A multilevel model for spatially correlated binary data in the presence of misclassification: an application in oral health research

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Dental caries is a highly prevalent disease affecting the tooth's hard tissues by acid-forming bacteria. The past and present caries status of a tooth is characterized by a response called caries experience (CE). Several epidemiological studies have explored risk factors for CE. However, the detection of CE is prone to misclassification because some cases are neither clearly carious nor noncarious, and this needs to be incorporated into the epidemiological models for CE data. From a dentist's point of view, it is most appealing to analyze CE on the tooth's surface, implying that the multilevel structure of the data (surface–tooth–mouth) needs to be taken into account. In addition, CE data are spatially referenced, that is, an active lesion on one surface may impact the decay process of the neighboring surfaces, and that might also influence the process of scoring CE. In this paper, we investigate two hypotheses: that is, (i) CE outcomes recorded at surface level are spatially associated; and (ii) the dental examiners exhibit some spatial behavior while scoring CE at surface level, by using a spatially referenced multilevel autologistic model, corrected for misclassification. These hypotheses were tested on the well-known Signal Tandmobiel® study on dental caries, and simulation studies were conducted to assess the effect of misclassification and strength of spatial dependence on the autologistic model parameters. Our results indicate a substantial spatial dependency in the examiners' scoring behavior and also in the prevalence of CE at surface level.

Keywords: Bayesian estimation, caries research, spatial model.