Theory of medical scoring systems and a practical method to evaluate Asian elephant (Elephas maximus) foot health in European zoos

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Abstract

Several established models in human and veterinary medicine exist to evaluate an individual health or disease status. Many of these seem unsuitable for further epidemiological research aimed at discovering underlying influential factors. As a case example for score development and choice, the present study analyses different approaches to scoring the foot health of Asian elephants (Elephas maximus) living in European facilities. Sum scores with varying degree of detail, and without or with a weighting method, were compared using descriptive statistics, i.e. kurtosis, skewness, Shannon entropy, total redundancy, their maximum and their actual ranges. With increasing score complexity, a higher level of differentiation was reached. In parallel, the distribution of score frequencies in the population shifted systematically: with the least complex scoring model the pattern indicated a severely unhealthy population with an opposite skew to a hypothetically healthy population, whereas the most complex scoring model indicated a mildly affected population with a skew corresponding to that expected for a healthy population. We propose the latter, in the form of the Particularised Severity Score (ParSev), which accounts for every nail and pad individually and weights the sub-scores by squaring, as the most relevant score for further investigations, either in assessing changes within an elephant population over time, or correlating foot health in epidemiological studies to potentially influencing factors. Our results emphasise the relevance of choosing appropriate scoring models for welfare-associated evaluations, due to implications for the applicability as well as the perceived welfare status of the test population.

Keywords: animal welfare, Asian elephant, epidemiology, foot health, scoring system, weighting factor

Introduction

Foot health of Asian elephants (Elephas maximus)

With the elephant being the heaviest terrestrial mammal on the planet, its foot is one of the most important load-bearing structures in the Animal Kingdom. According to a personal communication of Professor DK Lahiri-Choudhury, cited in Csuti et al (2001), about 50% of elephants in an Asian working camp are affected by foot problems. Sarma et al (2012) came to a similar conclusion with half of their investigated population of Asian elephants in India suffering from foot pathologies, whereas Ramanathan and Mallapur (2008) found that 74.1% of their respective sample population showed pad fissures and 46.9% nail cracks of some description. Under zoo conditions, foot health, especially in Asian elephants (Elephas maximus), is a widely discussed and difficult to assess management issue (Csuti et al 2001; Fowler 2006). To investigate the status quo of Asian elephant foot health in Europe, we determined the prevalence of foot pathologies (Wendler et al 2019). Several other studies have investigated links between the prevalence of foot health conditions and husbandry factors (Harris et al 2008; Lewis et al 2010; Haspeslagh et al 2013; Miller et al 2016), using different approaches to assess and evaluate foot health status. Due to the differences between these approaches, they depict varying elephant foot health status with prevalence ranging from 67.4 to over 80%. Therefore, meaningful conclusions cannot be readily drawn. For epidemiological evaluations, a quantitative score as an objective measurement of foot health is preferred, yet no commonly accepted method exists as to develop such a score. Here, we present and discuss different approaches to quantify health status in general and their consequences for the perception of a population’s health. The Asian elephant population currently living in European zoos presents a suitable example.