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Editorial opinion

# Comparing rat's to human's age: How old is my rat in people years?

## Introduction

Questions often arise when animals are being used as models of human disease and biology: "Is an 8-wk-old rat comparable to a teenager?" "When are these animals considered aged?" and "Is a newborn mouse a good model for a newborn human?" Because these questions are often asked after the study has been conducted, it's usually very tempting to just "do the math."

For example, let's take the question, "How many 'rat days' equals 1 human year?" The easiest way to approach this is to make a simple direct comparison between the life span of each, such as:

1. The average laboratory rat lives approximately 3 y.
2. The average humans lives approximately 80 y.
3. (80 × 365) ÷ (3 × 365) = 26.7 human days = 1 rat day.
4. 365 ÷ 26.7 = 13.7 rat days = 1 human year.

OK, seems simple enough. So let's see how some common milestones in the lives of rats and humans fit with our simple calculation.

## Birth: is a newborn rat just like a baby?

The birth weight of a newborn rat is approximately 5 to 6 g [1]. The average adult male weight of a Sprague-Dawley rat fed ad libitum levels off at about 550 g [2]. Therefore, rats' birth weight is approximately 1% of their adult weight. Human birth weight averages around 2.7 kg. Average adult male weight is around 82 kg [3]. Therefore, our birth weight is approximately 3% of our adult weight.

Romijn et al. [4] used a variety of measurements and determined that the cerebral cortex of a newborn human is developmentally most comparable to that of a 12- to 13-d-old rat pup. If you consider the birth weight comparison, a 12-d-old rat pup will weigh approximately 20 g [2], which corresponds to 3.6% of its adult weight.

Therefore, we can come to the conclusion that you should not even consider the rat "born" until postpartum day 12. The first 12 d of life are probably most comparable to the late gestational period of humans (but that's a whole different discussion I won't address here). Assuming this is accurate, we actually lose 12 d from the rat life span above, which corresponds to 1%; therefore, we would need to adjust our calculation above and the "true" conversion rate becomes 13.8 rat days = 1 human year.

## Weaning: when is a rat no longer a baby?

Because weaning is more of an artificially imposed time instead of a biological event (in humans and laboratory-reared rodents), making this comparison also may be somewhat artificial. In the United States, the average weaning age for humans is approximately 6 mo [5]. In most laboratory scenarios, the weaning age is usually set at 3 wk for rats and mice [1]. As long as the only comparison being made is the age at which they stop receiving maternal milk, the comparison is somewhat meaningful.

So, we've already said the rat isn't officially "born" until day 12. Therefore, from the time it is developmentally similar to a human newborn to the time it is weaned is 9 d.

Let's make the conversion now by using only the period of "birth" to "weaning":

1. Rats are weaned at 9 d after "birth."
2. Humans are weaned at (6 × 30) 180 d after birth.
3. 180 ÷ 9 = 20 human days = 1 rat day.
4. 365 ÷ 20 = 18.3 rat days = 1 human year.

OK, you're right. Because we're comparing the times that the "infant" is consuming maternal milk, we must count the rat from the day of delivery because they start nursing almost immediately; therefore:

1. Rats are weaned at 21 d after birth.
2. Humans are weaned at (6 × 30) 180 d after birth.
3. 180 ÷ 21 = 8.6 human days = 1 rat day.
4. 365 ÷ 8.6 = 42.4 rat days = 1 human year.

## Puberty: when can my rat have babies?

Rats reach sexual maturity at 40 to 60 d of age [6]. We'll assume an average of 50 d for our comparison. Humans reach sexual maturity at approximately 11.5 y on average [7]. Depending on why we are making the comparison, we probably want to know how the periods match up from the actual time of birth to the time that the individual can conceive; therefore:

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1. Rats reach sexual maturity at approximately 50 d of age.
2. Humans reach sexual maturity at approximately (11.5 × 365 =) 4198 d of age.
3. 4198 ÷ 50 = 84.0 human days = 1 rat day.
4. 365 ÷ 84.0 = 4.3 rat days = 1 human year.

OK, OK, I said that rats were not "born" until day 12, so:

1. Rats reach sexual maturity at approximately 38 d (50 − 12).
2. Humans reach sexual maturity at approximately 4198 d of age (11.5 × 365).
3. 4198 ÷ 38 = 110.5 human days = 1 rat day.
4. 365 ÷ 110.5 = 3.3 rat days = 1 human year.

## Musculoskeletal maturity: when is my rat an adult?

Using musculoskeletal maturity to determine adulthood in rats is problematic because, unlike humans, there is no epiphyseal closure in long bones [8]. There is a period when skeletal growth tapers off and this occurs at approximately 7 to 8 mo in male and female Sprague-Dawley rats [2]. In humans, growth plate closure is somewhat variable between individuals and between different growth plates within the body. One of the last growth plates to fuse is in the scapula, which closes at about 20 years of age on average [9]; therefore:

1. Rats reach "mature" skeletal size by 210 d (30 × 7).
2. Humans reach total skeletal maturity at approximately 7300 d (365 × 20).
3. 7300 ÷ 210 = 34.8 human days = 1 rat day.
4. 365 ÷ 34.8 = 10.5 rat days = 1 human year.

## Reproductive senescence: when can't my rat have babies?

In this case, we will only look at the female side of things because male "senescence" appears to be incredibly variable and even possibly non-existent in some animals and men. According to Meites et al. [10], reproductive senescence in female rats occurs variably somewhere between 15 and 24 mo of age. For argument's sake, let's average it to 20 mo. According to the American Medical Association, the average age of menopause in women is 51 y [11]; therefore:

1. Female rats reach reproductive senescence at 600 d (20 × 30).
2. Female humans reach reproductive senescence at 18 615 d (51 × 365).
3. 18 615 ÷ 600 = 31.0 human days = 1 rat day.
4. 365 ÷ 31 = 11.8 rat days = 1 human year.

## Postsenescence: how much longer does my rat got, doc?

If we make the comparison of what most would consider as the "aged" period from postsenescence to death (again, looking at the female), we get the following:

1. Female rats live an average of 485 d ([365 × 3] − 600) after senescence.
2. Female humans live an average of 10 585 d ([365 × 80] − 18 615) after senescence.
3. 10 585 ÷ 495 = 21.4 human days = 1 rat day.
4. 365 ÷ 21.4 = 17.1 rat days = 1 human year.

## So what does it all mean?

Primarily it means that there is no simple answer to making age comparisons between humans and the animals we use to model ourselves. In this case, if all of the above analyses are given equal consideration and we use actual parturition as the starting point for both species, the average age rate conversion would calculate as follows:

Total lifespan: 13.8 rat days = 1 human year.
Nursing period: 42.4 rat days = 1 human year.
Prepubescent period: 4.3 rat days = 1 human year.
Adolescent period: 10.5 rat days = 1 human year.
Adult phase: 11.8 rat days = 1 human year.
Aged phase: 17.1 rat days = 1 human year.

Average: 16.7 rat days = 1 human year.

The most important concept to derive from this exercise is that the results are different depending upon what age you're looking at and what factors are being analyzed. If you are making comparisons in the very early phases of life, the comparison will be drastically different than if you are comparing later adulthood. For example, say you are using an obese rat model to study neurobiological changes associated with bariatric surgery [12] and you are looking at changes in 10- to 12 wk-old animals. In this case a conversion rate of approximately 10 to 12 rat days per human year would probably be appropriate. In contrast, if you are studying mammary gland developmental changes in association with diet [13] and you are looking at gland development from 3 to 7 wk of age, then a conversion of approximately 4 rat days per human year would probably be more relevant.

Rats (and all other animal models) can be very powerful tools and very applicable representations of humans, just as long as they are not solely viewed as miniature people. Just because the rat's lifespan is 3 y does not mean it lives a miniature human lifetime within those 3 y. Differences in anatomy, physiology, and developmental biology must be taken into consideration when analyzing the results of any experiment in which age is a crucial factor.

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