An Exponential Model for Melanoma Mortality Trends

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Abstract: Cancer incidence and mortality trends in the Nordic countries show that most cancer types have been increasing for a long time, while a few show decreasing trends. The object of this study was to investigate melanoma mortality trends to see if there is a specific year for the trend breaks, possibly indicating a common causing factor affecting most of the population from the same time. The results clearly show that melanoma mortality started to increase exponentially by the time lived as an adult since 1955 and that the trends easily can be modeled and used for projection purpose. The findings are in support of earlier studies, suggesting reduced or temporarily disturbed DNA repair capacity due to a population-wide environmental change to be the main cause to increasing cancer rates in general, and increasing melanoma incidence and mortality in particular.

Keywords: Melanoma, cancer, mortality, incidence, exponential, model, DNA repair.

INTRODUCTION

Melanoma incidence and mortality have been increasing steadily since mid 20^{th} century. Traditionally, increased sun tanning habits have been blamed as the main cause of this public health problem. However, the mortality has stabilized among younger age groups while continued to increase in an exponential way among the older groups. This fact suggests that the melanoma risk suddenly increased for the whole population and that those younger age groups, having lived all their lives in this new environment, then should be expected to show a mortality level stabilizing at a higher level.

In order to better understand the trends noticed, we wanted to make a trend model considering a specific year for the start of the mortality increase, the exponential function used and the age at which the mortality increase takes action.

METHODS

We conducted a detailed analysis of age-specific melanoma mortality rates from 1952 to the present in order to investigate if a specific trend break year was associated with each age-specific trend line. We further investigated whether such trend break years would identify a specific year from which the whole population of Sweden might have been exposed to new environmental factors that may have increased or decreased cancer rates over time.

Since the initial exponential increase is similar for all age groups, it is easy to create a simple exponential model that applies to all ages using the following key parameters:

- A = age group, e.g. 70-79 years old
- Y_o = the year in which a sudden environmental change occurred
- Y = calendar year
- T = $Y-Y_o$; the number of years since the environmental change; $Y > Y_o$
- P = age from when the environmental change has any effect, e.g. 15 years.
- aA = Mortality in year Y_o for age group A
- b = the slope used in the exponential function for mortality

The mortality M is thus a function of T and A as given by equation (1).

$$M(T, A) = IF(T < A - P;\ aA * \exp(bT);\ aA * \exp(b * (A - P))) \quad (1)$$

In order to test the validity of this approach, we used equation (1) to calculate the age-standardized rates (ASR) of melanoma mortality since 1955. In searching for best fit between calculated and reported rates, we varied the exponential slope factor (b).

RESULTS

Figure **1** shows the result for melanoma mortality in the Nordic countries presented as World standard ASR. The best fit was obtained for b = 0.0347.

When the age-specific rates are compared with the calculated rates using b = 0.0347, the fit turns out to be

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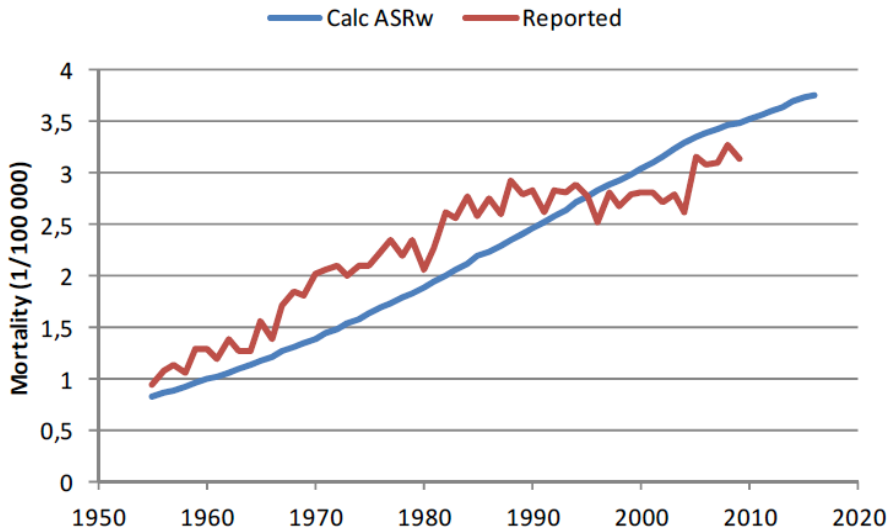

Figure 1: Calculated and reported age-standardized mortality of melanoma in the Nordic countries.

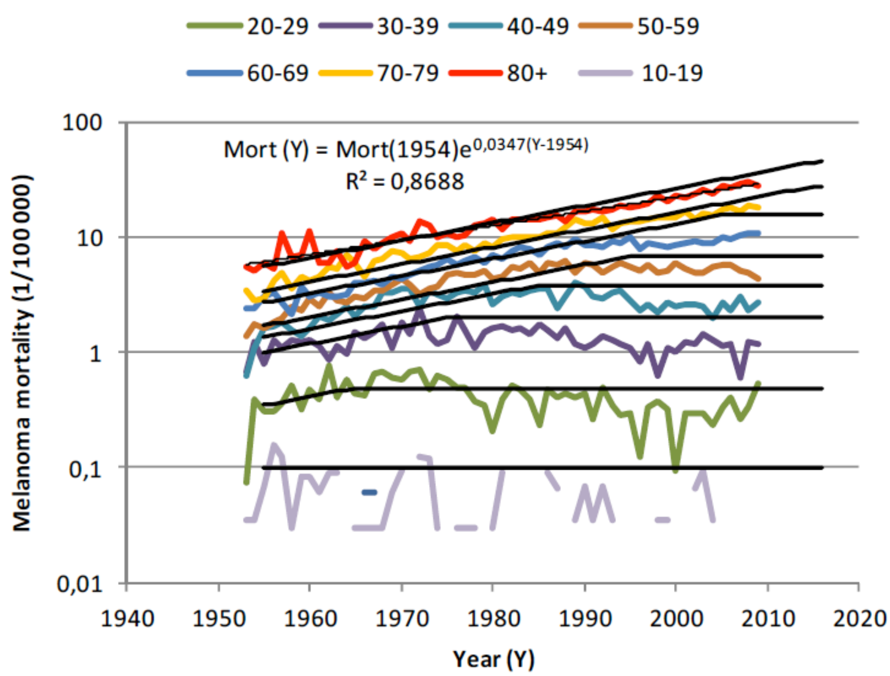

Figure 2: Calculated and reported age-specific melanoma mortality in the Nordic countries.

very good. Figure **2** gives the reported and calculated age-specific mortality of melanoma in the Nordic countries without any further adjustments of model parameters. The trend break point for the 20–29-years-old age group was around 1965; for the 30–39-years-old age group, the trend break point was around 1975, and so forth. The oldest groups have yet to reach their break points.

The mortality rates for melanoma were calculated according to equation (1) using the following parameters: Y_o = 1955; P = 15 years; a_A = reported mortality per age group in 1954; b = 0.0347 for all Nordic countries together. The corresponding slope for Sweden was b = 0,0352.

In this study we used data from the NORDCAN database of the International Agency for the Research of Cancer (IARC) [1].

DISCUSSION

It is clear that all age groups showed a similar exponential increase (similar slope value, b) until the age groups have been living all their adult lives (i.e.

after 15 years of age) since 1955. In 1965 e.g. the 25 year old group had been living all their lives after 15 years of age since 1955. After the break point, the mortality decreases slightly. This is not consistent with the common belief that increasing sun exposure is driving increasing melanoma rates. In Figure **2**, the R^2 –value represents the trend line for the oldest age group, 80+. It should be pointed out that the calculated break point years in Figure **2** are just a logical consequence from the model used, equation (1), while the interpretation of reported data to have similar break points is a conclusion made by the author. Theoretically, it would be easy to find the optimum start age (P) by searching for best fit between calculated and reported age-specific mortality rates. Here, we just used the start age P=15 years without any attempt to fine-tune the calculations.

The exponential increase in melanoma mortality is a strong indicator of a sudden increase in cancer risk due to an environmental change affecting the entire population.

Reduced or temporarily disturbed (e.g. at night) DNA Repair Capacity (DRC) may explain the increasing melanoma mortality trends [3-9], while decreasing mortality trends (as for stomach cancer, for example) suggest that the DRC has improved for some reason. Stomach cancer can also be described by equation (1), although the exponent in that case is negative (b = -0.040).

One environmental factor that appeared in 1955 and afterwards in the Nordic countries is the roll-out of the FM and television broadcasting networks. The body-resonant radiation from FM transmitters has been suggested to affect the DRC [2, 10-11].

This letter highlights the observation that both increasing and decreasing mortality trends of certain cancer types can be modeled using a simple exponential function. We also conclude that younger age groups, A, show stabilizing trend breaks A-15 years after 1955 regarding melanoma mortality. Figure **2** indicates, however, that melanoma mortality among the youngest has been increasing again since 2005 as is also the case regarding melanoma incidence, [12].

Figure **1** shows an 'overshoot' of reported age-standardized mortality compared with calculated data. This is quite similar to what has been noticed for e.g. lung cancer, where old smokers after 1955 had to pay with their lives for all smoke they had been inhaling before 1955 without getting lung cancer at that time.

CONCLUSIONS

This model explains why elderly people show exponentially increasing mortality rates, while younger age groups show stabilizing rates. It also strongly supports the idea that a sudden decrease in cell repair efficiency occurred from 1955 in the Nordic countries. Further research on cancer causing factors is necessary, not only research on cancer curing medications.

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