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Prediction of the variance of stereological volume estimates in systematic sampling with errors in sampling locations

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In the field of biomedicine, the use of stereological methods has been increasingly popular for obtaining robust quantitative estimates of structural tissue parameters. Thus, the stereological approach is now by many researchers and scientific journals considered the gold standard. In manyif not mostcases, when sampling organs or tissues for analysis, the standard stereological design is based upon systematic, uniformly random sectionsi.e. a randomly positioned set of equidistant sections. This is in particular the case when the target parameter is total volume which is typically estimated by the Cavalier estimator. Numerous methods have been developed for predicting the precision of the Cavalieri estimator, as well as other estimators using systematic sections, in the form of the coefficient of error (CE). However, in the past, these predictors of the CE ignored variation in intersectional distance. Unfortunately, such variation does occur in real life applicationse.g. due to loss of one or more sections or due to variation in slab thickness in the slicing of the organ. We have shown how to mathematically characterize this effect and demonstrated that subtle imprecision in section positions may substantially increase the estimator CE. Also, the method for initial slicing of an organ may substantially influence the precision of the final stereological estimates. We will present methods for predicting the CE of the Cavalieri estimator when such errors in sampling locations are present, and discuss various ways of minimizing the effect of variation in sampling positions.