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## The risk of cancer in the offspring and parental length of life



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### ABSTRACT

**Background:** We investigated if cancer onset in offspring is related to having short-lived parents for different cancer types and to see if there was a difference in smoking- and non-smoking related cancers. **Methods:** Our study included 524,391 individuals born in Norway 1940–1950. All children were followed up for cancer from the age of 20 until they were between 59 and 69 years. Parental longevity was examined by grouping parental age of death into parents dying before 75 years of age and parents dying at 75 years of age or older.

**Results:** An increased risk of 1.14 (95%CI = 1.10–1.19) among male offspring and 1.08 (95%CI = 1.04–1.12) among female offspring was observed for total cancer when both parents died before the age of 75 compared to offspring with two long-lived parents. The highest increase was found for cancer in the lungs and trachea for both male (HR = 1.67, 95%CI = 1.50–1.86) and female offspring (HR = 1.53, 95%CI = 1.33–1.76). For other smoking-related cancers, the risk was lower. No increased risk was observed for non-smoking-related cancers.

**Conclusion:** Offspring of long-lived parents have lower risk of developing cancer compared with offspring of short-lived parents. Intergenerational transmission of risk factors from parents to offspring may play an important role, especially for tobacco-related cancers. However, genetic factors cannot be ruled out, since consistent evidence has implicated genetic factors in smoking behaviour.

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## 1. Introduction

Long-lived parents tend to have long-lived children. The reason may include both genetic and environmental factors although studies have not been able to distinguish between these two sets of factors [1,2]. Twin studies show moderate heritability of longevity [3]. Advantages among offspring of long-lived parents have also been reported for some chronic diseases, such as cardiovascular diseases and diabetes [1–3]. Less is done in terms of investigating whether these advantages also apply to cancer. Terry et al. [4] found 71% lower risk of cancer-specific mortality in offspring of parents 100 years old or older. Dutta et al. [5] studied incidence and overall mortality. They reported lower cancer incidence among

offspring with one or two long-lived parents compared with parents living shorter. Atkins et al. studied parental longevity and cancer subtypes and found that combined parental longevity was associated with lower cancer mortality and incident cancer risk, especially lung cancer. They found no association with incident colorectal, prostate or breast cancer [6]. It is well known that many cancers aggregate in families, and that the patterns of familial cancer recurrence among distant relatives is suggesting that genetic mechanisms may explain much of the familiarity of cancer [7].

Common environmental factors including unhealthy shared lifestyles, e.g. tobacco smoking, may also play a role in the association of parental life span and health among offspring.

Intergenerational transmission through shared environment is grounded on the assumption that most youths grow up in the same type of environments as their parents. That could be intergenerational transmission of socioeconomic environment and transmission of risk factors such as substance use and smoking [8,9]. A

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strong association between tobacco smoking and human cancer, most notably lung cancer, is known since 1950 [10]. Experimental studies provide evidence that a number of different substances in tobacco smoke induce a variety of mutations that contribute to cancer development [11]. Smoking habits within families in turn may influence the incidence of chronic disease and premature death.

The aim of this study was to examine whether the onset of different site cancers before the age of 70 is associated with having short-lived parents. We further wanted to investigate if associations differed in cancer sites more strongly related to smoking and non-smoking related cancers. We assumed that if smoking-related cancer risk among offspring of short-lived parents was higher than among offspring of long-lived parents, it might be more strongly influenced by shared environment factors than for non-tobacco related cancers.

**2. Material and methods**

**2.1. Subjects and data sources**

All persons born alive in Norway in the period 1940–1950 were followed with regard to malignant cancer from the age of 20 to the date of primary cancer diagnosis, emigration, date of death or end of the study in 2009. There was minimal immigration to Norway from outside the other Nordic countries prior to 1970. 98,6% of the subjects included in this study were ethnic Norwegians and 1.3% percent were other Caucasians [12]. Data from The Norwegian Family and Life Course Study were linked to The Norwegian Cancer Registry, The Death Registry and data of educational level in 1990 from Statistics Norway [13,14]. Excluded were offspring with both parents unknown, and those with at least one of the parent dead from external causes (Appendix A).

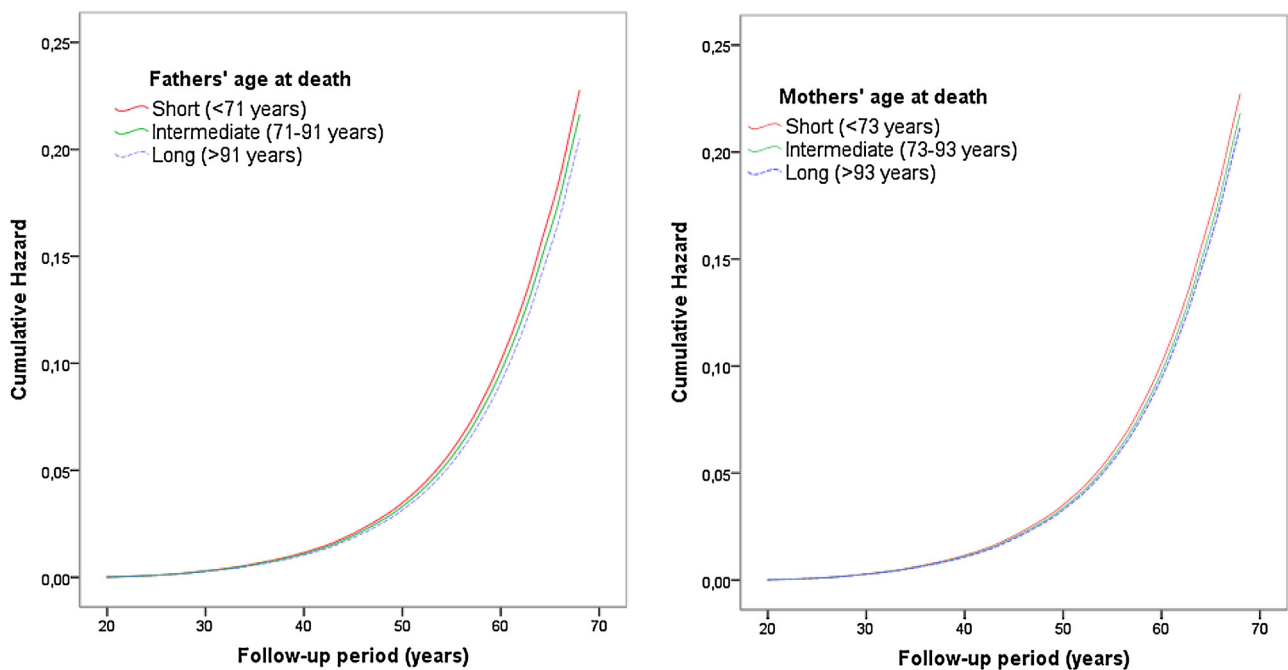
Cancers diagnoses were analyzed in 16 groups of solid cancers [15]. We started the follow up of cancer incidence when all offspring was 20 since we only had access to data on cancer from 1960 and onwards. All children were followed up for cancer from

**Table 1**

Demographic factors in a population-based cohort of children born in Norway 1940–1950.

Variables	No subjects (%)	
Children with information on at least one parent		
Sex		
Male	295,727 (53.2)	
Female	260,238 (46.8)	
Education level		
<10 years	162,470 (29.2)	
10–12 years	272,226 (49.0)	
>12 years	120,961 (21.8)	
Missing	308 (0.1)	
Parents with information		
Education level		
<10 years	356,784 (66.7)	402,374 (71.5)
10–12 years	140,578 (26.3)	142,931 (25.4)
>12 years	36,425 (6.8)	16,455 (2.9)
Missing	1424 (0.3)	808 (0.1)
Age of the parent at birth		
<35 y	318,888 (59.6)	429,834 (76.4)
≥35 y	216,323 (34.4)	132,734 (23.6)
Parental cancer <60 years of age		
Parental birth cohort		
<1906	138,180 (12.6)	
1906–1910	192,884 (17.6)	
1911–1915	275,434 (25.1)	
1916–1920	276,580 (25.2)	
1921–1925	165,686 (15.1)	
1926–1940	49,015 (4.5)	
Parents survival		
Total number of deaths	487,797 (91.1)	406,081 (72.2)
Mean age at death (range)	75.2 (29–107)	78.4 (30–110)
Deaths from external causes (excluded)	4272 (0.8)	6603 (1.6)
Parents alive at the end of the study	47,414 (8.9)	156,487 (27.8)

the age of 20 until they were between 59 and 69 years (their age at end of study in 2009) which corresponded to being born between 1940–1950.



**Fig. 1.** Cumulative hazard curves of the risk of all cancers in the offspring by parental survival. The model is adjusted for sex, parental age at the individual's birth, parental cancer before age 60, parental birth cohort and parental education level summarized by means of relative index of inequalities (RII).

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