

学位論文の要旨

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学位論文名 Inconvenience of Living Place Affects Individual HbA1c Level
in a Rural Area in Japan: Shimane CoHRE Study

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論文内容の要旨

INTRODUCTION

For effective prevention of diabetes, it is essential to clarify as many risk factors as possible. In terms of risk factors for diabetes and obesity, intensive studies have been performed on genetic factors, individual lifestyle such as exercise and eating habits. In addition to such classical risk factors, socio-geographical factors have been focused as a potential risk factor for obesity and/or diabetes. Recently, we showed that the altitude of the residential area affected salt intake and hypertension in a rural area. Based on these observations and previous studies, we hypothesized that altitude, one of the basic geographical features of a residential area, could affect glycemic control of individuals in a rural area, which may influence the risk of diabetes. To examine the hypothesis above, the objective of this study was to clarify the relationship between the altitude of a residential area and individual Hemoglobin A1c (HbA1c) level.

MATERIALS AND METHODS

This cross-sectional population-based study was conducted as a part of the Shimane CoHRE Study, a cohort study designed to determine risk factors of lifestyle-related diseases. A thousand and sixteen participants living in a mountainous region in Japan were recruited at health examinations performed in Un-nan City in 2012.

Interviews were done in a health examination regarding the history of hypertension, dyslipidemia and diabetes. Medications for diseases were confirmed by reviewing prescription

records. Regular physical activity, alcohol consumption, smoking and driving habit were obtained in the interview. Blood pressure (BP) was measured twice at the site with automatic sphygmomanometers after a 15-min of rest in the sitting position, and the lower value was taken as the representative BP. Serum was taken from the participants, high-density and low-density lipoprotein cholesterol (HDL-C and LDL-C, respectively), triglycerides (TG), fasting blood glucose (FBS), and HbA1c were measured by standard methods. The altitude of residence was estimated with a geographic information system (GIS) based on the address of participants. The distance to the nearest primary (clinics) and secondary medical facilities (middle-sized hospitals) and to the nearest grocery stores was calculated using a GIS. These distances were not estimated as a straight-line distance but as the shortest distance along with real roads on a map.

For univariate analyses, ANOVA, the contingency table analysis, the nonparametric Mann–Whitney U test and Spearman’s rank method were employed when appropriate. Parameters influencing HbA1c were then analyzed by the linear regression analysis. $P < 0.05$ was considered statistically significant.

The study protocol was approved by the Research Ethics Committee of Shimane University.

RESULTS AND DISCUSSION

We found a positive correlation of the altitude with HbA1c level in residents even under consideration of other confounding factors. This was shown in both two linear regression models using the altitude either in real values or in the form of a categorized variable. Further, when a standardized β was taken into account, the effect size of altitude was as large as that of body mass index (BMI), while HDL-C and TG had only a marginal effect. Therefore, the altitude had as a robust effect as a classical risk factor, BMI, in this studied population.

The influence of altitude on health may be mediated by oxygen concentration, climate, including temperature, and physical burden caused by slopes. It was reported that staying at an altitude of 1000 m or higher improved insulin resistance. However, it was not likely that climate and oxygen concentration (thin air) had a significant influence on diabetic status in our population because the altitudes of residence were less than 500 m.

On the other hand, it was possible that slopes around residential areas at a high altitude hampered physical activity and worsened diabetic status. This was more likely if the age of the population studied here was considered. However, the observation that physical activity *per se* had no significant effects on HbA1c did not support this hypothesis. Daily use of cars may reduce physical activity in any way, which may erase potential effects of altitude (or slope) on physical activity.

Inconvenience is another key concept when the influence of altitude on health is considered. In another word, inconvenience underlying high altitude may be a major mediator of the influence

of altitude. In the present study, distance not to primary but to secondary medical facilities was associated with HbA1c level. This was an interesting observation since both the distance to primary and to secondary medical facilities were increased significantly along with the altitude. According to previous studies, diabetics living in this area tended to opt for medical facilities in distant urban areas. This tendency may contribute to the above observations. On the other hand, distance to a secondary medical facility can also be a substitute for other unknown confounders.

The distance to the grocery store did not affect the HbA1c level of the linear regression model. Distance to grocery stores does not always affect the food consumption.

The altitude may have additional effects on HbA1c through pathways other than the inconvenience (or distance to medical facilities and grocery stores). To test this possibility, a model including all the parameters for the inconvenience and the altitude was examined. This model, however, did not improve the fitness of the model and, further, caused a distorted result, i.e., the effect of BMI on HbA1c, which was robust in other models, was disappeared. This might be due to substantial correlations of the parameters with one another.

CONCLUSION

HbA1c was significantly associated with the altitude of residence even after adjustment of other potential factors. Distance to medical facilities, especially to secondary medical facilities, was suggested to be an important factor mediating the influence of the altitude.