

# **Predictors of Exceptional Longevity: Effects of early-life childhood conditions, mid-life environment and parental characteristics**

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# Approach

**To study “success stories” in long-term avoidance of fatal diseases (survival to 100 years) and factors correlated with this remarkable survival success**

# An example of incredible resilience

Winnie ain't quitting now.

THE SUN, Tuesday, August 28, 2007



**LIFE'S A DRAG**

**Winnie, 100  
smokes for  
93 YEARS  
and she ain't  
quitting now**

Wartime memories... Winnie had her first cigarette in 1914

By GARETH DORRIAN

DEFIANT smoker Winnie Langley celebrates reaching 100 yesterday — by lighting her 170,000th cigarette from a candle on her birthday cake.

The newspaper article features a large black and white photograph of an elderly woman, Winnie Langley, wearing glasses and holding a lit cigarette. In front of her is a birthday cake with three lit candles. To the right of the main photo is a smaller inset photo showing a young girl, presumably Winnie as a child, standing on a train platform and waving to a man. The text of the article is arranged around these images, with the headline 'LIFE'S A DRAG' at the top left and the sub-headline 'Winnie, 100 smokes for 93 YEARS and she ain't quitting now' to the right. A byline 'By GARETH DORRIAN' is located below the main photo, and a short paragraph describing the event is at the bottom left. A small caption for the inset photo is at the bottom right.

Smith G D Int. J. Epidemiol. 2011;40:537-562

# Exceptional longevity in a family of Iowa farmers

- Father: Mike Ackerman, Farmer, 1865-1939 lived 74 years
  - Mother: Mary Hassebroek 1870-1961 lived 91 years
- 
1. Engelke "Edward" M. Ackerman b: 28 APR 1892 in Iowa **101**
  2. Fred Ackerman b: 19 JUL 1893 in Iowa **103**
  3. Harmina "Minnie" Ackerman b: 18 SEP 1895 in Iowa **100**
  4. Lena Ackerman b: 21 APR 1897 in Iowa **105**
  5. Peter M. Ackerman b: 26 MAY 1899 in Iowa 86
  6. Martha Ackerman b: 27 APR 1901 in IA 95
  7. Grace Ackerman b: 2 OCT 1904 in IA **104**
  8. Anna Ackerman b: 29 JAN 1907 in IA **101**
  9. Mitchell Johannes Ackerman b: 25 FEB 1909 in IA 85

**Studies of centenarians  
require careful design and  
serious work on age  
validation**

**The main problem is to find an  
appropriate control group**

# Approach

- **Compare centenarians and shorter-lived controls, which are randomly sampled from the same data universe: computerized genealogies**

# Approach used in this study

- Compare centenarians with their peers born in the same year but died at age 65 years
- It is assumed that the majority of deaths at age 65 occur due to chronic diseases related to aging rather than injuries or infectious diseases (confirmed by analysis of available death certificates)

# Case-control study of longevity

**Cases** - 765 centenarians survived to age 100 and born in USA in 1890-91

**Controls** – 783 their shorter-lived peers born in USA in 1890-91 and died at age 65 years

**Method:** Multivariate logistic regression

Genealogical records were linked to 1900 and 1930 US censuses providing a rich set of variables



# **Age validation is a key moment in human longevity studies**

- **Death dates of centenarians were validated using the U.S. Social Security Death Index**
- **Birth dates were validated through linkage of centenarian records to early U.S. censuses (when centenarians were children)**

# A typical image of 'centenarian' family in 1900 census

|               |          |   |   |     |      |     |   |    |   |   |
|---------------|----------|---|---|-----|------|-----|---|----|---|---|
| Ross, William | Head     | M | M | May | 1872 | 28  | M | 10 |   |   |
| —, Lizzie     | Wife     | M | F | Nov | 1876 | 23  | M | 10 | 5 | 4 |
| —, William A. | Son      | M | M | Aug | 1891 | 8   | M |    |   |   |
| —, Daniel     | Son      | M | M | Jan | 1894 | 6   | M |    |   |   |
| —, Virginia   | Daughter | M | F | Dec | 1897 | 2   | M |    |   |   |
| —, Callie     | Daughter | M | F | Oct | 1899 | 1/2 | M |    |   |   |

# **Genealogies and 1900 and 1930 censuses provide three types of variables**

- **Characteristics of early-life conditions**
- **Characteristics of midlife conditions**
- **Family characteristics**

# Early-life characteristics

- **Type of parental household (farm or non-farm, own or rented),**
- **Parental literacy,**
- **Parental immigration status**
- **Paternal (or head of household) occupation**
- **Number of children born/survived by mother**
- **Size of parental household in 1900**
- **Region of birth**

# Midlife Characteristics from 1930 census

- **Type of person's household**
- **Availability of radio in household**
- **Person's age at first marriage**
- **Person's occupation (husband's occupation in the case of women)**
- **Industry of occupation**
- **Number of children in household**
- **Veteran status, Marital status**

# **Family Characteristics from genealogy**

- **Information on paternal and maternal lifespan**
- **Paternal and maternal age at person's birth,**
- **Number of spouses and siblings**
- **Birth order**
- **Season of birth**

# Example of images from 1930 census (controls)

|                 |        |            |              |
|-----------------|--------|------------|--------------|
| Burke Bernard A | Head   | Bookkeeper | Retail cigar |
| — Erica         | Wife # | none       |              |
| — Raymond B     | Son    | none       |              |

|              |          |                |           |
|--------------|----------|----------------|-----------|
| Coy Mace A.  | Head     | superintendent | oil field |
| — Willie J.  | Wife #   | none           |           |
| — M. Lucille | Daughter | none           |           |
| — Billie L.  | Daughter | none           |           |

# Parental longevity, early-life and midlife conditions and survival to age 100. Males

## Multivariate logistic regression, N=714

| Variable                               | Odds ratio  | 95% CI           | P-value          |
|--|-------------|------------------|------------------|
| <b>Father lived 80+</b>                | <b>1.82</b> | <b>1.33-2.50</b> | <b>&lt;0.001</b> |
| <b>Mother lived 80+</b>                | <b>1.97</b> | <b>1.44-2.70</b> | <b>&lt;0.001</b> |
| <b>Farmer in 1930</b>                  | <b>1.80</b> | <b>1.30-2.49</b> | <b>&lt;0.001</b> |
| Age at first marriage                  | 1.01        | 0.99-1.03        | 0.204            |
| <b>Born in North-East</b>              | <b>1.89</b> | <b>1.16-3.10</b> | <b>0.011</b>     |
| <b>Born in the second half of year</b> | <b>1.43</b> | <b>1.05-1.96</b> | <b>0.022</b>     |
| Radio in household, 1930               | 0.92        | 0.67-1.28        | 0.620            |



# Parental longevity, early-life and midlife conditions and survival to age 100

## Women

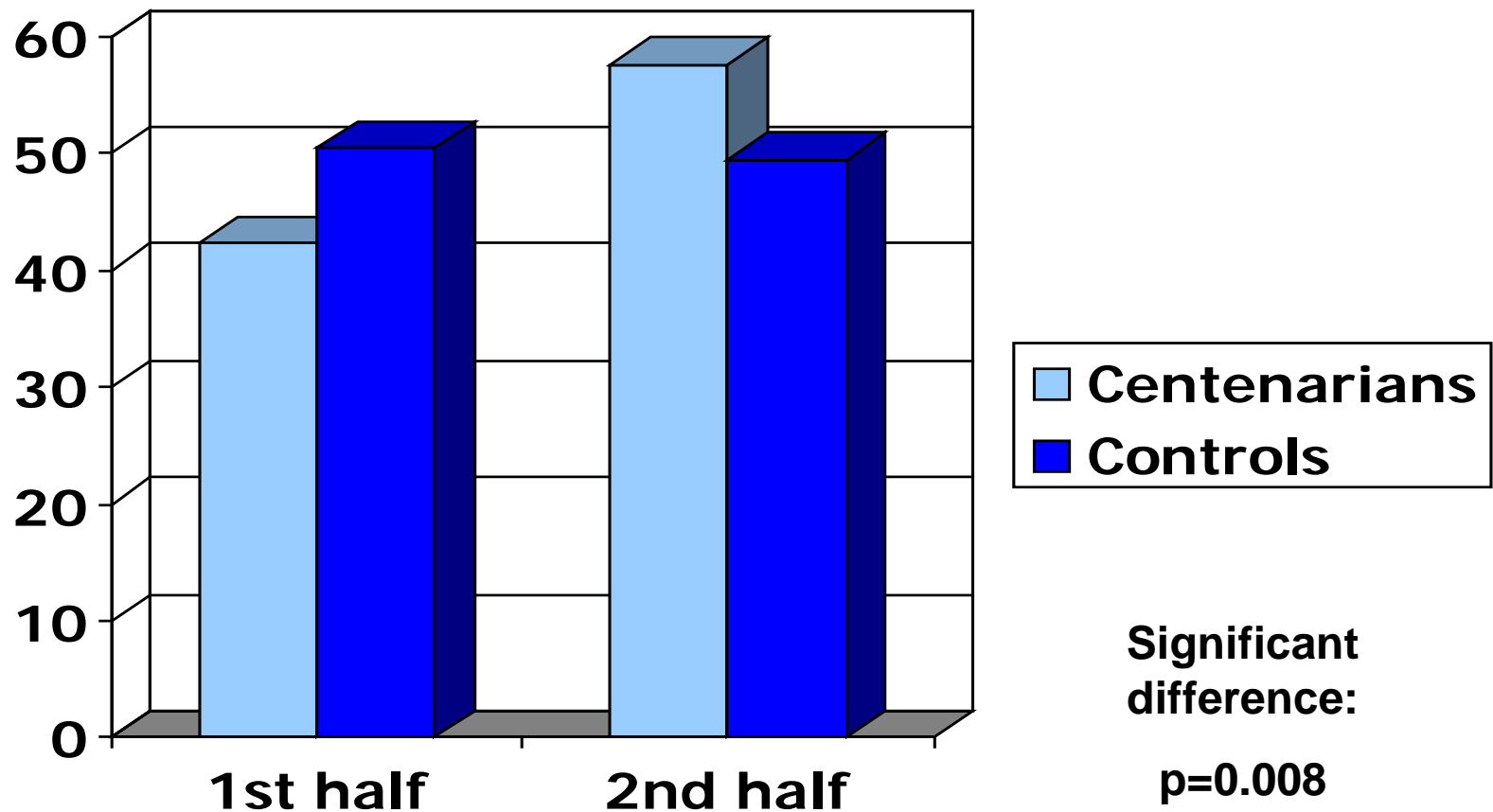
| <b>Multivariate logistic regression, N=750</b> |                   |                   |                  |
|--|-------------------|-------------------|------------------|
| <b>Variable</b>                                | <b>Odds ratio</b> | <b>95% CI</b>     | <b>P-value</b>   |
| <b>Father lived 80+</b>                        | <b>2.04</b>       | <b>1.48-2.81</b>  | <b>&lt;0.001</b> |
| <b>Mother lived 80+</b>                        | <b>2.33</b>       | <b>1.71-3.17</b>  | <b>&lt;0.001</b> |
| Husband farmer in 1930                         | 1.23              | 0.89-1.70         | 0.210            |
| <b>Age at first marriage</b>                   | <b>1.02</b>       | <b>1.001-1.04</b> | <b>0.013</b>     |
| <b>Radio in hh, 1930</b>                       | <b>1.60</b>       | <b>1.16-2.23</b>  | <b>0.005</b>     |
| Born in the second half of year                | 0.99              | 0.69-1.43         | 0.966            |
| Born in North-East                             | 1.02              | 0.62-1.65         | 0.950            |

# **Variables found to be non-significant in multivariate analyses**

- **Parental literacy and immigration status, farm childhood, size of household in 1900, percentage of survived children (for mother), sibship size, father-farmer in 1900**
- **Marital status, veteran status, childlessness**
- **Paternal and maternal age at birth, loss of parent before 1910**

# Season of birth and survival to 100

Birth in the first half and the second half of the year among centenarians and controls died at age 65

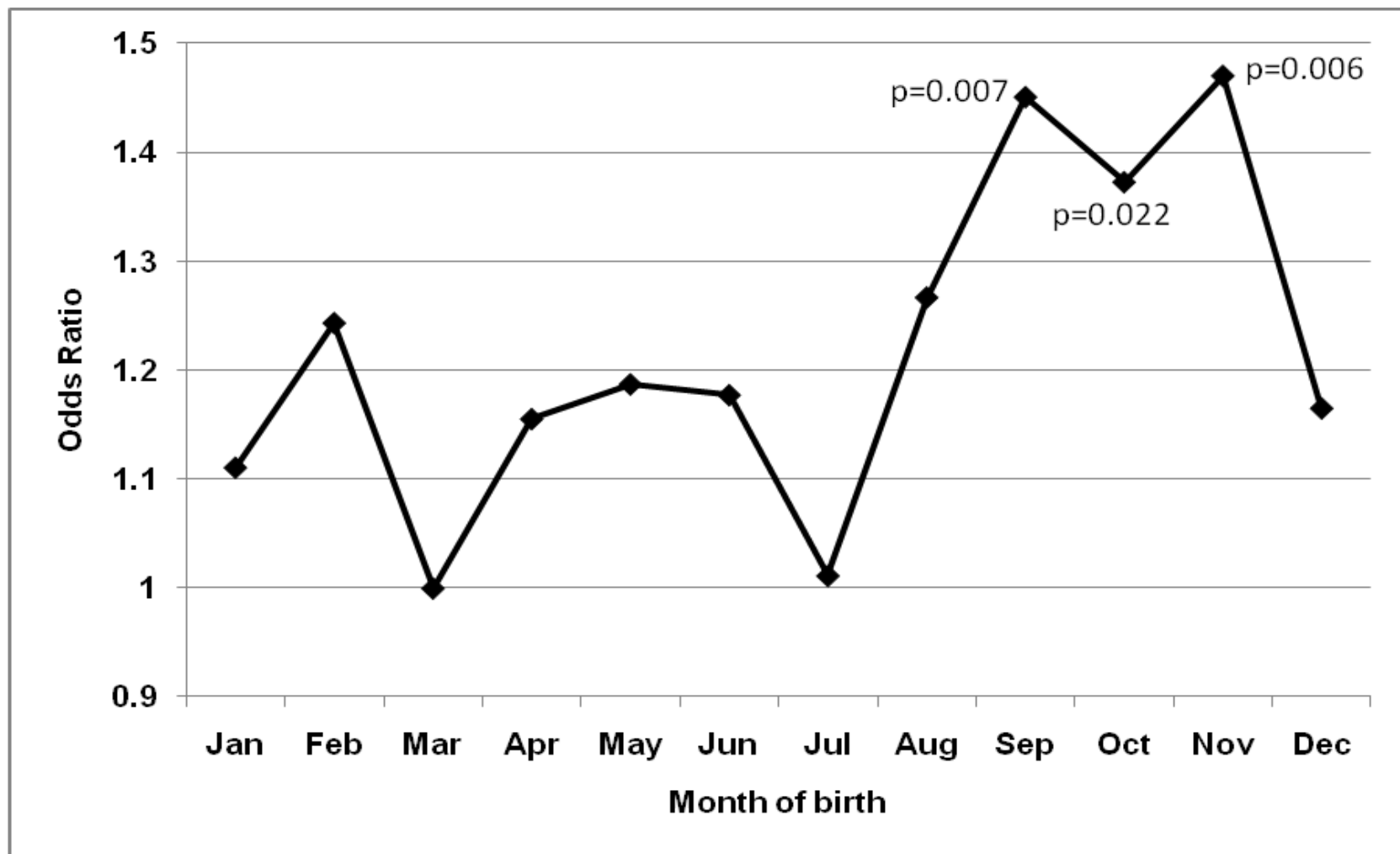


# **Within-Family Study of Season of Birth and Exceptional Longevity**

**Month of birth is a useful proxy  
characteristic for environmental  
effects acting during in-utero  
and early infancy development**

# Siblings Born in September-November Have Higher Chances to Live to 100

Within-family study of 9,724 centenarians born in 1880-1895 and their siblings survived to age 50



# Possible explanations

These are several explanations of season-of-birth effects on longevity pointing to the effects of early-life events and conditions:

- **seasonal exposure to infections,**
- **nutritional deficiencies,**
- **environmental temperature and sun exposure.**

All these factors were shown to play role in later-life health and longevity.

# Conclusions

- Both midlife and early-life conditions affect survival to age 100
- Parental longevity turned out to be the strongest predictor of survival to age 100
- Information about such an important predictor as parental longevity should be collected in contemporary longitudinal studies

# **Study of biological and non-biological relatives of centenarians**

- **Numerous studies showed that biological relatives of centenarians have substantial survival advantage compared to biological relatives of shorter-lived individuals**



# Who lives longer in centenarian families? Siblings > Spouses > Siblings-in-law

Relatives of 1,711 centenarians born in 1880-1895

| Relatives:           | Men  |       | Women |       |
|----------------------|------|-------|-------|-------|
|                      | N    | LS50* | N     | LS50* |
| Parents              | 1590 | 76.2  | 1557  | 77.2  |
| Spouses              | 877  | 75.4  | 283   | 81.4  |
| Siblings             | 5324 | 77.6  | 4877  | 82.4  |
| Siblings in law      | 2363 | 75.1  | 2410  | 79.5  |
| 1900 US birth cohort |      | 73.3  |       | 79.4  |

\*Mean lifespan conditional on survival to age 50

# **Little is known about effects of centenarian's sex on longevity of relatives**

**In this study effects of centenarian's  
sex were used to explore genetic and  
environmental effects on longevity**

# Dataset

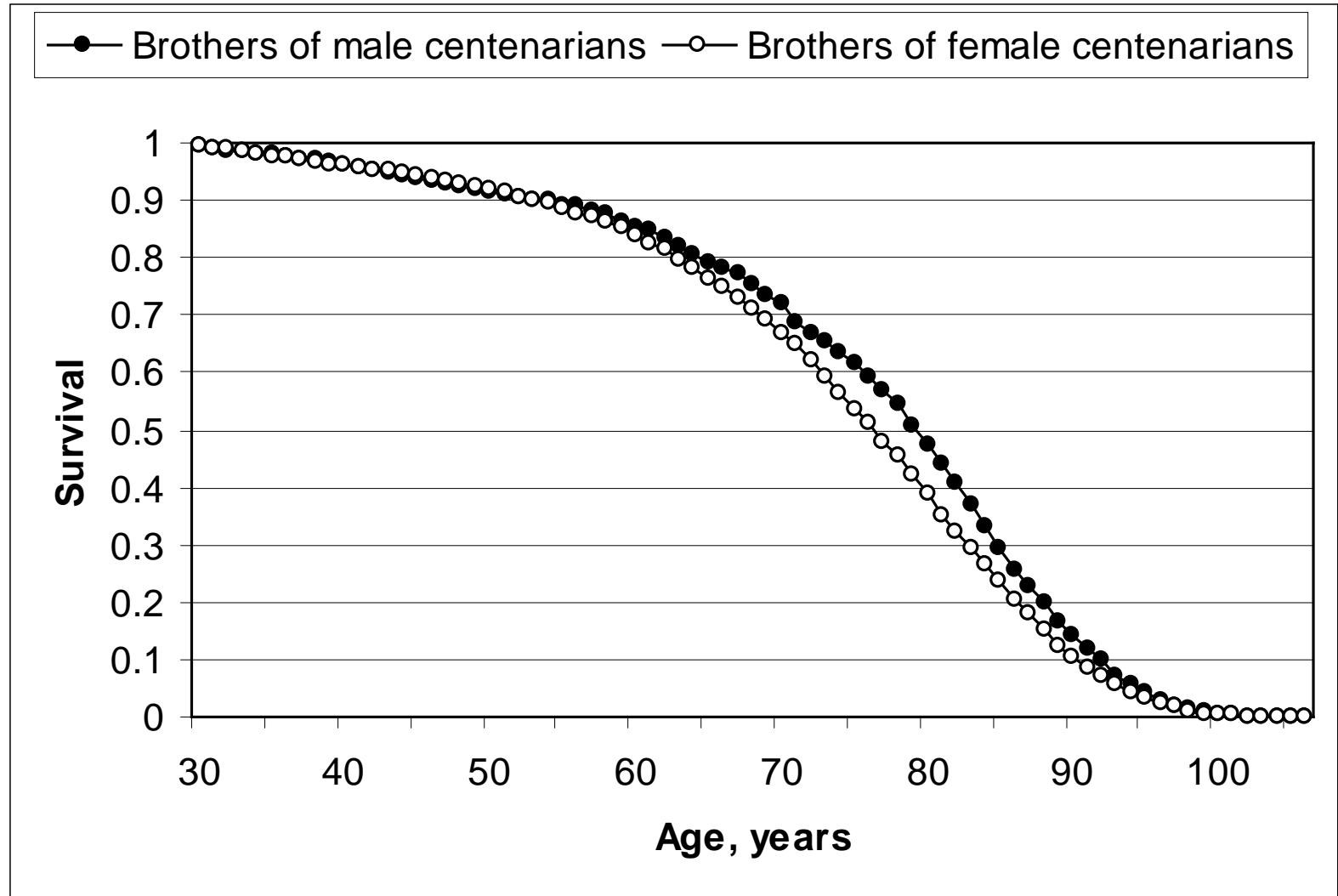
**We have developed and analyzed a new computerized database on 1,711 validated centenarians born in 1880-1895 in the the United States, their parents and 13,185 shorter-lived siblings.**

# Having centenarian brother is 'better' than centenarian sister (for males only)

| Siblings of centenarians | Male centenarians |       | Female centenarians |       | P-value |
|--------------------------|-------------------|-------|---------------------|-------|---------|
|                          | N                 | LE50  | N                   | LE50  |         |
| Brothers                 | 1268              | 29.25 | 4056                | 27.09 | <0.001  |
| Sisters                  | 1071              | 32.06 | 3806                | 32.45 | 0.328   |

Life expectancy of siblings at age 50 depending on the sex of centenarian

# Survival of male siblings of centenarians, by sex of centenarian



# Having centenarian son is 'better' than centenarian daughter (for fathers only)

|                | Male centenarians |              | Female centenarians |              | P-value      |
|----------------|-------------------|--------------|---------------------|--------------|--------------|
|                | N                 | LE50         | N                   | LE50         |              |
| <b>Fathers</b> | <b>374</b>        | <b>27.22</b> | <b>1216</b>         | <b>25.93</b> | <b>0.023</b> |
| Mothers        | 362               | 27.97        | 1195                | 27.03        | 0.176        |

Life expectancy of parents at age 50 depending on the sex of centenarian

# **Using siblings-in-law as a control group**

**Siblings-in-law do not share genetic background and living conditions with centenarians**

**On the other hand, they usually come from a similar socio-economic background, so may be a good control group**

# Sex of centenarian is important for siblings but not for siblings-in-law

| Married relatives: | Male centenarians |              | Females centenarians |              | P-value          |
|--------------------|-------------------|--------------|----------------------|--------------|------------------|
|                    | N                 | LE50         | N                    | LE50         |                  |
| <b>Brothers</b>    | <b>784</b>        | <b>29.53</b> | <b>2437</b>          | <b>27.12</b> | <b>&lt;0.001</b> |
| <b>Sisters</b>     | <b>650</b>        | <b>31.36</b> | <b>2378</b>          | <b>32.40</b> | <b>0.045</b>     |
| Brothers in law    | 492               | 24.95        | 1857                 | 25.06        | 0.846            |
| Sisters in law     | 611               | 29.22        | 1796                 | 29.55        | 0.539            |

Life expectancy of relatives at age 50 depending on the sex of centenarian



## Only women benefit from having centenarian spouse

|                                    | Centenarian spouses |              | Sibling spouses |              | P-value      |
|------------------------------------|---------------------|--------------|-----------------|--------------|--------------|
| Sex of spouse                      | N                   | LE50         | N               | LE50         |              |
| Men                                | 875                 | 25.40        | 2349            | 25.04        | 0.411        |
| Men (married to 103+ centenarians) | 214                 | 25.36        | 2349            | 25.04        | NS           |
| <b>Women</b>                       | <b>283</b>          | <b>31.40</b> | <b>2407</b>     | <b>29.46</b> | <b>0.007</b> |

Life expectancy of spouses at age 50 depending on the sex of centenarian

# Conclusion

**Familial factors in human longevity are likely to be sex-specific.**

**Exploring complex environmental and genetic effects in longevity could be facilitated by further analysis of sex-specific effects**

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