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Multilevel multistate competing risks survival analysis of primary caries

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Should dentists fill children's teeth?

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Consider a child presenting to a dentist with tooth decay in the primary dentition

Assume the child is not in pain, and there is no evidence of sepsis

The dentist COULD fill the decayed tooth…

…but in a few years' time, it is going to fall out anyway!

So… is filling the tooth actually worthwhile?

Restoration strategies

Some dentists follow a policy of “selective restoration” in children

- Symptomless carious teeth allowed to remain in the mouth untreated

Others follow “traditional” restoration strategies

Aim to assess the value of restoring symptomless primary teeth, using a suitable data set and survival analysis model for childhood caries

The Cardiff cohort study

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- 4-year cohort study undertaken by Cardiff University School of Dentistry collected data on 2654 children aged 4-6 years at baseline
  - 2408 children completed follow-up
  - Interval-censored data obtained on about 20,000 primary molar teeth and 100,000 molar teeth surfaces
  - Data set augmented by Dental Practice Board records from consenting children (51%)
- Combined data set used to model primary caries using multilevel multistate competing risks survival analysis methods

Demographic data

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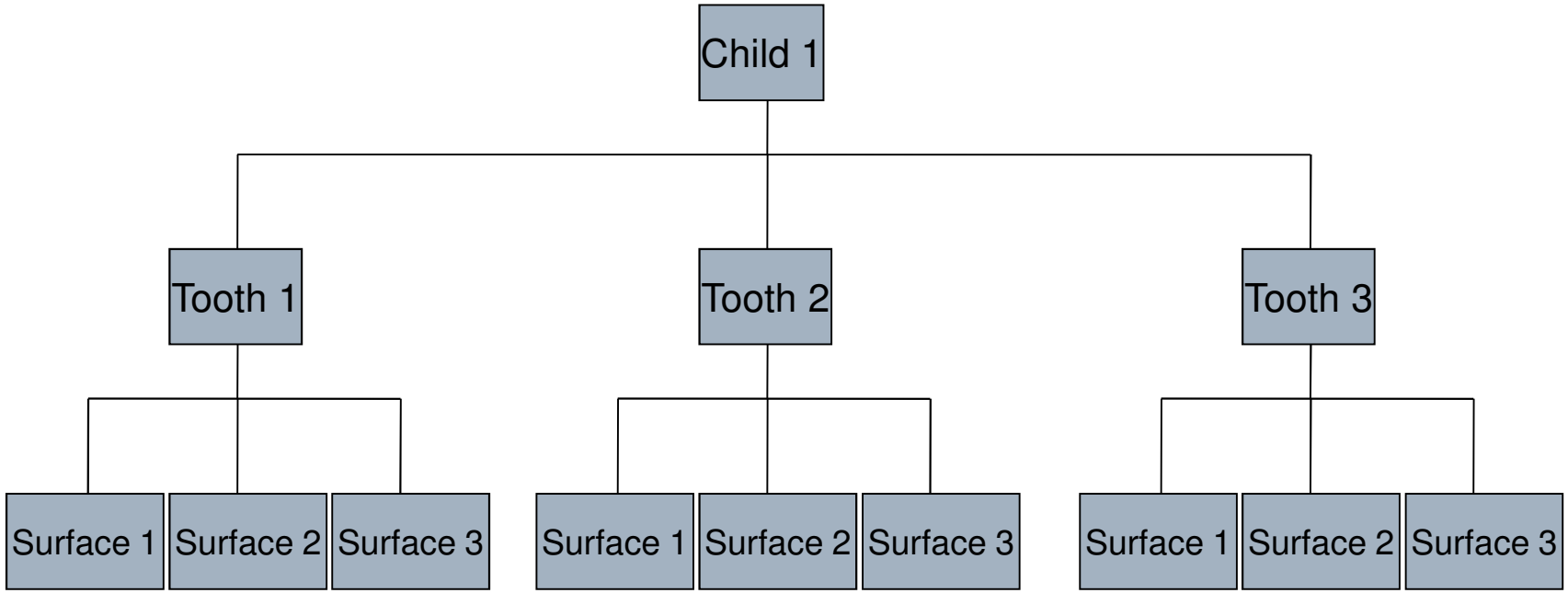
- Gender
- Social deprivation (measured using the Townsend index)
- Fluoridation status
  - Children studied from West Midlands (fluoridated water) and South Wales (non-fluoridated water)
- Tooth and surface type
  - Occlusal/non-occlusal surface
  - Maxillary/mandibular 1st and 2nd primary molars

Multilevel data structure schematic



Analysis of sound teeth

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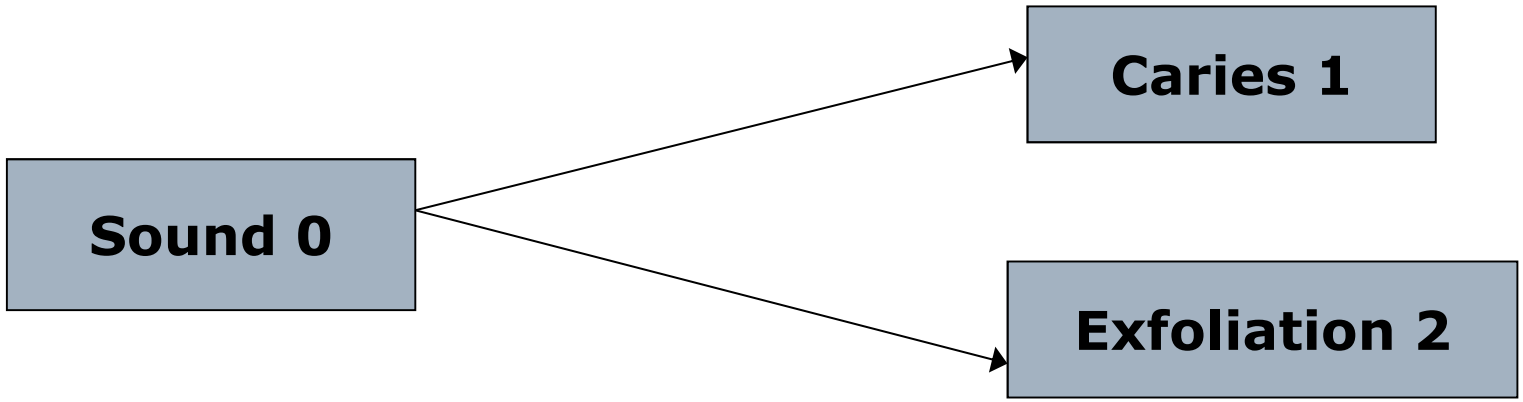
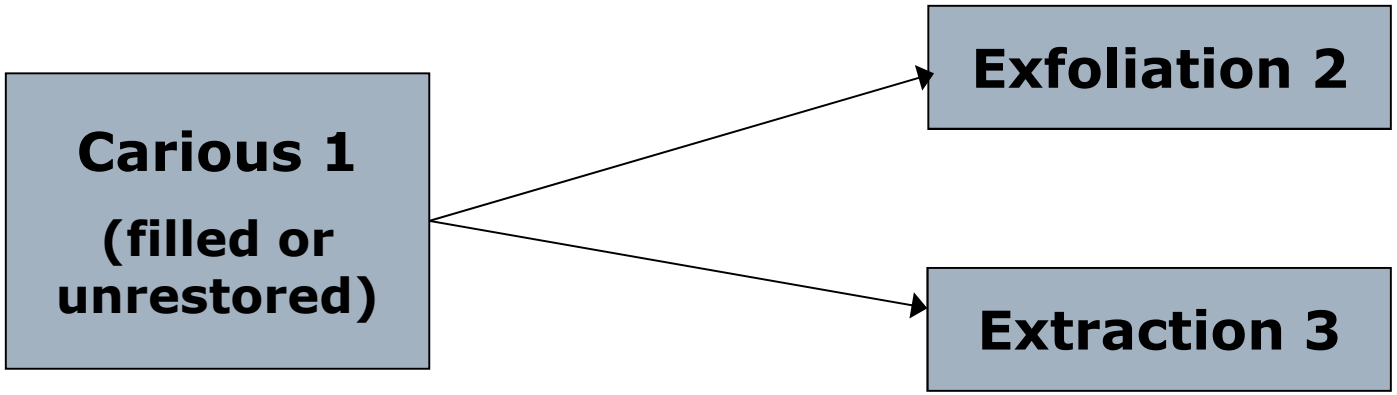
- Sound teeth/surfaces subject to the “competing risks” of caries and exfoliation



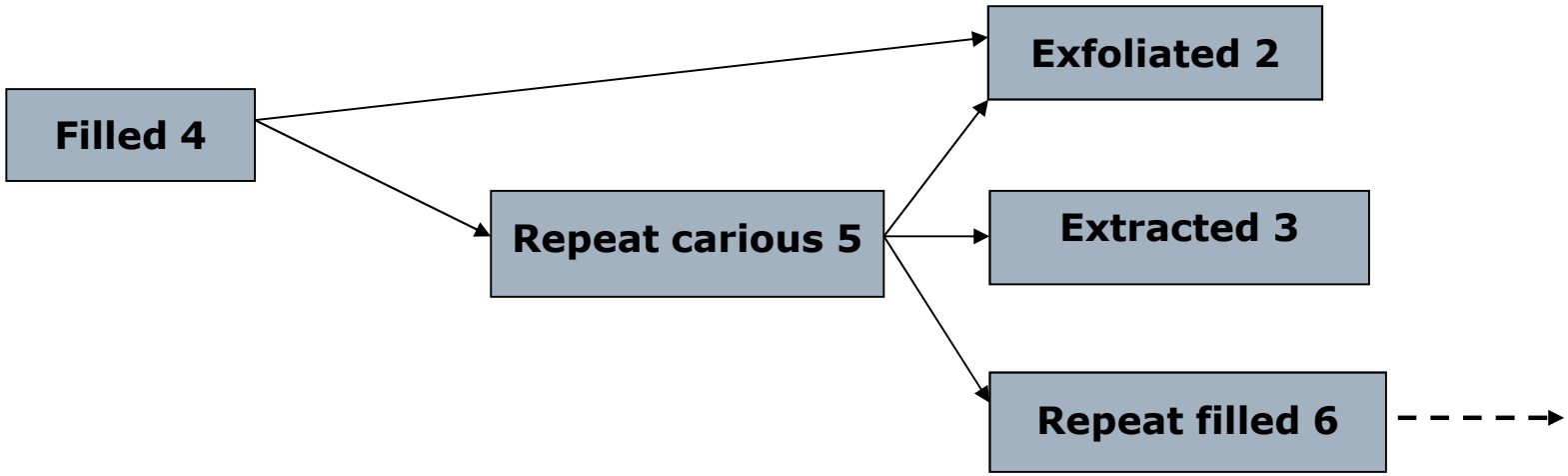
Subsequent transitions

- Exfoliation is absorbing state
- Teeth in state *Carious* may experience further transitions (multistate model)



Subsequent transitions

- Extraction is also an absorbing state
- Filled teeth may subsequently experience further transitions



Parametric survival distributions

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- Suitability of several candidate parametric distributions for each transition assessed using AIC statistic
- Log-logistic distribution selected for all transitions
- Parallel 2-level models considered
  - *Surfaces* within *children*
  - *Teeth* within *children*
- Exploratory logistic regression modelling indicates about 20% of model variance at upper (child) level

Transitions from *sound* state 0

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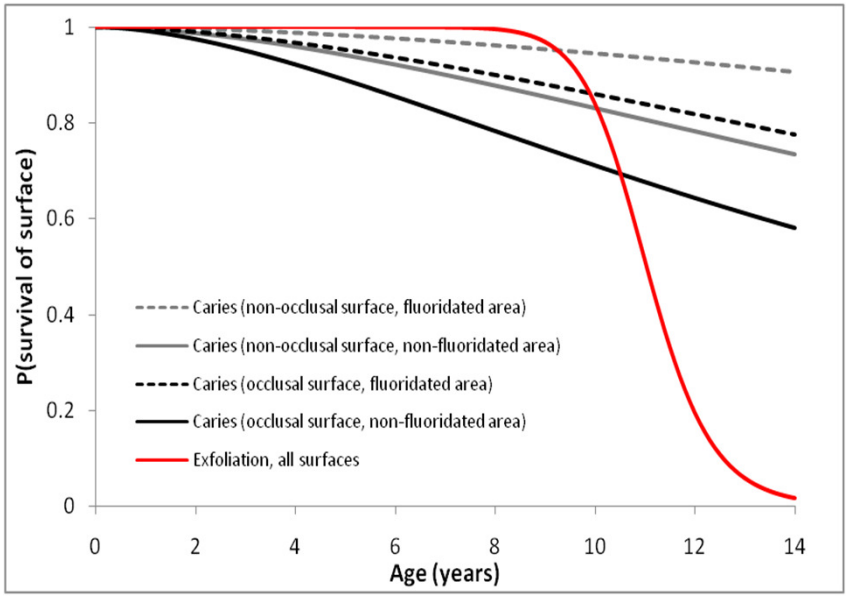
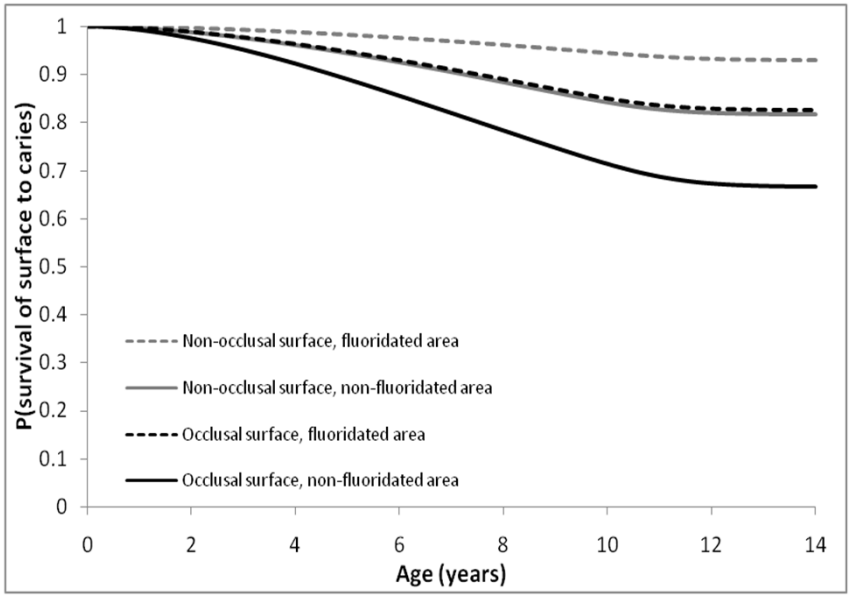
- Marginal survival models derived for sound-caries and sound-exfoliation transitions
  - Can be interpreted as survival experience to particular risk in the absence of other risks
- Cumulative incidence survival curves also derived
  - Represents survival to particular failure mode in competing risks model
- Some surface-level results illustrated

Typical survival curves: 01 and 02 transitions



Marginal survival curves for caries and exfoliation



Cumulative incidence survival curves for caries

Survival to caries greatest on non-occlusal tooth surfaces of children with fluoridated water

Surface type and SEC status may also be shown to be statistically significant (teeth/surfaces of children from less deprived areas show better survival experience)

Effect of restoration: 13 and 43 transitions

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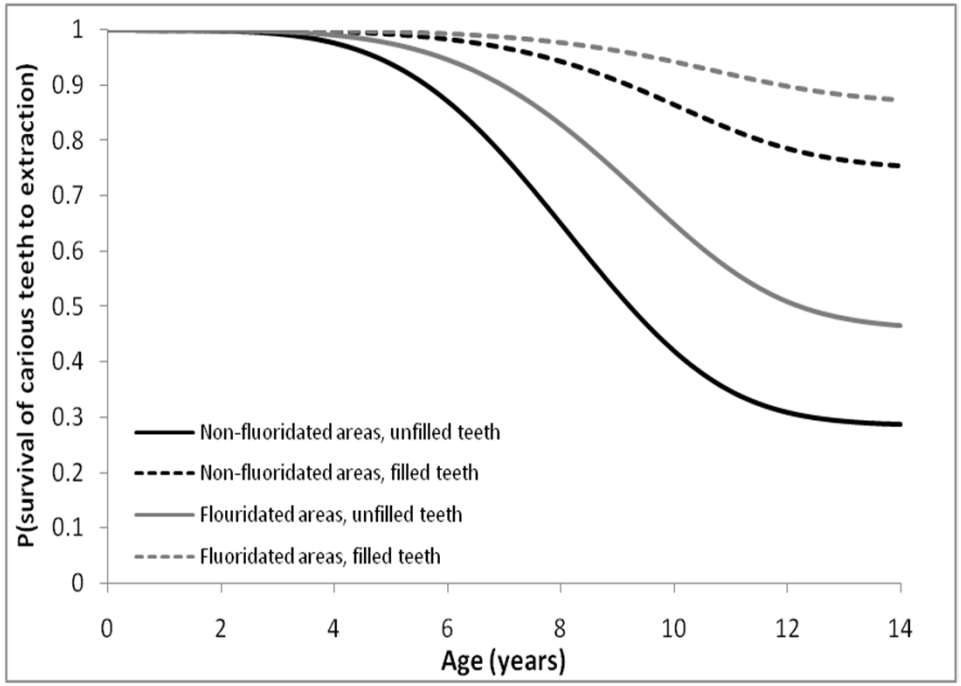
- Survival to extraction of restored/unrestored carious primary teeth compared (13 and 43 transitions)
- Typical *tooth*-level curves shown



Restored teeth show better survival to extraction at all ages

Some substantive effect of fluoridation also illustrated

Mean residual decay lifetime (MRDL)

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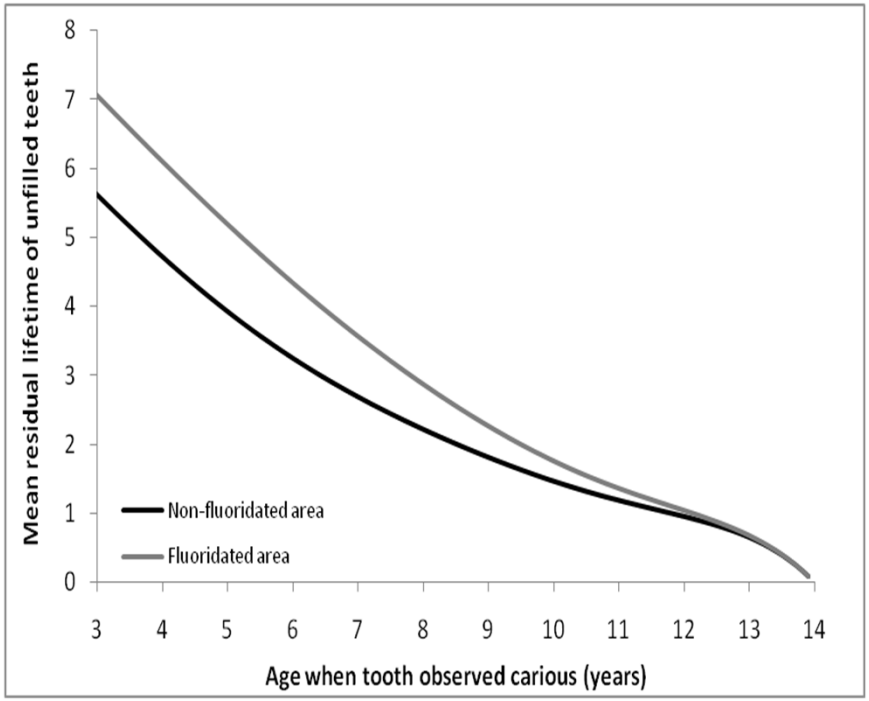
- Further analysis considers the consequence of allowing symptomless carious primary teeth to remain in the mouth until exfoliation
- Expressed as function of age when tooth first observed carious
- Restoration virtually eliminates MRDL, benefitting successional permanent teeth
  - Filling at 8 years saves 2-3 years MRDL
  - Filling at 11 years saves 1-1.5 years MRDL
  - Some substantive effect of fluoridation



MRDL for unrestored teeth

Conclusions

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- Restoration of carious primary tooth surfaces substantially increases the likelihood of exfoliation without the need for subsequent further treatment
- Childhood caries is most strongly associated with occlusal surfaces, non-fluoridation and higher levels of socio-economic deprivation
  - Gender and tooth type non-significant in most models
  - Marginal effect of data clustering on inferences of parameter significance

References

- Stephenson, J., Chadwick, B., Playle, R. and Treasure, E. (2010). A Competing Risk Survival Analysis Model to Assess the Efficacy of Filling Carious Primary Teeth *Caries Research*, **44** (3), pp. 209-293. ISSN 0008-6568
- Stephenson, J., Chadwick, B., Playle, R. and Treasure, E. (2010). Modelling Childhood Caries Using Parametric Competing Risks Survival Analysis Methods for Clustered Data. *Caries Research*, **44** (1), pp. 69-80. ISSN 0008-6568
- Stephenson, J. (2012). A Model for the Analysis of Caries Occurrence in Primary Molar Tooth Surfaces. *Caries Research*, **46** (5), pp. 452-459. ISSN 0008-6568