

regardless of individual-level income, adults living in affluent areas had a higher number of remaining teeth than those living in deprived areas, after adjusting for age, sex, and educational attainment [8]. Dental health is considered to be affected to a greater extent by community-level factors. Previous studies conducted in one Japanese prefecture reported larger geographical differences in the dental outcome of number of remaining teeth compared to self-rated health [7]. Therefore, a public health intervention considering community-level social determinants would be more effective.

There are at least three possible pathways between community-level income and oral health. First, access to dental care could explain the mechanism. Second, individual health behaviors are formed by the surrounding environment. Third, people living in affluent communities are less likely to have psychosocial stress than those living in deprived communities. In relation to the first pathway, although we considered access to dental clinics in the models, there might be unexplained variance of the outcome associated with access to dental care. A previous study demonstrated that low-income individuals had less access to dental clinics than high-income individuals [33]. Moreover, access to dental clinics was significantly associated with area-level income after adjusting individual income [28]. This study suggested that people living in affluent areas were more likely to visit a dental clinic than those in deprived areas, regardless of individual socioeconomic status. Although the variable we used, density of dental clinics, could change throughout the life-course of each respondent, we could not consider possible changes in this variable. Therefore, this might have caused the unexplained variance of the outcome, which was associated with access to dental care. For the second pathway, compared to deprived communities, affluent communities tend to have positive social environments, including sufficient grocery stores with fresh and healthy food, public safety, and good access to hospitals and dental clinics [34,35]. People living in affluent communities tend to eat more fruits and sugar-free foods because they can easily purchase healthy foods at grocery stores in their communities [36,37]. In addition, people living in affluent communities are also more likely to drink healthy beverages, such as non-sugared teas rather than sodas [38]. Sugar is an established risk of dental caries [39]. Moreover, recent study also indicated that sugar associated with risk of periodontal diseases [40]. Healthy lifestyles can help prevent them. For the third pathway, people living in affluent communities are less likely to have psychosocial stress because of increased safety, good social capital (e.g., social connections and social networks), and social norms than those living in deprived communities [41]. Psychosocial stress is also associated with smoking status, which affects periodontal diseases causing tooth loss [42]. In addition, community public safety affects oral health by reducing the possibility of dental injuries. Dental injury was affected by community social environment [43].

Present study showed that community explanatory variable partially mediated the association between community-level income and edentulousness. To examine the possibility of the pathway “access to dental care”, we include the variable into the model. However, variable on access to dental care explained only 2.1% of the association between community-level income and edentulousness. Further studies that consider the wider range of variables related to the pathway, such as social capital and geographical clustering of dental health behaviors, are needed.

In the present study, women’s dental health was affected by community-level income to a greater extent than men’s health. Previous studies on other health outcomes have reported similar results. Compared to men, the self-rated health of women is considered to be affected to a greater extent by the neighborhood social environment [44]. Another study on self-rated health reported similar findings and the authors suggested that this might be because women

tend to spend more time at home and in the community [45]. Thus, women were more likely than men to communicate with neighbors. Therefore, women's health behaviors are more likely to be affected by neighbors through informal social control and social influence. A previous study in Japan demonstrated that, for older women, the distance to a dental clinic was an important factor for dental attendance, while distance was not significantly associated with access to dental care among older men [27]. Because many older women in Japan do not have a driver's license, public transportation is considered an important factor for dental clinic access [27].

## **Public health implications**

Community factors are important because they potentially affect the health of all residents in a given area. The present study revealed the importance of community-level socioeconomic status on oral health. Therefore, interventions should focus not only on individual efforts but also consider community-level social determinants underlying the oral health of a population. Therefore, after relevant factors are determined by future studies, *upstream* approaches including structural and environmental interventions for improving various social determinants of communities (e.g., smoking policies for public spaces, food policies for reducing sugar consumption, health care system reforms for improving access to preventive and curative care, and access to fluoride in the water system or in schools) are necessary for reducing oral health inequalities [46-48]. In addition to these *upstream* approaches, building society which focuses on not only economic growth, but also fair distribution of well-being of individuals are required [34]. As various socioeconomic environment of community affect health of residents, broader social and economic policies should consider health and well-being of residents [34].

## **Limitation and strengths**

This study has some limitations. First, this was a cross-sectional study; thus, we cannot rule out the possibility of reverse causation. Consequently, prospective follow-up studies are required. Second, although the validity of self-reporting number of remaining teeth was validated, measurements were obtained from a self-administered questionnaire [49]. However, if we can obtain clinical measurements of remaining teeth, which are more accurate than self-administered questionnaires, the association between income variables and edentulousness will be strengthened. Third, there might have a potential bias because of a lack of many cases. The main strength of this study was its large sample size. In addition, our survey was conducted across an adequate number of municipalities with various characteristics and we used appropriate statistical analysis. Therefore, the present study could legitimately describe the effects of community factors.

## **Conclusion**

In conclusion, community-level income, as well as individual-level income, formed social gradients for edentulousness, even after accounting for individual- and community-level factors. The oral health of women living in municipalities with higher community-level incomes benefited from the social environment.

## **Availability of supporting data**

Raw data is available from corresponding author.

## **Standards of reporting**

This study was prepared according to STROBE check list for cross-sectional studies.

## **Consent**

Present study was an observational study and not using human biological specimens. We explained all relevant details regarding the study to be carried out and provide each prospective subject an opportunity to refuse inclusion in the research. Subject who consented to participate in the study wrote the self-reported questionnaire and send it by mail.

## **Abbreviations**

JAGES, Japan Gerontological Evaluation Study; OR, Odds ratio; CI, Confidence interval

## **Competing interests**

The authors declare that they have no competing interests.

## **Authors' contributions**

KI participated in the acquired the data and the study design, performed the statistical analysis, and drafted the manuscript as the principal author. JA helped to develop the idea of the study, participated in the acquired the data, advised the statistical analysis, and edited the manuscript. TY participated in the acquired the data and the study design, and edited the manuscript. RO and MN participated in the acquired the data and reviewed the manuscript. KS helped to edit the manuscript, participated in its design, and advised the statistical analysis. KK is the principal investigator of the JAGES project, helped to develop the idea of the study, participated in the acquired the data and the study design, and edited the manuscript. KO participated in the acquired the data, helped with data analysis, and critically revised the manuscript. All authors read and approved the final manuscript.

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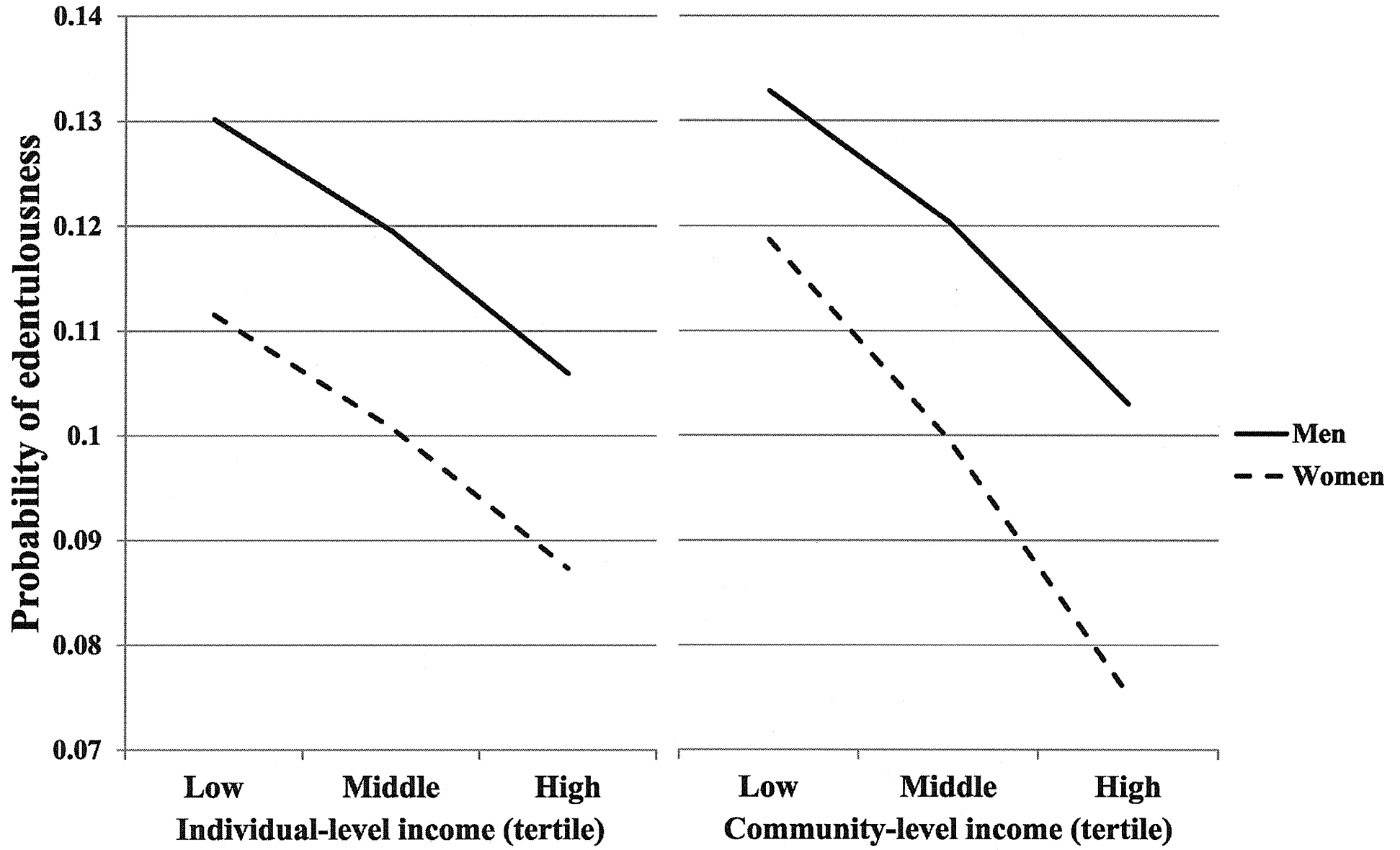
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## 地域の平均所得が 100 万円増えると無歯顎(歯が 0 本)は減少する

個人所得および地域平均所得が 100 万円高くなると、  
無歯顎になるリスクが個人所得では 1 割、地域所得では 6 割減る  
女性の高齢者は男性に比べて、より地域所得の影響を受けることが示された

65 歳以上高齢者 79,563 名を対象とした調査により、個人所得だけでなく地域平均所得と無歯顎(歯が 0 本)との関連もあることが明らかとなりました。歯の喪失に関する、性別や年齢、婚姻状態、教育歴、地域の歯科医院密度を考慮した上でも、個人所得だけでなく地域の平均所得が高くなるほど、無歯顎になるリスクが約 6 割少なくなっていました。また、所得と無歯顎との関連について、男女差を見たところ、女性では男性に比べ、より地域所得が高い地域に住むほど、無歯顎になるリスクがより低くなる傾向があることが明らかとなりました。健康な地域づくりの必要性が示されました。

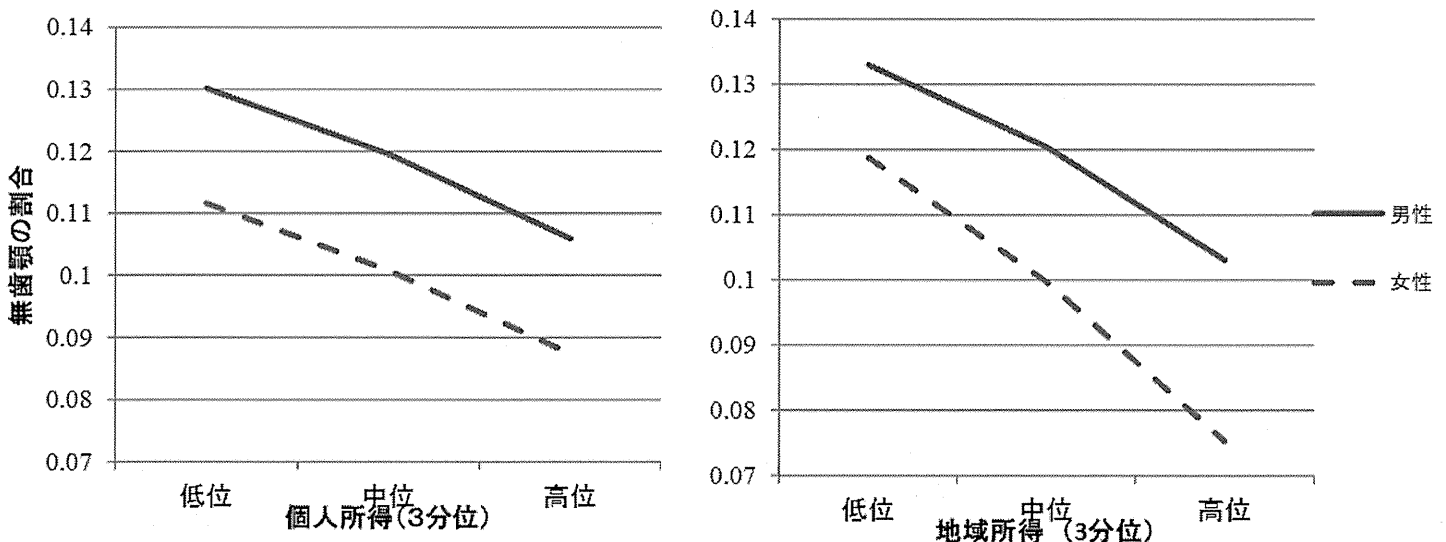


図. 無歯顎の割合と所得との関連についての男女差

個人所得が増えることで無歯顎が減る程度には男女差は見られないが、地域所得では、女性の方が地域所得が高くなるほど、無歯顎のリスクが減少する傾向がより強く見られた。

### 【お問い合わせ先】

埼玉県立大学 保健医療福祉学部 健康開発学科 口腔保健科学専攻  
助教 伊藤 奏(いとう かなで)

TEL & FAX: 048-973-4331

Email: ito-kanade@spu.ac.jp, kanade-i@umin.ac.jp

## <背景>

「健康日本 21(第2次)」などで、口の健康を含む全身の健康における、個人および地域間の格差が注目されている。所得の低い人々では高い人々に比べ口腔の健康が悪いというような個人の特性との関連と同時に、地域環境からの影響も受けている可能性が指摘されている。個人と地域の所得、および無歯顎(残っている歯が0本)に着目し、個人所得が同じレベルの人でも、裕福な地域に住む人では貧しい地域に住む人よりも口の健康状態が良いのかを検証した。

## <対象と方法>

2010~2012年にかけて、全国12都道府県31市町村の65歳以上高齢者169,215名を対象とした郵送調査を実施した(回収率66.3%)。歯の本数や所得に関する情報が得られた対象者79,563名のデータを使用し、無歯顎の有無と個人及び地域所得との関連を同時に検討するマルチレベル分析という統計手法を用いて検証した。

## <結果>

性別、年齢、婚姻状態、教育歴、及び歯科医院密度を調整した上で、個人所得と地域所得のどちらも高いほど無歯顎になるリスクが減少する傾向が見られた(個人所得(100万円ごと)の無歯顎オッズ比=0.90(95%信頼区間[0.88 - 0.91])、地域所得(100万円ごと)の無歯顎オッズ比=0.43(95%信頼区間[0.27 - 0.63])。また、所得と無歯顎との関連についての男女差は、女性が男性に比べて、より地域所得が高い地域に住むほど、無歯顎になるリスクが統計学的有意に小さくなることが示された( $p < 0.001$ )。

## <結論>

個人の所得が同じレベルの人でも地域所得が高い地域に暮らす人では無歯顎のリスクが低く、特に女性では、地域所得の影響をより強く受けていることが明らかとなった。

## <本研究の意義>

個人特性に加え地域特性の影響も受けていることが明らかになった。無歯顎を防ぐためには個人に対するアプローチだけでなく、地域経済水準の向上や地域に暮らすすべての人に対する公衆衛生的アプローチによって社会環境的な要因を改善し健康な地域づくりを進める必要性が示唆された。

## <論文発表>

Ito K, Aida J, Yamamoto T, Otsuka R, Nakade M, Suzuki K, Kondo K, and Osaka K: Individual- and Community-level Social gradients of Edentulousness. *BMC Oral Health*; 2015;34 (doi:10.1186/s12903-015-0020-z, 2015.03.11 published online first).

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