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**Effect of number of teeth on social participation among older adults in Japan: longitudinal modified treatment policy approach**

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## Abstract (389 words)

### **Background**

Participating in social activities and interacting with others in the community has numerous positive effects on older adults’ health and quality of life. Studies that use causal inference methods are primarily based on binary exposures. We aimed to estimate the causal effect of number of teeth on social participation among older adults in Japan using a method that allows non-binary exposures.

### **Methods**

Using longitudinal data (baseline=2010, follow-ups=2013 and 2016) from 24,872 participants of the Japan Gerontological Evaluation Study, we employed a longitudinal modified treatment policy approach to determine the causal effect of number of teeth on social participation. Participation in any of the activities such as hobby groups, sports clubs, senior citizens’ clubs, residence groups, or volunteer groups at least once a month in 2016 was assessed as the outcome. The observed level of number of teeth of each individual was shifted to several new levels mimicking multiple hypothetical interventions to specify the effect of number of teeth on counterfactual outcomes. Corresponding statistical parameters were estimated using targeted minimum loss-based estimation (TMLE). Number of teeth (edentate, 1-9 teeth, 10-19 teeth, 20 teeth) was treated as a time-varying exposure and the estimates were adjusted for time-varying (income, self-rated health, denture use, marital status) and time-invariant (age, sex, baseline social participation) covariates. The lmtp R package was used to compute TMLE estimates with Super Learner (glm, xgboost, and neural nets were used as candidate algorithms). All the R codes used in analyses can be found at https://github.com/upulcooray/social-participation.

### **Results**

After six years of follow-up, 48.4% reported less frequent social participation (less than once a month). Causal odds ratios, calculated by contrasting counterfactual TMLE estimates at different levels of the exposure, showed a clear dose-response effect on social participation. When the exposure was shifted from being edentate to having 20 teeth, the likelihood of social participation increased by 30% (OR=1.30, 95%CI=1.23-1.38). A shift from the observed level number of teeth to all participants being edentate, reduced social participation by 15% (OR=0.85, 95%CI=0.79-0.92).

**summary**

This study provides causal evidence that having a higher number of teeth and maintaining a functional dentition positively affects social participation among Japanese older adults, while being edentate or having relatively fewer teeth negatively affects social participation.

**Next step**

Check the robustness of evidence by conducting same the analysis using longitudinal data from a different country (eg: ELSA data).

**Questions** **for discussion**

1. What are/ Are there other methods available to define causal effects with non-binary exposures (continuous/ categorical)?

2. How important is it to investigate dose-response effect in causal inference studies?

3. What are the pros and cons of incorporating machine learning algorithms into causal inference methods?