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Review article

Men and mice: Relating their ages

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ABSTRACT

Since the late 18th century, the murine model has been widely used in biomedical research (about 59% of total animals used) as it is compact, cost-effective, and easily available, conserving almost 99% of human genes and physiologically resembling humans. Despite the similarities, mice have a diminutive lifespan compared to humans. In this study, we found that one human year is equivalent to nine mice days, although this is not the case when comparing the lifespan of mice versus humans taking the entire life at the same time without considering each phase separately. Therefore, the precise correlation of age at every point in their lifespan must be determined. Determining the age relation between mice and humans is necessary for setting up experimental murine models more analogous in age to humans. Thus, more accuracy can be obtained in the research outcome for humans of a specific age group, although current outcomes are based on mice of an approximate age. To fill this gap between approximation and accuracy, this review article is the first to establish a precise relation between mice age and human age, following our previous article, which explained the relation in ages of laboratory rats with humans in detail.

Contents

1. Introduction

Most studies in the field of life science (almost 59% of the experimental studies [1]) use experimental murine models (*Mus musculus*) for investigating the implications on human health and body (Fig. 1). In terms of their maximum lifespan, mice (4 years) and humans (120

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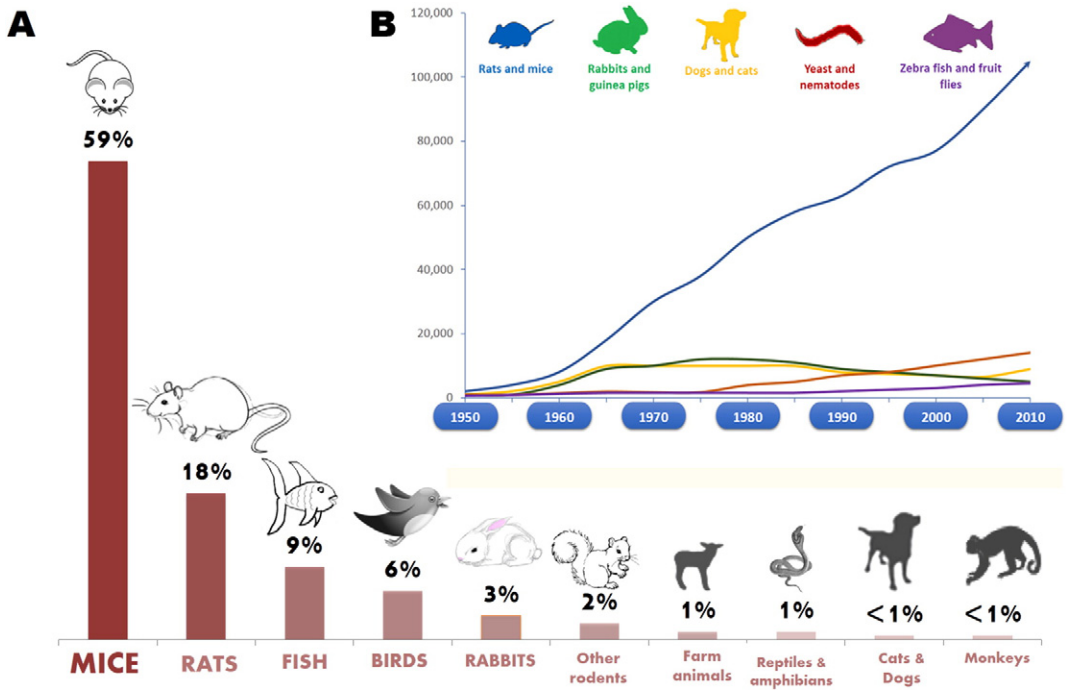

Fig. 1. (A) Use of animals in research and other scientific purposes and (B) animals cited in biomedical research papers (1950–2010).

years) differ significantly, although murine models have been widely used to analyse human body functioning and its modulation (see Ref. [2]). In two pioneering studies, Sir L. Demeritus (published in 2005 and 2006) documented their similarities and differences in diverse metabolic processes, describing the molecular process of ageing in detail (see Refs. [2,3]), but not the precise correlation of their ages in different phases of their lifespan.

Despite the large differences in their lifespan, humans and mice show similar patterns in disease pathogenesis as well as organ and systemic physiology. Their cells contain similar molecular structures that regulate the functioning of cells, differentiation. Moreover, the molecular mechanism of ageing in mice is similar to that in humans (see Ref. [3]). For instance, mice acquire mutations in the spectrum of proto-oncogenes and tumour suppressor genes, similar to those affected in human cancers (see Ref. [4]). Almost 99% of mouse genes resemble the human genome, thus making the murine model an ideal candidate for studying the functions of human genes in health as well as in the regulation of multifactorial diseases such as cancer, cardiovascular diseases, diabetes and arthritis (Table 1). Acute promyelocytic leukaemia (APL), although previously untreatable, is currently treated in humans after successful experimentation in murine models. Although certain larger mammals can better simulate human genotypic and phenotypic features, they can be expensive and difficult to maintain or handle [5].

Mice provide analogous experimental conditions and comparable results to humans. Findings of general experiments with mice, pharmaceutical trials for newly designed drugs in murine models, or studies on different developmental phases of mice are intended to be applied on human health and life. In all such cases, using mice of an approximate age rather than precisely correlated age or phase with humans limits the accuracy of experiments and their implications for human physiology. It is imperative that researchers consider the phase and age of animals used in experiments in relation to human physiology, which was explained in detail in our previous review work on the relation between the age of rats and humans (see Ref. [6]). Thus, the aim of this comprehensive review is to precisely analyse the relation between mice age and human age in various life stages to bridge the gap between the approximation and accuracy of future research in the biomedical field.

2. Age determination of laboratory mice: common methods

Various methods have been used to correlate the ages of small mammals with human age, for example, by determining the weight of eye lens (see Refs. [7–11] and [12]), epiphyseal closure (see Refs. [13,14]), tooth wear (TW) pattern [15], and body weight correlation [15]. As these methods provide a relative age that does not exactly coincide with the exact age, more than one method is required for a closer

Table 1
Commonly used strains of laboratory mice and their research applications.

Mostly used strains	Strain abbreviation	Rotation length (weeks)[a]	Mean litter size	Wean to born ratio	Research applications
BALB/C	Cby	30	4.40	0.88	Mostly in immunological research
C3H/HEJ	C3	22	4.60	0.90	In a wide variety of research including cancer, infectious disease, sensoneural and cardiovascular research
C57BL/6 J	B6	30	4.90	0.80	General purpose, cardiovascular research, background strain for mice carrying transgenes, spontaneous or targeted mutations
DBA/2 J	D2	26	4.70	0.80	General purpose, atherosclerosis, glaucoma research.
SWR	SW	22	4.6	0.80	General purpose, highly susceptible to experimental allergic encephalomyelitis
129P3/J	129P	26	5.0	0.90	Spontaneous testicular teratomas, targeted mutagenesis
NZB/B1NJ	NZB	26	4.5	0.90	Autoimmunity

[a] The average length of time a breeding unit reliably delivers progeny (also called the *optimum reproductive lifespan*).