

Additional file 2 - Appendix A: BYM Model in WinBUGS as employed by the RIF

Model

```
{  
  for(i in 1:N) the number of areas[i] in the study  
  {  
    Y[i] ~ dpois(lambda[i]) the Poisson likelihood distribution for the  
observed count Y[i] in area[i] where lambda[i]  
is a function of the SIR[i] and the expected  
count, E[i]  
  
    log(lambda[i]) <- log(E[i]) + alpha + a[i] + b[i]  
  
    smoothedSMR[i] <- exp(alpha + a[i] + b[i]) the log of the smoothed SMR is a  
linear function of both fixed effects  
and random effects. In this case,  
alpha denotes the overall log of the  
SIR (i.e., for the entire study region),  
a[i] denotes unknown random effects  
that are not spatially correlated, and  
b[i] denotes random effects that ARE  
spatially correlated.
```

It should be noted that where additional fixed covariates (e.g. neighbourhood income quintiles) are included in the model, these are subsumed in the E[i] term.

```
    residRR[i] <- exp(a[i] + b[i]) the residual relative risk is simply the RR of  
each area over( or under) the total study  
region's SMR.  
  
    postprob[i] <- step(a[i]+b[i]) the posterior probability for each area is simply the  
likelihood distribution for the SIR in each area [i].  
  }
```

Prior distributions

```
    alpha ~ dflat() this denotes a fixed effect, i.e., assumption that the overall  
SIR doesn't vary.  
    overallRR <- exp(alpha) the overall SIR across the entire study region is simply  
alpha exponentiated.  
    for(i in 1:N){
```

```

a[i] ~ dnorm(0, tau.a)      prior distribution for the uncorrelated heterogeneity;
                             assumption that the non-spatial random effects for each
                             area[i] are distributed according to the normal
                             distribution, with a standardized mean of zero and a
                             variance of tau.a.
}

b[1:N] ~ car.normal(adj[],weights[],num[],tau.b) Conditionally autoregressive
                                                    distribution for spatially correlated
                                                    heterogeneity; assumption that the
                                                    spatial random effects for each
                                                    area[i ] are conditional on
                                                    adjacency for each area[i], and
                                                    weighted according to the strength of
                                                    the adjacency and with a variance of
                                                    tau.b.

# Hyperpriors

tau.a ~ dgamma(0.5, 0.0005) These parameters of variability are also assumed to
                             be variable and not fixed. Thus, tau.a is assumed to
                             follow the gamma distribution, where the scale
                             parameter ( $\kappa=0.5$ ) and shape ( $\theta=0.0005$ )
                             parameters are fixed. This is usually a skewed
                             distribution with mean= $\kappa/\theta$  and variance= $\kappa/\theta^2$ 

tau.b ~ dgamma(0.5, 0.0005) Tau.b is also assumed to follow the gamma
                             distribution, where the scale parameter and shape
                             parameter are fixed.

# Weights for the car.normal distribution

for(i in 1:sumNumNeigh){
weights[i] <- 1              Where areas are adjacent, the assigned weight is
                             one (1). Otherwise zero.
}

# Variability of the RRs explained by the spatial factor

marginal.var.a <- sd(a[])*sd(a[])
marginal.var.b <- sd(b[])*sd(b[])
fracspatial <- marginal.var.b / (marginal.var.a + marginal.var.b) This is a global
estimate for the fraction of all variation in the SIRs attributable to the spatial effect.
}

```