Dunedin Multidisciplinary Health & Development Study Concept Paper Form

Provisional Paper Title: A spatial & temporal model of dental caries occurrence	
Proposing Author: Matthew Schofield	
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P.I. Sponsor: Jonathan Broadbent	
Today's Date: 30/09/2020	

Objective of the study:

The objective of the study is to develop statistical models that describe spatial patterns of tooth decay through time.

Several statistical models have been developed to explore spatial patterns from cross-sectional data, e.g. Bandyopadhyay, Reich and Slate (2009, 2011); Zhang et al., (2011); Jin, Yuan and Bandyopadhyay (2016). These models allow for assessment of risk factors for dental caries while accounting for spatial error structure. The spatial correlation itself is also of interest. It can help us understand the relationship between tooth surfaces. For example, if one surface is decayed, we can quantify the likelihood that an adjacent (or opposite) tooth surface is carious or will become carious in future.

Data collected for the Dunedin Multidisciplinary Health and Development Study provide a unique opportunity to assess they spatial patterns through time. This provides richer information about how tooth decay develops through time and the role that dental intervention can play. However, there are no statistical models available "on the shelf" that can be used for data of this sort. We will develop models that can be used for this class of models.

Data analysis methods:

We will develop hierarchical models that account for spatial and temporal correlation. Hierarchical (or multilevel) models describe variation at different levels. Bayesian inference will be used to fit the models.

We plan to assess model properties via simulation experiments (if computational demands allow). We will validate the model using posterior model checking,

ensuring that the data adequately fit the model proposed.

Variables needed at which ages:

Outcomes
Dental caries, restoration, and tooth presence for each tooth & each tooth surface from each age where teeth were examined. Specifically, we will need data for the status of the mesial, buccal, distal, and lingual surfaces of the anterior deciduous teeth (51-53, 61-63, 71-73, 81-43) as well as the mesial, buccal, distal, lingual, and occlusal surfaces of the posterior deciduous teeth (54-55, 64-65, 74-75, 84-45) at ages 5 and 9 years. Similarly, we will need data for the status of each permanent tooth (11-18, 21-28, 31-38, 41-48) surface at each age where permanent teeth were examined (9, 15, 18, 26, 32, 38, 45).

Secondary outcome
Oral health-related quality of life (OHIP-14 scale & subdomains) at age 32, 38, 45

Risk factors & confounders
Sex, socioeconomic status
brushing freq (twice daily, not twice daily), flossing freq (daily/not daily), use of F-toothpaste (y/n, from ages when available), use of dental services (routine for checkups or not), crowding of teeth (from DAI index), plaque scores (OHI-S)

Significance of the Study (for theory, research methods or clinical practice):

The proposed model will be (to our knowledge) the first to consider spatio-temporal models for dental caries data. This study is important from a statistical perspective. Earlier papers that have described cross-sectional models have been published in leading statistical journals, especially Bandyopadhyay, Reich and Slate (2009) and Jin, Yuan and Bandyopadhyay (2016). This is because there were no models that could be used for such data. The model development required was of interest in its own right. The same is true for this work. There are currently no models available that can used to adequate model tooth decay across space and time. The models that we will develop may have applications that extend beyond dental applications and be of benefit to the wider statistical community.

The proposed work will also benefit public health and epidemiological research research. We will get a better understanding of how tooth decay develops through time and space (across the mouth). This is important for clinical practice, as it will allow dental clinicians to provide patients with estimates of risk of other tooth surfaces being affected by dental caries, modifiable risk factors

(such as brushing as well as identifying tooth surfaces that should be targeted for preventive interventions such as professional application of fluoride varnish.

References:

Bandyopadhyay, B., Reich, B. J. and Slate E. H. (2009). Bayesian modeling of multivariate spatial binary data with applications to dental caries. *Statistics in Medicine* 28: 3492 – 3508.

Bandyopadhyay, B., Reich, B. J. and Slate E. H. (2011). A spatial beta-binomial model for clustered count data on dental caries. *Statistical Methods in Medical Research* 20: 85 – 102.

Jin, I. H., Yuan, Y. and Bandyopadhyay, D. (2016). A Bayesian hierarchical spatial model for dental caries assessment using non-Gaussian Markov random fields. *Annals of Applied Statistics* 10: 884 – 905.

Zhang, Y., Todem, D., Kim, K. and Lesaffre E. (2011). Bayesian latent variable models for spatially correlated tooth-level binary data in caries research. *Statistical Modelling* 11: 25 – 47.

Data Security Agreement

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Please keep one copy for your records and return one to the PI Sponsor

Please initial your agreement: (customize as necessary)

MS	I am current on Human Subjects Training [CITI www.citigrogram.org] or equivalent.
MS	My project is covered by the Dunedin Study's ethics approval OR I have /will obtain ethical approval from my home institution (please specify).
MS	I will treat all data as "restricted" and store in a secure fashion. My computer or laptop is: • encrypted (recommended programs are FileVault2 for Macs, and Bitlocker for Windows machines) • password-protected • configured to lock-out after 15 minutes of inactivity AND • has an antivirus client installed as well as being patched regularly.
MS	I will not "sync" the data to a mobile device.
MS	In the event that my laptop with data on it is lost, stolen or hacked, I will immediately contact my PI Sponsor or Study Director, Richie Poulton (richie.poulton@otago.ac.nz).
MS	I will not share the data with anyone, including my students or other collaborators not specifically listed on this concept paper.
MS	I will not post data online or submit the data file to a journal for them to post. *Some journals are now requesting the data file as part of the manuscript submission process. The Dunedin Study Members have not given informed consent for unrestricted open access, so we have a managed-access process. Speak to your PI Sponsor or Richie Poulton for strategies for achieving compliance with data-sharing policies of journals.*
MS	I will delete all data files from my computer after the project is complete. Collaborators and trainees may not take a data file away from the office. The data remains the property of the Study and cannot be used for further analyses without an approved concept paper for new analyses.

Signature: _MSchofield_ _____

CONCEPT PAPER RESPONSE FORM

A To be completed by the proposing author:

Provisional Paper Title	A spatial & temporal model of dental caries occurrence
Proposing Author	Matthew Schofield
Other Contributors	Jonathan Broadbent, Marilette Lotter, Tilman Davies
Potential Journals	Caries Research, Journal of Dental Research, Community Dentistry & Oral Epidemiology (or beyond dental literature)
Today's Date	30/9/2020
Intended Submission Date	1/7/2021

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B. To be completed by potential co-authors:

☑ Approved ☐ Not Approved ☐ Let's discuss, I have concerns

Comments: _Really innovative approach — very happy do assist._

Please check your contribution(s) for authorship:

	Conceptualizing and designing the longitudinal study
	Conceptualizing and collecting one or more variables — *already done*
	Data collection
	Conceptualizing and designing this specific paper project
✓	Statistical analyses → *assisting with model design & the interpretation of findings*
✓	Writing
✓	Reviewing manuscript drafts
✓	Final approval before submission for publication
	Acknowledgment only, I will not be a co-author

Signature: _____

WM Thomson