptions, that are in line with previous studies (Panel B). This underprediction was for women, on average, about five years more than for men. Furthermore, on average, smokers and obese individuals underpredicted their lifetime less than, respectively, non-smokers and individuals with normal weight (BMI<25). The individuals who reported as being in bad health underpredicted their lifetime more than those not in bad health.

Table 1: Estimated marginal changes in the annual mortality belief, using data on survival beliefs, and in the annual mortality rate, using data on (actual) survival, with changes in the covariates

Cells: Marginal changes (percentage changes)	Annual mortality rate		Annual mortality belief	
Covariates	Coef.	(Std. Err.)	Coef.	(Std. Err.)
Female (vs male)	–42.65	(7.70)	9.88	(2.14)
Age gradient (a one-year increase)	12.68	(0.68)	7.23	(0.23)
Age at interview (a one-year increase)	4.71	(10.11)	0.11	(2.10)
Knowledge of population life expectancy (PLE)				
Does not know PLE, DK–PLE = 1 (vs. DK–PLE = 0)	6.51	(13.90)	20.90	(3.42)
PLE-knowledge (conditional on DK–PLE = 0) (a one-year increase)	–0.23	(1.38)	–3.03	(0.27)
Socioeconomic status				
Low educated (vs medium educated)	7.26	(11.11)	1.07	(2.03)
High educated (vs medium educated)	4.72	(11.89)	0.30	(2.11)
Not employed (vs employed)	8.38	(20.21)	1.00	(3.75)
Retired (vs employed)	14.74	(18.30)	18.25	(4.43)
On disability (vs employed)	49.01	(30.85)	4.37	(6.01)
Homeowner (vs renter)	–7.87	(9.05)	1.71	(1.92)
Low household income (vs medium income)	6.42	(14.27)	–12.04	(2.39)
High household income (vs medium income)	–9.64	(10.00)	1.74	(2.19)
Divorced (vs married)	–6.38	(23.31)	–26.22	(3.86)
Widowed (vs married)	–6.05	(13.84)	–14.71	(2.43)
A single person (vs married)	–0.84	(22.09)	16.86	(3.50)
Health or health behavior				
Smoker (vs non-smoker)	89.23	(17.05)	14.99	(2.31)
Heavy drinker (vs no heavy drinker)	46.11	(19.80)	23.60	(3.63)
Overweight (vs normal body weight)	7.60	(9.87)	0.08	(1.77)
Obese (vs normal body weight)	49.50	(26.32)	–11.64	(2.61)
Has a chronic illness (vs has no chronic illness)	34.73	(12.49)	20.28	(2.42)
In bad health (vs in good health)	33.97	(23.13)	73.68	(3.52)
Feels unhappy (vs feels happy)	31.78	(15.63)	17.29	(2.38)
Number of individuals	1,273		1,273	
Test results	p-value		p-value	
H_0: No associations with knowledge of PLE	0.863		0.000	
H_0: No associations with socioeconomic status	0.285		0.000	
H_0: No associations with health (behavior)	0.000		0.000	

Notes: PLE = population life expectancy (DK–PLE or PLE-knowledge; see Figure 2). Based on estimates of mortality risk models (section 3). A marginal change is the percentage difference in the annual mortality rate, or in the annual mortality belief, compared to a reference individual. The reference individual is a 55-year-old male (at the time of interview); medium educated; employed; married; with medium household income; a non-smoker; not a heavy drinker; has a normal body weight; with no chronic illnesses; feels happy; and reports as being in good health. All covariates affect the annual mortality rate proportionally.

Individuals with better knowledge of population life expectancy had, on average, relatively more accurate beliefs regarding their lifetimes (Panel C). Individuals who answered they do not know population life expectancy, underpredicted lifetime, on average, about the same as the reference group, which consists of 55-year-old individuals who underestimated population life expectancy by six years (PLE-knowledge = –6). Furthermore, individuals who knew population life expectancy exactly, underpredicted their lifetime less than the reference group by, on average, almost two years (95% CI:

0.55–3.20). Finally, in terms of marginal changes, the last row of Panel C shows that 55-year-old individuals who had one-year of better knowledge of population life expectancy, underpredicted their lifetime with, on average, about 0.3 years less (95% CI: 0.09–0.52). These main findings are by and large robust to different sample selections (see Appendix).

Table 2: Predicted lifetimes based on the estimation results of Table 1, and the estimated marginal changes in the accuracy of predicted lifetime based on survival beliefs, in years, due to changes in the socioeconomic status, health-related covariates, and knowledge of population life expectancy

	Coef.	(Std. Err.)
Panel A: Predictions for a reference individual [a]		
Predicted lifetime based on survival beliefs (*SL*), in years	81.12	(0.46)
Predicted lifetime based on survival (*OL*), in years	87.85	(1.52)
Accuracy of survival beliefs (*SL–OL*), in years	–6.73	(1.62)
Panel B: Marginal changes in the accuracy of survival beliefs *(SL–OL)*		
Female (vs male)	–5.23	(1.04)
Age at interview (a one-year increase)	0.03	(0.08)
Low educated (vs medium educated)	0.41	(0.84)
High educated (vs medium educated)	0.32	(0.92)
Not employed (vs employed)	0.48	(1.48)
Retired (vs employed)	–0.74	(1.28)
On disability (vs employed)	2.52	(1.74)
Homeowner (vs renter)	–0.81	(0.80)
Low household income (vs medium income)	1.85	(1.09)
High household income (vs medium income)	–0.96	(0.90)
Divorced (vs married)	2.80	(2.16)
Widowed (vs married)	1.25	(1.24)
Single person (vs married)	–1.70	(1.71)
Smoker (vs non-smoker)	3.29	(0.76)
Heavy drinker (vs no heavy drinker)	0.63	(1.08)
Overweight (vs normal body weight)	0.54	(0.74)
Obese (vs normal body weight)	4.34	(1.42)
Has a chronic illness (vs has no chronic illness)	0.31	(0.74)
In bad health (vs in good health)	–3.42	(1.35)
Unhappy (vs feels happy)	0.41	(0.93)
Panel C: Marginal changes in the accuracy of survival beliefs *(SL–OL), due to a change in knowledge of population life expectancy (PLE)*		
Does not know PLE (vs reference individual)	0.30	(0.78)
Knows PLE exactly (vs reference individual)	1.87	(0.68)
Knows PLE & underestimates it with 6 years (reference individual)	0.00	(–)
Knows PLE & underestimates it with 5 years (vs reference individual)	0.31	(0.11)

[a] See notes of Table 1.

4. Conclusion

Our empirical findings support the hypothesis that individuals with a better knowledge of population life expectancy have more accurate survival beliefs. Future research may examine if survival beliefs' inaccuracies are not only associated with but also caused by (insufficient) knowledge of population life expectancy. For instance, by using an experimental setup in which respondents are given, at random, information on population life expectancy. With such a setup, one can investigate whether a policy intervention aimed at improving this knowledge can help individuals form more accurate survival beliefs and, ultimately, make better long-term decisions that require knowledge on their survival chances.

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Appendix

Table A-1: Robustness checks of the estimates of Panel C, Table 2

Cells: Marginal changes the accuracy of survival beliefs *(SL–OL)*.	Coef.	(Std. Err.)
Specification I: Instead of a linear relationship between PLE-knowledge and (log-)mortality rate, a nonlinear relationship using a spline function with knots at -12 and 0 years.[a)]		
Does not know PLE (vs reference individual)	0.45	(0.81)
Knows PLE exactly (vs reference individual)	3.33	(1.24)
Knows PLE & underestimates it with 6 years (reference individual)	0.00	(–)
Knows PLE & underestimates it with 5 years (vs reference individual)	0.35	(0.14)
Specification II: Influence of possible outliers. Dropped 56 observations with PLE-knowledge <-12 or >0		
Does not know PLE (vs reference individual)	0.49	(0.79)
Knows PLE exactly (vs reference individual)	2.77	(0.89)
Knows PLE & underestimates it with 6 years (reference individual)	0.00	(–)
Knows PLE & underestimates it with 5 years (vs reference individual)	0.45	(0.15)
Specification III: Influence of not knowing population life expectancy. Dropped 347 individuals with DK–PLE=1.		
Does not know PLE (vs reference individual)		
Knows PLE exactly (vs reference individual)	1.99	(0.65)
Knows PLE & underestimates it with 6 years (reference individual)	0.00	(–)
Knows PLE & underestimates it with 5 years (vs reference individual)	0.33	(0.11)
Specification IV: By gender, only women (551 observations; 228 died) [b)]		
Does not know PLE (vs reference individual)	-0.04	(1.23)
Knows PLE exactly (vs reference individual)	0.86	(1.25)
Knows PLE & underestimates it with 6 years (reference individual)	0.00	(–)
Knows PLE & underestimates it with 5 years (vs reference individual)	0.14	(0.21)
Specification V: By gender, only men (722 observations; 401 died) [b)]		
Does not know PLE (vs reference individual)	0.38	(1.05)
Knows PLE exactly (vs reference individual)	2.97	(0.92)
Knows PLE & underestimates it with 6 years (reference individual)	0.00	(–)
Knows PLE & underestimates it with 5 years (vs reference individual)	0.49	(0.15)

Note: See note of Table 2.
[a)] Furthermore, there is no empirical support for a quadratic relationship.
[b)] For these results, all mortality risk models were estimated by gender. Arguably, sample size, or rather the number of deaths, matters for the precision of the results for women. Results not reported show a large and imprecisely estimated association of PLE-knowledge with the annual mortality rate, while the association with annual mortality belief is in line with that of Table 1.