Effects of age and gender on success and death of mountaineers on Mount Everest

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Increasing numbers of climbers are attempting Mount Everest, the highest mountain on Earth. We compiled interview data and computed the probabilities of summiting and of dying as a function of climber age and gender (2211 climbers, spring season) for the period of 1990–2005. Men and women had similar odds of summiting and of dying. However, climbers older than 40 years have reduced odds of summiting, and those older than 60 years have increased odds of dying, especially when descending from the summit. On Mount Everest, phenotypic selection appears blind to gender but favours young mountaineers.

Keywords: gender differences; hypoxia; mountaineering; senescence

1. INTRODUCTION

Each year approximately 1500 mountaineers venture to the Himalayan peaks of Nepal (Salisbury 2004). Their triumphs and tragedies have attracted international attention for nearly a century, but a climber’s odds of summiting or of dying have rarely been quantified (Town 1986; Pollard & Clarke 1988; Huey & Eguskitza 2000; Huey et al. 2001; Huey & Salisbury 2003). In particular, whether those odds differ by age or gender has never been examined and is challenging to predict. Whether those odds differ by age or gender is particularly whether those odds differ by age or gender or gender. We included only ‘members’ on climbing permits and thus excluded high-altitude assistants and porters, who have different responsibilities (and for whom age is often unknown). Chinese expeditions were also excluded, as local authorities do not distinguish members and porters. Data are for spring, when most attempts are made (77.9% of climbers between 1990 and 2005), and for climbers (88.2% of spring climbers) using a main ‘commercial’ route (Salisbury 2004); other routes are rarely attempted and are relatively difficult and dangerous (Huey & Salisbury 2003). Age and gender were known for most climbers (98% and 100%, respectively) and the level of prior experience (0, 1) based on whether a climber had previously attempted a Nepalese peak, as mountaineering experience elsewhere is unknown. Even though climbers usually climb in teams (Huey & Eguskitza 2000), we treated individual climbers as independent because we are analysing attributes (e.g. age, gender) of individuals.

(a) Statistical analyses

Exploratory analyses suggested that rates (e.g. of summiting) were nonlinearly related to age and appeared to show a ‘breakpoint’, an age at which rates shifted abruptly. A non-parametric approach based on generalized additive models (GAMs, Hastie & Tibshirani 1990) confirmed that log odds were nonlinearly related to age and showed a breakpoint. Thus, logistic regression is unsuitable; instead, we used joint-point models, where log odds are piecewise linear at the breakpoint. Specifically, we report quasi-binomial models (generalized linear models, GLMs, with a dispersion parameter) with factors (gender, prior experience, and route); a joint-point model for age and year of climb as a covariate. A route factor partitioned attempts via the Southeast Ridge in Nepal versus those from Tibet (n=878 and 1333, respectively; see Huey & Salisbury 2003). Interactions were non-significant. In analyses of death rates, year of climb had significant nonlinear effects; thus, we used semi-parametric GAMs that were similar to GLMs, but including a non-parametric effect of year. Statistics were computed in R (Ihaka & Gentleman 1996).

3. RESULTS

The gender ratio and age structure on Everest has been shifting since the first ascent in 1953. Men still outnumber women, but women are increasing in proportion (p<0.001; table 1) and constituted approximately 10% of all climbers between 2000 and 2005. The ‘greying’ of mountaineers on Everest is also apparent (table 1). In the early decades, 18.7% of climbers were equal to or older than 40 years (the age at which summit rate begins to drop; figure 1a) and only 0.3% were equal to or older than 60 years (the age at which death rates increase; figure 1). In recent years (2000–2005), 45.6% were 40 years old and above and 3.6% were 60 years old and above. In particular, 12.5 sexagenarians per year attempted Everest between 2000 and 2005.

For the period of 1990–2005, climbers ranged from 15 to 69 years (grey histogram; figure 1b), though 50% were between 31 and 43. Most (88.8%) were men and few (38.1%) had prior experience on a Nepalese peak, but men were slightly more likely to have prior experience than women (38.9% versus 32.0%, p=0.041). Prior experience increased...
but varied nonlinearly with year \((p = 0.93)\). Even so, the difference in experience with age was relatively small \((29.1\% \text{ for age less than 30 years and age}\) 40.3\% for age 30 years and above). Overall death rate was independent of gender \((men 2.3\%, women 2.35\%\), respectively). Death rate was also \((p = 0.10)\). However, since only 60 climbers were sexagenarians and only three of them died, an increased overall death rate for sexagenarians is tentative.

Changes of summing changed little until the age of approximately 40 years \((p = 0.19)\), but then declined dramatically \((p \leq 0.001; \text{figure}\) 1a). We used a GLM joint-point model (for ages less than 40 years versus 40 years and above), which gave a better fit than did a model with age alone \((p = 0.05)\). Rate of summing was independent of gender \((p = 0.36)\), as men and women had similar rates of summing \((30.9\% \text{ and } 28.3\%)\), respectively. Rate of summing increased between 1990 and 2005 as well as with prior experience \((p \leq 0.001)\), and was higher on the Southeast Ridge \((p = 0.03)\) than on northern routes. GAMs gave similar results.

Overall death rate changed little until the age of approximately 60 years \((1.5\%, p = 0.53)\) but then increased suggestively thereafter \((5.0\%; \text{figure}\) 1a). We fit a GAM joint-point regression model (less than 60 years versus 60 years and above). The increased death rate for older climbers was marginal \((p = 0.07)\), and the model only approached significance \((p = 0.10)\). Death rate was independent of gender \((p = 0.91)\), as men and women had similar death rates \((1.62 \text{ and } 1.63\%)\), respectively. Death rate was also independent of experience and route \((p > 0.60)\), but varied nonlinearly with year \((p = 0.02)\), primarily because many climbers died during the 1996 storm. In a parallel GLM analysis, the increased death rate for climbers older than 59 years was significant \((p = 0.037)\). A joint-point regression analysis was again suggestive \((p = 0.10)\). However, since only 60 climbers were sexagenarians and only three of them died, an increased overall death rate for sexagenarians is tentative.

A comparison of overall death rates underestimates risks facing older climbers, simply because very few older climbers reach extreme altitudes (figure 1a) where risk is greatest. To compare the death rates of climbers who reached equivalent altitudes, we analysed the death rates only of climbers descending from Everest’s summit \((N = 677; \text{figure}\) 1b). We used a GAM joint-point regression that improved the fit \((p = 0.001)\). Descent death rate was essentially constant until the age of approximately 60 years \((p = 0.89)\) and then increased significantly \((p = 0.0004)\). Descent death rate was independent of gender \((men 2.3\%, women 4.3\%, p = 0.20)\) and experience \((p = 0.43)\), but varied nonlinearly with year \((p = 0.006)\), again reflecting storm deaths in 1996. Not surprisingly, the overall success rate (above) decreased steeply for climbers older than approximately 40 years \((p \leq 0.001; \text{figure}\) 1b) but did not differ between men and women \((30.3 \text{ and } 27.1\%)\), respectively, \(p = 0.36)\).

4. DISCUSSION

Over a half century has elapsed since the first ascent of Everest, and the number of climbers attempting Everest continues to grow. The number and proportion of women and older climbers are increasing (table 1), hence we examined whether a climber’s odds of summing or of dying varied by gender or

Table 1. Demographic shifts in mountaineers attempting Mount Everest between 1953 and 2005.

<table>
<thead>
<tr>
<th>year</th>
<th>no. of women per year</th>
<th>percentage of women</th>
<th>no. of climbers</th>
<th>percentage for age &gt; 39 years</th>
<th>no. of climbers</th>
<th>percentage for age &gt; 59 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1953–1989</td>
<td>2.8</td>
<td>4.7</td>
<td>11</td>
<td>18.7</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>1990–1999</td>
<td>21.3</td>
<td>8.5</td>
<td>85.8</td>
<td>34.5</td>
<td>3.1</td>
<td>1.2</td>
</tr>
<tr>
<td>2000–2005</td>
<td>35.7</td>
<td>10.3</td>
<td>159.5</td>
<td>45.6</td>
<td>12.5</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Figure 1. Senescence of mountaineers on Everest. (a) Probabilities of summing (1990–2005; black line, ± 95% CI) and of death (red line) anywhere on the mountain versus climber age. (b) Probabilities of success (black line, summing and surviving) and of death during descent from the summit (red line), with a histogram of climber ages (grey). Curves are non-parametric GAM fits.
age. We found that women and men have similar odds of summiting, death overall and death during descent. In fact, none of these odds even approaches statistical significance, so this pattern is robust. Similarity of these odds may reflect similar physiological performances of men and women in hypoxia and cold (Wagner et al. 1979; Wagner & Horvath 1985; Ward et al. 2000; Roach & Kayser 2001), as well as similar resistance to acute mountain sickness (Schneider et al. 2002).

Older climbers are also increasing in number and proportion on Everest (table 1), probably reflecting general demographic and health trends (Burtatscher 2004). However, climbers older than approximately 40 years clearly face an uphill battle to summit Everest (figure 1a), and those in their 60s achieve the summit far less frequently (13.3%) than do those in their 30s (35.7%). Older climbers may be less likely to summit because they are physically less capable (Moore 1975; Burtatscher 2004; Tsianos et al. 2006) or they climb in a more conservative manner.

Climbers older than approximately 60 years also have elevated death rates (38.7% versus 25.7%) though not a lower death rate (1.8% versus 1.5%). Increased odds of summiting might reflect direct benefits of prior experience (Kimoshita et al. 2000) that sexagenarians can safely climb 8000 m peaks. In fact, sexagenarians had an overall death rate approximately three times higher than that of younger climbers (5.0% versus 1.5%, risk ratio = 3.3, 95% CI 1.1–9.4), even though they rarely summit. Moreover, sexagenarians who summited had a descent death rate strikingly higher (25% versus 2.2%, p = 0.015; risk ratio = 11.1, 95% CI 3.0–31.7) than that of younger summitters (figure 1).

Climbers with prior experience on a Nepalese peak had elevated rates of summiting (38.7% versus 25.7%) though not a lower death rate (1.8% versus 1.5%). Increased odds of summitting might reflect direct benefits of prior experience (Kimoshita et al. 2000) or self-selection; perhaps only climbers who performed well on a lower peak later returned to attempt Everest.

When evaluating whether to attempt Everest, mountaineers should have access to quantitative data on their odds of summiting and of death. We find that these odds are independent of gender, but sensitive to age. On Everest, youth and vigour trump age and experience.

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