**Why do we have a 1-1-3 Compartment System**

Originally we had a model system where we had just 3 compartments a vulnerable, shielders and a general population. Which we said had a 20%, 20%, 60% population size relative to one another. This ran into some issues - as ideally we would all 3 compartments to have the same amount of infectious pressure as one another - with the same number of cases at the trigger day.

This would require a moving away from the density-dependent framework and moving to a system where the rate of infectious transmission is independent of the density - essentially a frequency dependent network.

**Differences in Beta**

In the frequency dependent model, beta will scale alongside population size so that no matter what population size you have R0 will always scale to the same value throughout the model - you can scale your beta alongside it so the get the same output.

This contrasts with a density dependent formulation which does not scale beta to the population size - so that when the population size increases the beta stays the same. This means that when the infectious pressure will increase as population size gets bigger.

**Our Model**

Mark suggested a plan where we shift to a frequency dependent framework. This means we are scaling the β to their population sizes. In a homogenous population. This would not matter - N = 1 - but in the metapopulation style model we have here it is a bit different with different subpopulations possessing different population sizes (0.2, 0.2 and 0.6).

* If I\_j is count [though I don't think it is] then we weight by 1/(absolute size of subgroup j)
* If I\_j is prevalence then no change is required
* **If I\_j = count/(N=total populations size) [which I think it might be] then we weight by 1/f\_j (which is equivalent to replacing N by N\_j)**

However, there was a slight problem with this approach since we were still artificially inflating random betas. We instead derived a simpler approach, where we explicitly model the population as equally sized populations belonging to different subgroups. What this achieves is that now we can have standardised transmission parameters that act the same in different sub-groups (due to identical population sizes). We now just have multiple copies of sub-groups as needed - divisible by the populationf raction in the smallest sub-population.

This now uses a frequency dependent formulation, with identically sized subgroups. Making the sub-populations the same size has done away the need to look at this. Since before the populations were differently sizes we would have to weight betas and divide them by their relative population size etc. Now the populations are the same size and no weighting is needed.

Although, we still divide each population by its own fraction sizeNj to scale it to a single population for the modelling output (I guess this makes is look like each subpopulation has its own N = 1).