Supporting Information

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SI Materials and Methods

Study Subjects. Study subjects were wild, adult male baboons living in the Amboseli ecosystem, Kenya. Amboseli is a semiarid savannah with a few scattered trees and excellent visibility for observing baboons. Since 1971, the Amboseli Baboon Research Project (ABRP) has collected continuous, individual-based data on the members of several social groups (1). The baboons are individually known, and full-time, experienced observers collect several types of data by visiting each study group several times per week for half-day monitoring visits. Relevant to this study, observers collected information on the incidence and recovery from naturally occurring injuries and illnesses, as well as a variety of life history and behavioral information.

Observations of Injuries and Illnesses. Injuries and illnesses in this study were observed from 1982 through 2009. These data are not clinical diagnoses; instead, observations were collected noninvasively by observing the animals at a distance of a few meters on each observation day. Whenever observers noticed a baboon displaying signs of injury or illness (e.g., coughing, diarrhea, limping, bleeding from a wound), they recorded on standardized sheets the type of injury or illness and whether it impaired the animal's locomotion. For cutaneous wounds, observers also recorded the location of the wound on the body and, whenever possible, a visual estimate of its size in centimeters. Because the data were collected noninvasively, and because baboons sometimes conceal signs of injury and illness, our observations probably exclude many mild injuries and illnesses.

Once an injury or illness was observed, observers monitored its progress toward healing during subsequent visits to the animal's social group. Through 1991, healing was monitored every few days until the injury or illness healed. After 1991, ABRP changed its methods, and observers monitored the progress of injuries and illnesses more opportunistically, from once every few days to once every couple of weeks; all wounds and illnesses were monitored systematically only on the last observation day of each month. Through 1991, observers updated records on average once every 5 d; after 1991, these records were updated on average once every 14 d. Specifically, illnesses were considered healed when the animal no longer displayed physical symptoms such as coughing, sneezing, or diarrhea. Cutaneous wounds were considered healed when a scab no longer was visible on the wound site, leaving only healed skin or scar tissue. When the injury or illness impaired locomotion, an individual was considered healed when it no longer limped.

We found no evidence that observer bias or differences in injury severity across males could explain status-related differences in healing rates. A full description of these analyses is provided below.

Measuring Predictor Variables. Our goals were to test whether differences in male age and dominance rank predicted the incidence of injury and illness and whether any of the following variables predicted male healing rates: (*i*) the male's dominance rank at the time he was injured or became ill; (*ii*) the male's age at the time he was injured or became ill; (*iii*) the size of his social group as measured by the number of adult male and female members; (*iv*) whether the male that was injured or became ill was a member of a wild-feeding group or of the group that foraged part-time at the refuse pit of a nearby tourist lodge; and (*v*) the season (wet or dry). Below we describe how we collected data on each variable.

Dominance rank. Male dominance ranks were assigned monthly based on agonistic interactions recorded as part of regular monitoring during all observation days. Dominance ranks were determined by assigning wins and losses in dyadic agonistic interactions between males. Males "won" agonistic encounters when their opponent gave only submissive gestures and they gave only aggressive or neutral gestures (2). We later used these wins and losses to construct dominance matrices. Each male then was assigned an ordinal dominance rank; the highest ranking or alpha male was assigned the rank of 1, and subsequent adult males in the hierarchy were ranked by successively higher numbers. Males were considered adult when they attained their first, nonreversed dominance rank among the adult males in their social group (3).

Age. Male ages were derived from two sources of data. First, 48% of the adult males in this study were born into one of our study groups, so we knew their birth dates and could calculate their ages to within a few days. Second, because male baboons disperse between social groups as adults, the remaining 52% of males immigrated into the population as adults. For these males, age was estimated to within 1 or 2 y using well-defined metrics based on body size, coat condition, tooth wear, body carriage, and appearance compared with known age males (4).

Group size and group type. In addition to male age and rank, we tested whether two aspects of males' social groups influenced healing rates. First, we tested whether the number of adult males and females present in the group created a density effect. Group size is known from near-daily censuses of all group members conducted during each monitoring visit. Second, around 15% of the injuries and illnesses in our study occurred in males who were in a group that was not fully wild-feeding but instead foraged at a refuse site at a nearby tourist lodge. We were concerned that this supplemented feeding might influence healing rates. Hence we also tested whether feeding regime (wild feeding or food-supplemented at the lodge) influenced healing rates.

Season. Previous research has shown that season and photoperiod can influence immune function and healing rates (5). The Amboseli ecosystem is 2° 39′ south of the equator and experiences little variation in day length; hence we did not examine photoperiod as a predictor. However, Amboseli experiences a predictable, 5-mo dry season from June through October when the ecosystem receives no rain and when food and water are relatively scarce. In the remaining 7 mo of the year (November through May), the ecosystem receives an average of 350 mm of rain. We tested whether this seasonal difference in rainfall predicted healing rates by comparing injuries and illnesses received in the dry season with those during the 7-mo wetter season.

Analyzing the Incidence of Injury and Illness as a Function of Age and Rank. To understand how male rank and age predicted the incidence of injury and illness, we calculated age and rank-specific incidences of injury and illness. To calculate age-specific incidences, we counted the total number of new injuries or illnesses observed in males in a given year of life and then divided that number by the total number "male-years" of data during which we had observed a male of that age in our population. Male-years were calculated by summing the total number of days that different adult males of a given age were alive and present in a study group; that is, if 12 different males were all alive and adult in a given study group for 365 d each while at age 10, these data would be calculated as 12 male-years of data for 10-y-old males. This process was repeated to calculate rank-specific incidences of injury and illness by dividing the total number of injuries or illnesses observed in males of a given rank by the total number male-years of data during which we had observed a male of that rank in our population. To understand how the incidence of injury and illness change with age and rank, we correlated age and rank with the age-specific incidences and found the best-fitting line or curve to describe the relationship.

Testing for Differences in Healing Rates. We tested predictors of healing rates using a subset of 448 injuries and illnesses observed in adult males (Table S1). This data set was smaller than the total number of injuries and illnesses observed since 1982, because we excluded several injuries and illnesses on three main grounds. First, we excluded from our analysis three injuries and illnesses that led to an animal's death, because such injuries or illnesses can never be said to heal. Second, we excluded 17 cases in which an observer noted an injury or illness but there were no subsequent updates to track the healing process (for instance, if the animal went missing shortly after the initial observation). Third, we excluded 165 cases that were marked as healed but for which the length of time between the penultimate and final observation was longer than 1 mo, making our estimate of the time to heal unusually poor. Many of these cases occurred in the food-supplemented group (a.k.a. the "lodge group"), which had a lower rate of observations than the wild-feeding groups. In the final set of 448 injuries and illnesses, 88 cases were right-censored, meaning that the injury or illness had not healed by the final observation. These cases tended to occur when a given injury or illness took an especially long time to heal or when the animal in question left the study group before the injury or illness had healed. These cases were not excluded; rather, they were treated as censored in the analyses.

Univariate methods. Before exploring multivariate predictors of healing rates, we performed univariate survival analyses to test which single variables predicted healing rates. First, we tested whether the study period (before or after 1991) had a significant effect on how long it took observers to record an injury or illness as healed. Second, we tested for significant differences in the healing rates among the eight different types of injuries and illnesses in our data set (Table S1). Third, we tested whether the predictor variables described above (i.e., dominance rank, age, group size, group type, and season) predicted significant differences in healing rates. Univariate survival analyses were performed using JMP software (version 9.0.2), and significance was determined using log-rank tests.

Multivariate methods. We used multivariate proportional hazards models (i.e., Cox regression) to test whether, controlling for differences in monitoring methods and differences in healing rates across injury and illness types, any of our predictor variables significantly predicted healing rates. We chose proportional hazards models because they use a nonparametric approach that depends on the ranks of event times, not their numerical value; hence this approach is robust to uncertainty in event times and variation in the underlying hazard function (6). We also explored our data using interval-censored parametric models and found no difference in the results. Tests were performed using JMP software (version 9.0.2). Specifically, we constructed proportional hazards models by entering several combinations of variables into the model and used likelihood-ratio tests to identify the model that best explained the variance in our data set. Proportional hazards models produce hazard ratios, which can be used to understand the size of an effect. In terms of this study, hazard ratios represent the probability that a baboon will heal at time t; for instance, a hazard ratio of 2 means that baboons on one end of the distribution are twice as likely to heal as baboons on the other end of the distribution.

Testing for Observer Bias or Differences in Injury and Illness Severity. In the course of our study, we found that high-ranking males healed more rapidly than low-ranking males. We wanted to rule out the possibility that observer bias could explain this result. In particular, because observations of male recovery from injuries and illnesses were somewhat opportunistic, observers might be biased to monitor the injuries and illnesses of high-ranking males. Increased frequency of observation alone could create an appearance of faster healing. We tested this idea by comparing the rate of observation (number of times a given injury or illness was monitored per days to heal) as a function of male rank category (alpha, other high-ranking, and low-ranking). Because these data were not normally distributed, we performed a log transformation before using an ANVOA to compare the rate of healing updates for alpha males, other high-ranking males, and low-ranking males. We found that there were no significant differences between the rate at which observers updated the injury and illness records of alpha males, other high-ranking males, or low-ranking males, either before or after 1991 (pre-1991: $n = 186$, F ratio $= 0.36$, $P = 0.6975$; post-1991: $n = 262$, F ratio $= 1.87$, $P = 0.1558$).

Furthermore, although we were able to control for differences in healing rates across injury and illness types, we could not control for differences in injury severity across males in our multivariate analyses. This point is important, because if low-ranking males received more severe injuries and illnesses than high-ranking males, then high-ranking males might appear to have better rates of healing than low-ranking males. We used two methods to test for differences in injury and illness severity across males of different ranks. First, we used an ANOVA to test whether there were significant differences in injury size across males of different ranks, assuming that larger wounds were more severe. Second, we used a χ^2 test to determine whether males of different ranks were more likely to receive injuries and illnesses that impaired their locomotion, assuming that injuries or illnesses that impaired locomotion were more severe and detrimental than those that did not impair locomotion. We found no support for the idea that high-ranking males received less severe injuries than low-ranking males; the average estimated wound size for alpha males was 4.83 ± 0.71 cm, which was not significantly different from wounds in other high-ranking males (3.77 ± 0.31 cm) or low-ranking males (3.85 ± 0.78 cm; F ratio $= 0.95$, $P = 0.3909$). Similarly we found no evidence that the injuries and illnesses of low-ranking males were more likely to impair locomotion (percentage impairing locomotion for alpha males = 47.06%; males ranked 2–8 = 42.86%; and males ranked less than 8 = 44.14%; $\chi^2 = 0.327$, $P = 0.85$).

Finally, we tested whether differences in the location of injuries on the body could explain differences in healing rates. This factor may be important if injuries to some parts of the body heal faster than others. To test this idea, we used a χ^2 test to determine whether males were injured in different sites on the body as a function of age and rank. However, we found that males experienced the same distribution of injuries on the body regardless of age or rank [site of injuries as a function of age: $\chi^2 = 16.93$, degrees of freedom (DF) = 18, $P = 0.53$; site of injuries as a function of rank: $\chi^2 = 18.08$, DF = 18, $P = 0.45$].

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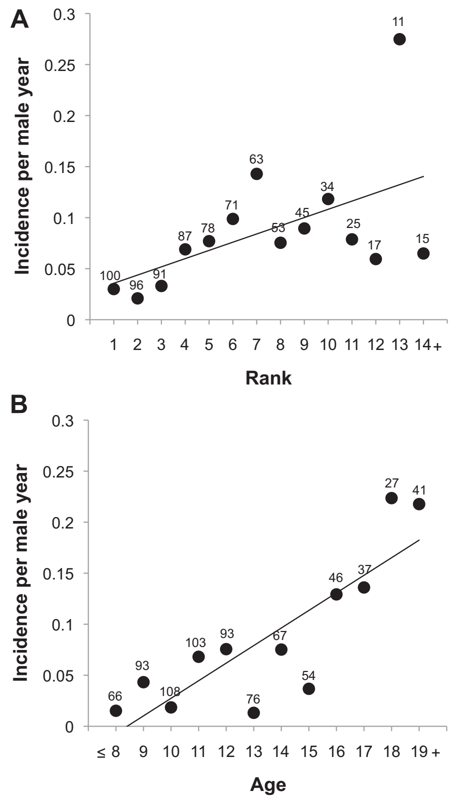

Fig. S1. Graphs depicting (*A*) rank- and (*B*) age-specific incidences of illness in adult male baboons. Numbers above data points are the number of either rank-related or age-related male-years of data contributing to each data point. The relationship between rank and the incidence of illness is best fit by a line (r^2 = 0.25, F = 5.38, P = 0.0388), as is the relationship between age and the incidence of illness (r^2 = 0.64, F = 20.59, P = 0.0011).

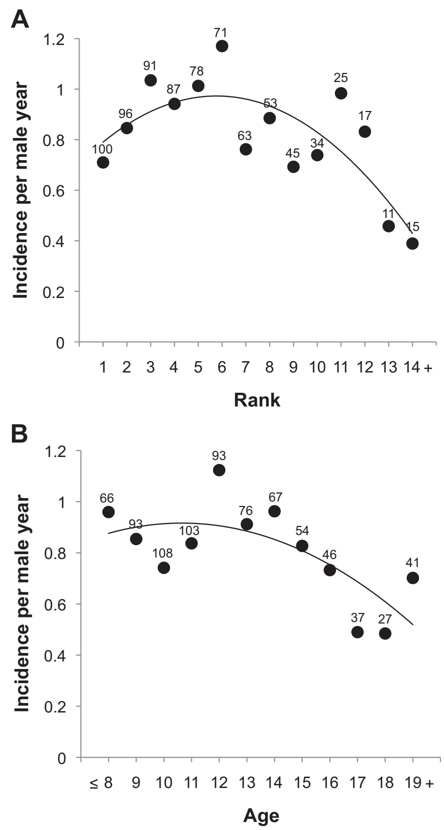

Fig. S2. Graphs depicting (*A*) rank- and (*B*) age-specific incidences of injury in adult male baboons. Numbers above data points are the number of either rank-related or age-related male-years of data contributing to each data point. The relationship between rank and the incidence of injury is best fit by a second-order polynomial ($r^2 = 0.52$, $F = 8.18$, $P = 0.0067$), as is the relationship between age and the incidence of injury ($r^2 = 0.64$, $F = 10.10$, $P = 0.0038$).

Table S1. Information on the sample of injuries and illnesses used to compare healing rates across males (n = 448 injuries and illnesses)

Injury or illness type	*n*	Percent of sample	Median no. of days to heal	Mean no. of days to heal	SE
Linear cut or slash	162	36.16	27	29.48	1.90
Puncture wound	41	9.15	26	24.45	2.33
Other cutaneous wound	109	24.33	30	38.57	3.72
Limp	116	25.89	20	38.17	4.28
Eye injury	1	0.22	20	20.00	—
Digestive illness	3	0.67	9	7.67	2.40
Respiratory illness	6	1.34	7	7.44	1.70
Lethargy and weakness	10	2.23	12	12.00	2.42

Table S2. The best-supported proportional hazards models of male healing rates from injuries only

Source of variation	Hazard ratio	DF	χ^2	*P*
Time period (pre- or post -991)	2.29	1	25.00	< 0.0001
Injury type	—	3	6.56	0.0875
Dominance rank	2.63	1	10.33	0.0013
Group size	2.19	1	7.48	0.0062

Data were determined using only the 423 injuries in our data set; likelihood ratio tests (n = 423; whole model χ^2 = 45.00; DF = 6, P < 0.0001, log likelihood = 1,733.550).

Table S3. Proportional hazards model of male healing rates including age but not dominance rank or group size as predictor variables

Source of variation	Hazard ratio	DF	χ^2	*P*
Time period (pre- or post-1991)	1.84	1	27.19	< 0.0001
Injury or illness type	—	8	17.06	0.0479
Age	2.28	1	6.36	0.0117

$n = 448$; whole model $\chi^2 = 48.21$; DF = 10, $P < 0.0001$, log likelihood = 1,865.845.

Table S4. Proportional hazards model of male healing rates, including the effects of dominance rank, group size, and age

Source of variation	Hazard ratio	DF	χ^2	*P*
Time period (pre- or post-1991)	1.82	1	25.78	< 0.0001
Injury or illness type	—	8	17.25	0.0449
Dominance rank	2.67	1	8.60	0.0034
Group size	2.13	1	6.62	0.0101
Age	1.37	1	0.77	0.3818

$n = 448$; whole model $\chi^2 = 60.21$; DF = 12, $P < 0.0001$, model log likelihood = 1,853.928.

Table S5. Proportional hazards model of male healing rates including dominance rank but not age or group size as predictor variables

Source of variation	Hazard ratio	DF	χ^2	*P*
Time period (pre- or post -991)	1.86	1	27.62	< 0.0001
Injury or illness type	—	8	16.08	0.0652
Dominance rank	2.2	1	8.16	0.0043

$n = 448$; whole model $\chi^2 = 50.01$, DF = 10, $P < 0.0001$, log likelihood = 1,864.949.

Table S6. Proportional hazards model of male healing rates including group size but not dominance rank or age as predictor variables

Source of variation	Hazard ratio	DF	χ^2	*P*
Time period (pre- or post-1991)	2.18	1	22.24	< 0.0001
Injury or illness type	—	8	19.19	0.0236
Group size	1.51	1	2.42	0.1196

$n = 448$; whole model $\chi^2 = 45.00$, DF = 10, $P < 0.0001$, log likelihood = 1,861.531.

Table S7. Proportional hazards model of male healing rates including an interaction between rank and group size as predictor variables

Source of variation	DF	χ^2	*P*
Time period (pre- or post-1991)	1	25.29	< 0.0001
Injury or illness type	8	17.72	0.0234
Dominance rank	1	18.86	< 0.0001
Group size	1	12.41	0.0004
Dominance rank x group size	1	4.81	0.0283

$n = 448$; whole model $\chi^2 = 64.18$, DF = 12, $P < 0.0001$, log likelihood = 1,851.942.