

THE USE OF MULTI-YEAR AGE GROUPS IN VACCINATION MODELS MAY BIAS THE RESULTS FOR VACCINATED INDIVIDUALS

Kharitonova E¹, Aballéa S², Tytula A³, Cristeau O¹

¹Creativ-Ceutical, Paris, France; ²Creativ-Ceutical, Rotterdam, Netherlands; ³Creativ-Ceutical, Krakow, Poland

OBJECTIVES

- Age-structured models are widely used to simulate the impact of vaccination on health and economic outcomes.
- The population in such models is split into groups based on age. Ideally, each group only includes one year of age. However, in order to reduce computational intensity many models make use of multi-year age groups.
- The objective of the present study was to demonstrate that the use of multi-year groups may bias the results if the model includes age-specific parameters.

Figure 1. Ageing process with single-year age groups

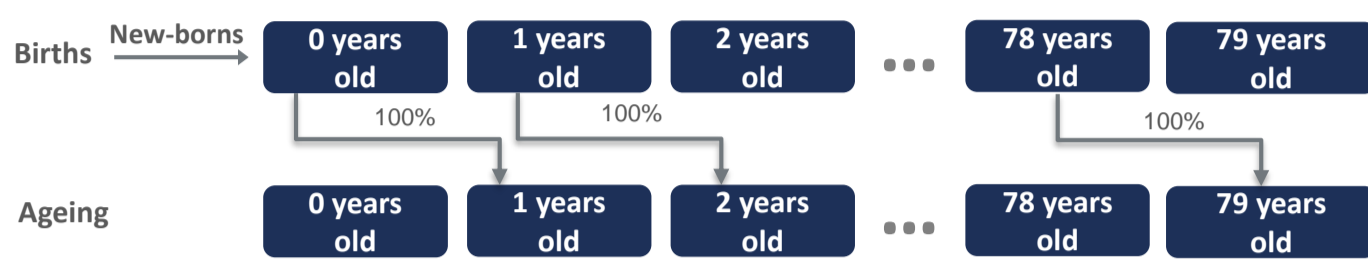
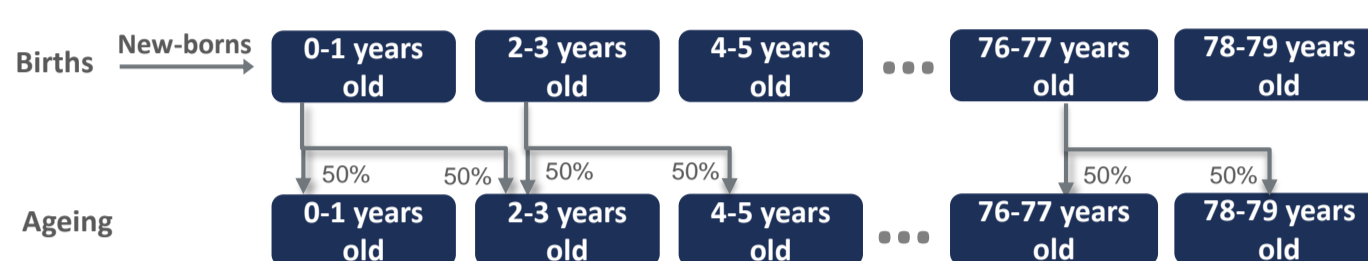


Figure 2. Ageing process with multi-year age groups



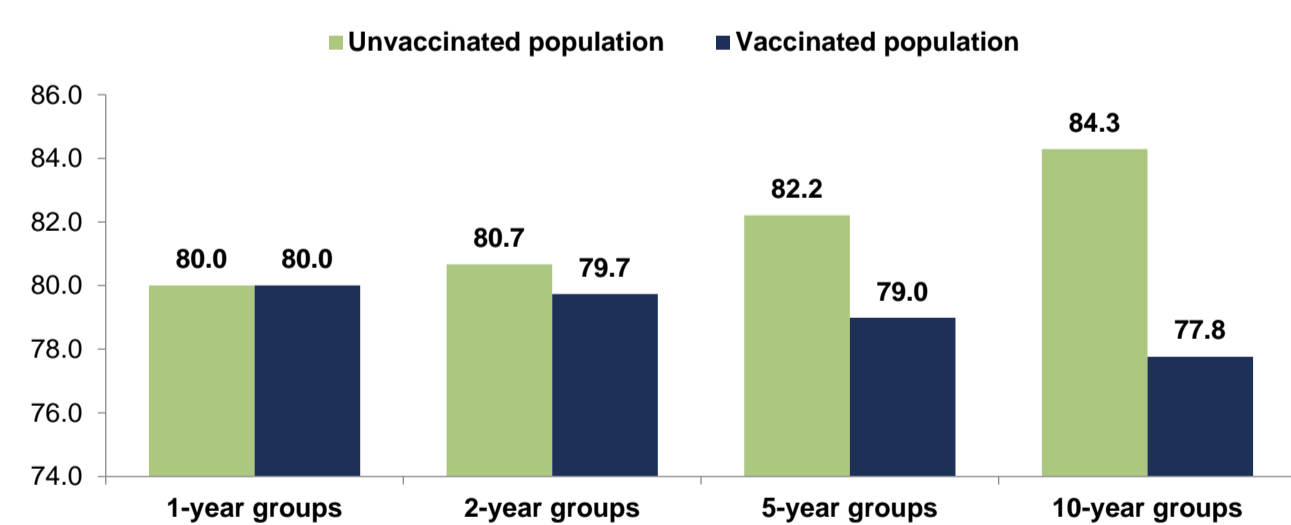
METHODS

- A simple simulation was developed tracking a hypothetical population. The population was split into age groups and different lengths of age groups were tested – one year (“0 years”, “1 year” etc.), two years (“0-1 years”, “2-3 years” etc.), five years and ten years.
- Ageing occurred discretely after each year. When multi-year age groups were used, the rate of ageing (i.e. transition to the next age group) was the inverse of the group length (e.g. if a group included two years of age, one half of the individuals would move into the next group after each year; Figures 1 & 2).
- The population was followed for 80 years. For the sake of simplicity it was assumed that the individuals do not die before reaching the age of 80 years.
- Vaccination took place at birth with 75% coverage in the base case.
- Average life expectancy and the population distribution by age were analysed separately for the vaccinated and unvaccinated individuals.

RESULTS

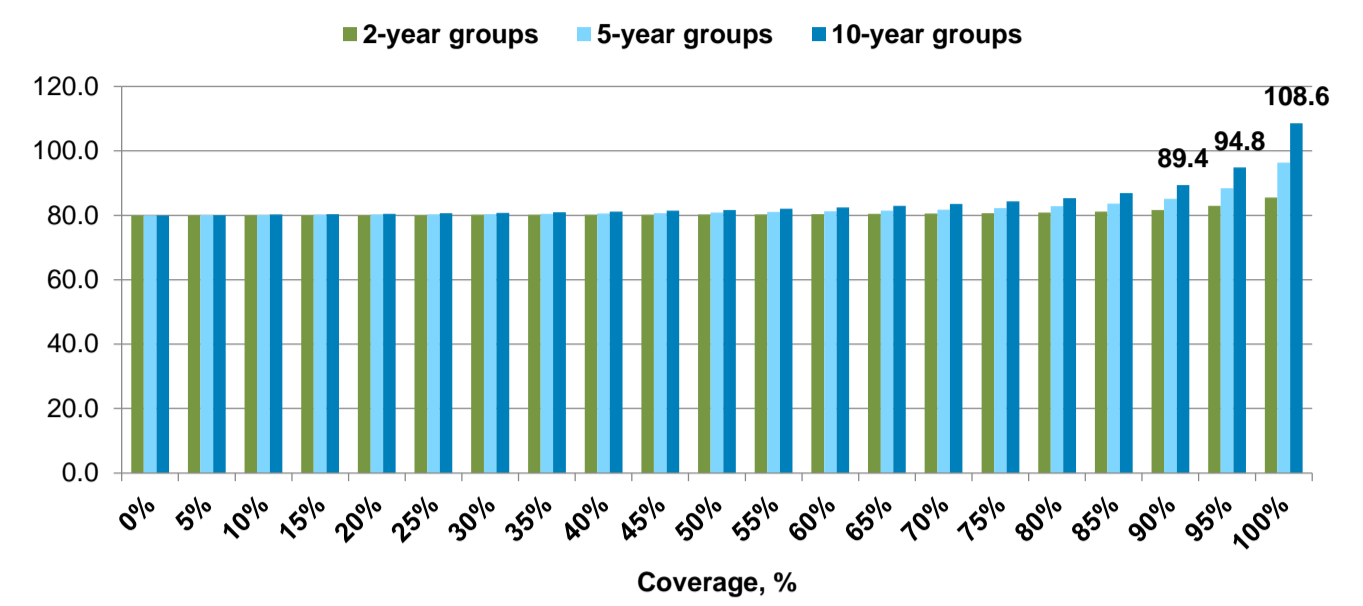
- Following the vaccination of the first cohort after the vaccine introduction, the population within multi-year age groups was no longer uniformly distributed across single years of age. In the vaccinated population this within-group distribution was skewed towards younger ages (e.g. age group labelled “0-1 years” in fact only included individuals aged 0 years in the first year of vaccination campaign).
- As a result, some of the vaccinated subjects aged already after one year (before they spent an appropriate amount of time in each respective age group). Accelerated transition between the groups resulted in a shorter average life expectancy. Age group length was found to be inversely related with the average life expectancy in the vaccinated population (see Figure 3).

Figure 3. Average life expectancy, by vaccination status & age group length



- In unvaccinated population the opposite effect was observed – the population distribution within each age group was skewed towards older ages. On average the individuals spent more time in each age group, which resulted in a longer average life expectancy (see Figure 3).
- The described effect was more pronounced when the vaccination coverage was high, as higher coverage further unbalanced the distribution within each age group. Figure 4 describes the relationship between the coverage rate and observed average life expectancy in unvaccinated individuals.

Figure 4. Average life expectancy in unvaccinated individuals, by coverage rate & age group length



- The use of multi-year age groups affected the population distribution within the age groups, but also across them. Thus, accelerated ageing of vaccinated individuals resulted in their higher average age (and vice versa for unvaccinated individuals).
- Two figures below describe the population distribution across large age bands. One can observe a greater proportion of older vaccinated subjects in the simulations with five- and ten-year age groups (Figure 5).
- For unvaccinated subjects the degree of bias was not as noticeable due to its larger overall size (only one cohort was vaccinated each year with imperfect coverage). Nevertheless, one can observe the increase in the proportion of younger individuals in the simulations with five- and ten-year age groups (Figure 6).

Figure 5. Distribution of vaccinated population by age & by age group length

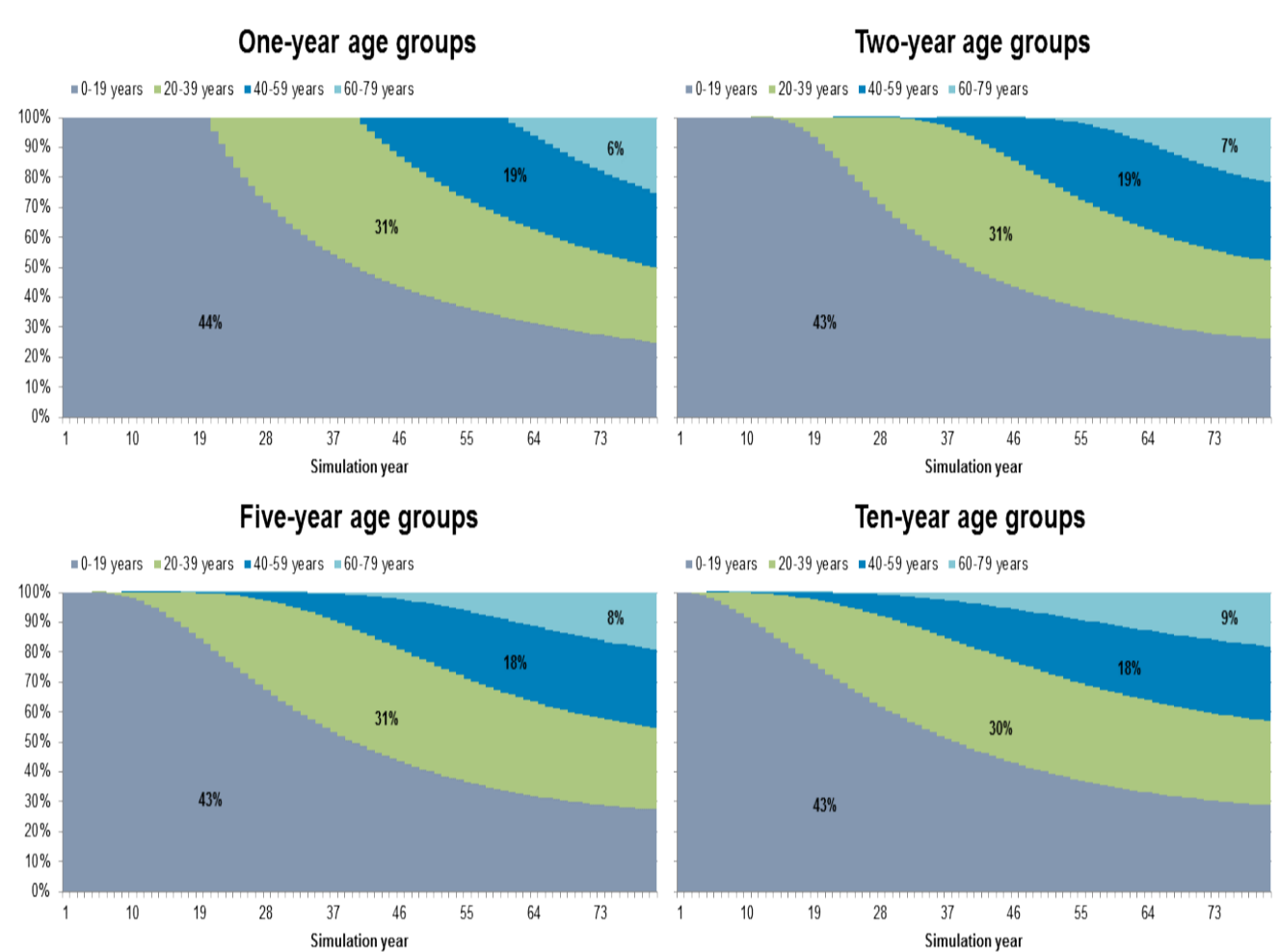
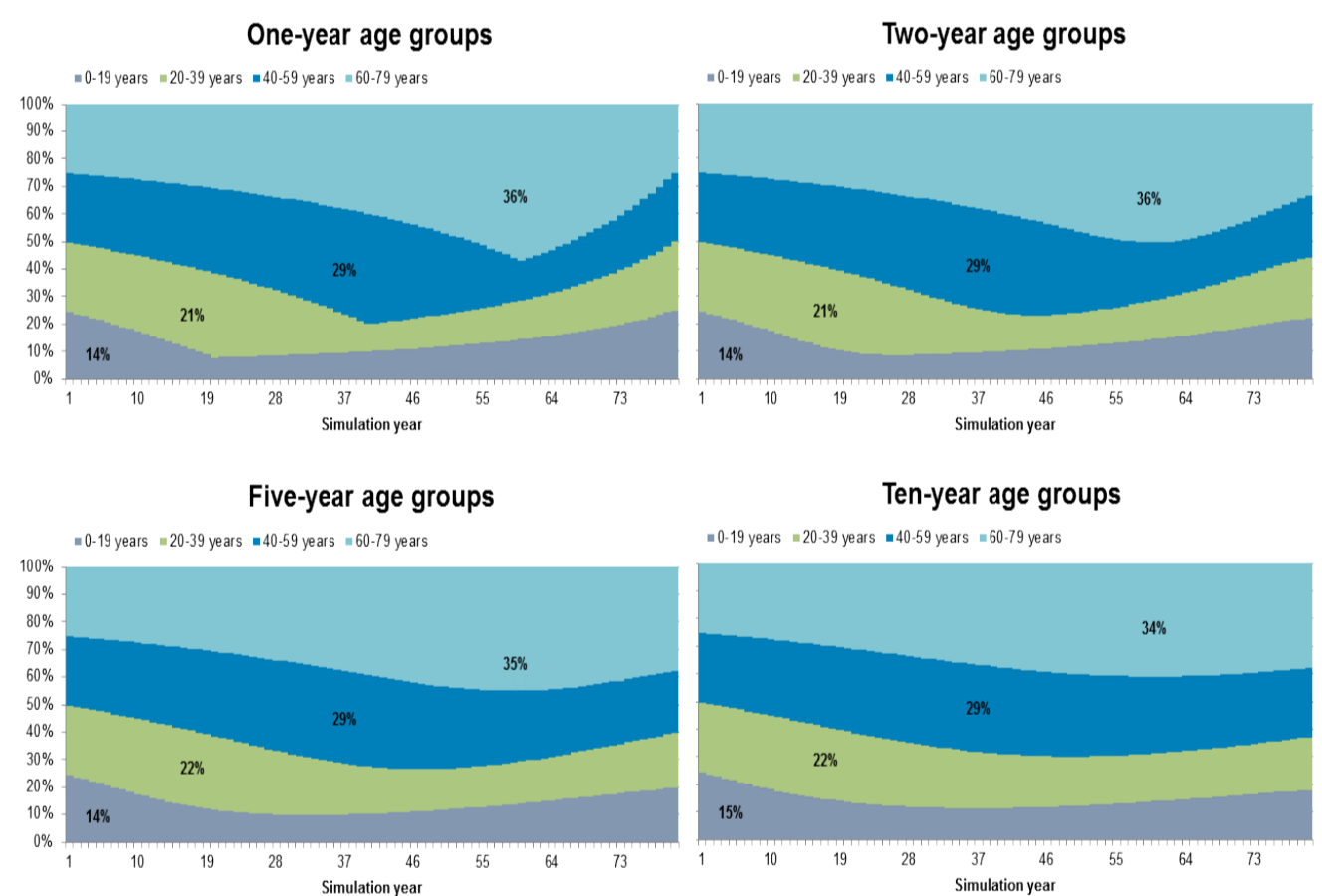


Figure 6. Distribution of unvaccinated population by age & by age group length



CONCLUSIONS

The use of multi-year age groups is often dictated by computational intensity of age-structured models. The present study demonstrates that this choice may result in a biased assessment of the outcomes of a vaccination campaign.

The demonstrated individual effects (change in the life expectancy and average age) may have a considerable impact on the results if the model parameters vary by age and vaccination status (e.g. infection severity and/or cost of treatment).

In order to avoid these potential biases, single-year age groups are the recommended option. When not feasible, it is advised to estimate the degree of bias and to address it by introducing correction factors.

