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GENERALISED LINEAR MODELLING AND SURVIVAL MODELLING OF CHILDHOOD CARIES

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INTRODUCTION

The occurrence of childhood caries was investigated using multilevel and survival analysis of data from a cohort study of 2654 children aged ~5 years at baseline, undertaken by Cardiff University School of Dentistry from 1999 to 2003.

AIMS & OBJECTIVES

- To identify factors significantly linked with childhood caries within the framework of a hierarchical model structure
- To compare and contrast caries occurrence across individuals with differing characteristics
- To compare the survival of primary molar teeth and surfaces to the competing risks of caries and exfoliation

MATERIALS & METHODS

Children were selected from 2 fluoridated areas (Dudley, Walsall) and 2 non-fluoridated areas (Mid Glamorgan, South Glamorgan). Caries data was recorded on all surfaces of all primary molar teeth on 3 occasions at intervals of ~2 years. Gender, age, and socio-economic status (SEC) of all children were recorded at each exam. Tooth and surface parameters were also recorded. Parallel analyses were undertaken on the surface data, and on the data transformed into *tooth*-level responses.

Generalised linear models (GLMs) were derived on discretised data using the logit and complementary log-log (CLL) links. Parametric survival modelling was undertaken using the 3-parameter Weibull, Gompertz and log-logistic survival distributions, considering the competing risks of caries and exfoliation.

RESULTS

Generalised linear modelling

Several model structures were tested using variance components multilevel GLMs. Results for a 4-level and a 3-level hierarchy are presented.

Level	4-level model	3-level model
Surface	66.0%	-
Tooth	8.8%	76.5%
Child	21.5%	18.3%
School	3.7%	5.2%

The proportion of model variance at each of these levels averaged across all examinations was calculated using a simulation method.

The majority of variance in caries at *surface* and *tooth*-level demonstrates the clustering of caries within children.

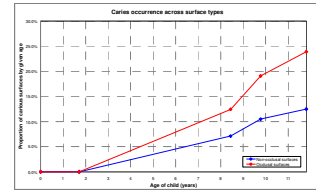
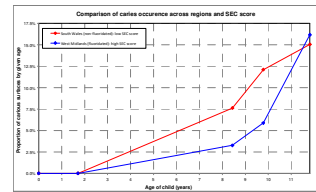
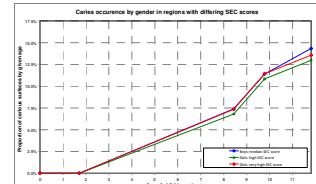
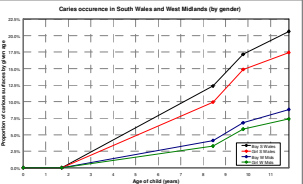
Multivariate logistic GLMs indicate risk factor significance by odds ratios (95% confidence intervals) and *p*-values:

Covariate	4-level model		3-level model	
	Odds ratio	<i>p</i> -value	Odds ratio	<i>p</i> -value
Gender	0.83 (0.72, 0.97)	0.017	0.85 (0.74, 0.96)	0.012
Age at exam	1.32 (1.06, 1.65)	0.014	1.22 (1.00, 1.48)	0.044
SEC score	1.09 (1.06, 1.11)	0.000	1.08 (1.06, 1.11)	0.000
F-status	0.33 (0.27, 0.41)	0.000	0.30 (0.25, 0.35)	0.000
Left	1.01 (0.95, 1.07)	0.809	0.98 (0.92, 1.05)	0.627
Upper	0.83 (0.78, 0.88)	0.000	0.85 (0.79, 0.91)	0.000
First	0.98 (0.92, 1.04)	0.561	0.92 (0.86, 0.99)	0.018
Occlusal	2.13 (2.04, 2.22)	0.000	n/a	n/a

Values recorded at 2nd exam are shown.

Caries is associated with all recorded *child*-level characteristics, lower teeth and occlusal surfaces. A *tooth*-level model shows 2nd molars also to be at higher risk.

A series of multilevel GLMs (CLL link) were used to investigate variation in caries occurrence between groups. Some *surface*-level analyses are illustrated.

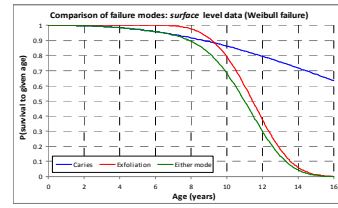


Survival modelling

Comparison of survival distribution goodness-of-fit was undertaken by calculation of the log-likelihood statistic:

Distribution	Failure mode	
	Caries	Exfoliation
Weibull	-54014	-45846
Gompertz	-56279	-52906
Log-logistic	-54247	-47180

The Weibull distribution shows slightly better fit for both failure modes.



Caries is the dominant failure mode to ~9 years. After this time primary molars are more likely to exfoliate than to develop caries.

CONCLUSIONS

Childhood caries is associated with all recorded attributes at child level, with lower teeth and with occlusal surfaces. Higher caries rates are found in boys, in older children, in socially deprived children and those living in non-fluoridated areas. Consideration of multilevel structures did not greatly affect significance of association of risk factors.

Exfoliation is a significant limiter on caries occurrence later in the lifetime of primary molar teeth.