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# Residential Areas vs. Home Environment: Impacts Analysis of Surrounding Factors on Children's Health Using the Longitudinal Survey of Newborns in Japan

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# Residential Areas vs. Home Environment: Analysis of Surrounding Factors on Children's Health Using the Longitudinal Survey of Newborns in Japan


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## Abstract

This study analyzes how residential area and home environment impact children's health, specifically the likelihood and severity of colds and influenza infections. Based on an analysis of the Longitudinal Survey of Newborns in the 21st Century in Japan, we showed that there are separate influencing factors for colds and influenza. The study also confirmed that the influence of the home environment is greater than that of the residential area. Moreover, even after controlling for individual effects, the influence of children's attributes remains significant. Especially, children become less susceptible to infectious diseases as they grow older.



**Keywords:** Residential Area, Home Environment, Children's Health, Colds, Influenza, Longitudinal Survey of Newborns

## 1. Introduction

There are many studies analyzing the effects of the residential area and home environment on children's health and their genetic and physical problems. The early years are a critical stage of development for children, and if they are not properly supported and nurtured, it could have significant ramifications in later life (Christian et al., 2017). Since improving children's surrounding environment is essential for their healthy growth, much research on this topic is being conducted in many countries. Among this research, many studies have been conducted on children's health, for example on cold, infectious diseases, and asthma, and its relationship to residential areas, housing, and home environment (e.g., Dong, 2008; Solari and Mare, 2012: Shmeer, 2016).

As long-term mortgages of over 25 years are quite common in Japan[1], it is common to buy a new house before the first child reaches school-going age[2]. However, such changes in the place of residence may affect children's health. Gambaro (2016) focused on moving homes and examined the effect of frequent moving on children's health in their early childhood. Similarly, Morris et al. (2017) used the data from the UK to verify the presence of exacerbating mental illness in children after moving.

Very few studies in Japan focus on the effect of moving a new house on children's health before or after they begin attending school. Therefore, to address this gap in the literature, this study analyzes the impact of residential area and home environment on children's health in their early years through a panel analysis of the data on families who undertook such a housing move.

For this purpose, we use the data from the "Longitudinal Survey of Newborns in the 21st Century (hereinafter "newborns' data")" conducted by the Ministry of Health, Labor and Welfare (MHLW) in Japan[3]. The newborns' data is a type of panel data that the MHLW collects each year from the parents of children born in January and July of 2001. The first survey was conducted in

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1 Japan Housing Finance Agency https://www.jhf.go.jp/files/400351738.pdf (21 October 2022)
2 MLIT https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00600630&tstat=000001017729&cycle=8&year=20211&month=0&result_back=1&tclass1val=0 (21 October 2022)
3 MHLW https://www.mhlw.go.jp/english/database/db-hw/newborns6th/2-4.html (21 October 2022)

2001 Aug/2002 Feb with a sample size of 47,015. Despite the loss of some samples in the process, the survey was still able to maintain a sample size of 36,136 by its eighth year. Although the newborns' data includes the yearly data of the same children, it is an unbalanced panel that does not contain continuous data on housing. This study focuses on the residential area and housing environment data in the newborns' data. Questions regarding residence were introduced into the survey in the third and eighth surveys.

The newborns' data surveyed children born in January and July, but the months the data were collected varied. Specifically, in the third survey, those born in January were surveyed in August and those born in July were surveyed in February. Since this seasonality may distort the estimation results, we limited our sample to the children born in January. Furthermore, to avoid duplication of household and surrounding environment data, data for households with twins and triplets were excluded from the sample. We also used responses only from mothers to avoid respondent bias.

The novelty of this study is that it considers the impact of both residential area and home environment on children's health. This is an evolution from previous studies that clarified the individual relationship of children's health with the residential area, houses, home environment, and so on.

This paper is organized as follows. Section 2 provides an overview of the literature and the position of this study. Section 3 describes the analysis method and data. Section 4 presents the results of the analyses, and Section 5 discusses them. Section 6 concludes and presents policy implications.

## 2. Literature

Previous studies have analyzed factors that affect children's health, and they can be broadly classified into five categories: Residential area, Outdoor play, Houses, Home environment, and Attributes and customs of the child.

For the Residential area category, Hüttenmoser (1995) showed that living in areas with heavy traffic worsened motor development in early childhood, employing Swiss micro cross-section data.

Jia et al. (2019) showed that greater walkability in residential neighborhoods may lead to lower obesity in children by promoting physical activity, using micro panel-data from the United States for children from kindergarten to 8th grade. Poulain et al. (2020), employing German micro cross-section data, found that higher road ratios in residential areas was associated with increased obesity in children aged 3–19 years. Edwards and Bromfield (2009) affirmed that parents' perception of neighborhood safety mediated the relationship between neighborhood socio-economic status and behavioral problems in young children using Australian micro cross-section data.

There are many studies that focus on the effects of Outdoor play. Most measure the relation between Outdoor play and children's health and residential environment (Fjørtoft, 2004). Fan and Chen (2012) showed that enriching recreational resources, such as parks in a neighborhood, improved the health of children aged 6–17 years in that neighborhood, using American micro cross-section data on outdoor play and children's health. Feng and Astell-Burt (2017) focused on surrounding green spaces and confirmed their positive influence on children's health using Austrian micro panel-data for children aged 0–13 years.

For Houses, previous studies have focused on types of housing, yards, ownership, housing density, and more. Moore et al. (2020) used Canadian micro cross-section data to show that children aged 5–17 living in detached houses spend more time walking and cycling, with more physical activity outside. Using micro panel-data on early childhood in low-income households in the United States, Miller et al. (2020) found that the larger the yard of the house, the more physical activity the children engage in. These can be interpreted as an indication of the superiority of detached housing. Schüle et al. (2016), using German cross-section data, revealed that living in a housing complex leads to obesity in early childhood because of limited access to private gardens and restricted outdoor activity. There are also studies that analyze the impact of the number of residential floors in apartment buildings on children's health. Oda et al. (1989), using Japanese micro cross-section data, showed that living on higher floors delayed the physical and mental development in young children because of restricted outings. Evans et al. (2002) pointed out that high housing density worsens children's health and causes behavioral problems and infections. Many previous studies demonstrate the same results regarding housing density (e.g., Liddell and Kruger, 1989, Widmayer et al., 1990, Malaty and Graham, 1994, Ertem et al., 2003, Solari and Mare, 2012). Dong et al. (2008) showed that large living areas and many rooms in houses suppress the prevalence of respiratory illness in children. Green and White (1997), Boyle (2002), and Haurin et al. (2002) found that children from high-income homeowner families are less likely to develop behavioral problems.

Home environment also affects children's health. Wang et al. (2017) revealed that low-income levels in the household and parents' low educational backgrounds increase the probability of children aged 9–12 years being obese, using micro cross-section data from Hong Kong. Ertem et al. (2003), and Malaty and Graham (1994) indicated that the high-income level of households and mothers' high educational background suppress infectious diseases in children. Quihui et al. (2006) used the data on intestinal parasitism in two Mexican states and found that mothers' unemployment and low education level represented high risks of infection in children. Conversely, Nozaki and Matsuura (2020) found that mother's employment has no effect on school-aged children's development, using the newborns' data, the same data that has been used in this study.

Children's attributes, which include constitution, lifestyle etc., also affect their health. Ball (2002) used U.S. micro-panel data to identify a common cold constitution among children. Baker et al. (1998) also verified that there is a negative relationship between the duration of breastfeeding and the onset of infectious diseases in infants. Ertem et al. (2003) averred that short breastfeeding sessions are more likely to cause pylori infection in kindergarten and elementary school children, using micro cross-section data from Turkey. In addition, Sinha et al. (2003) found that breastfeeding has an effect on the immunity of infant girls, using American micro cross-section data. Nakamuro et al. (2015) found that excessive time spent watching television or playing video games has an increasing effect on obesity in school-aged children. Moreover, Hinkley et al. (2018) indicated that television watching may be adversely, and outdoor play favorably, associated with pre-school children's social skills.

Previous studies on children's health are reclassified into four factors, as shown in Figure 1. In addition, we assume that children's outdoor play is related to both the residential area and housing environment. Based on what we have learnt from previous studies, this study merged four factors into three, and surrounding environment into residential area, home environment, and attributes. It simultaneously analyzes these three factors and clarifies their relationship with children's health.

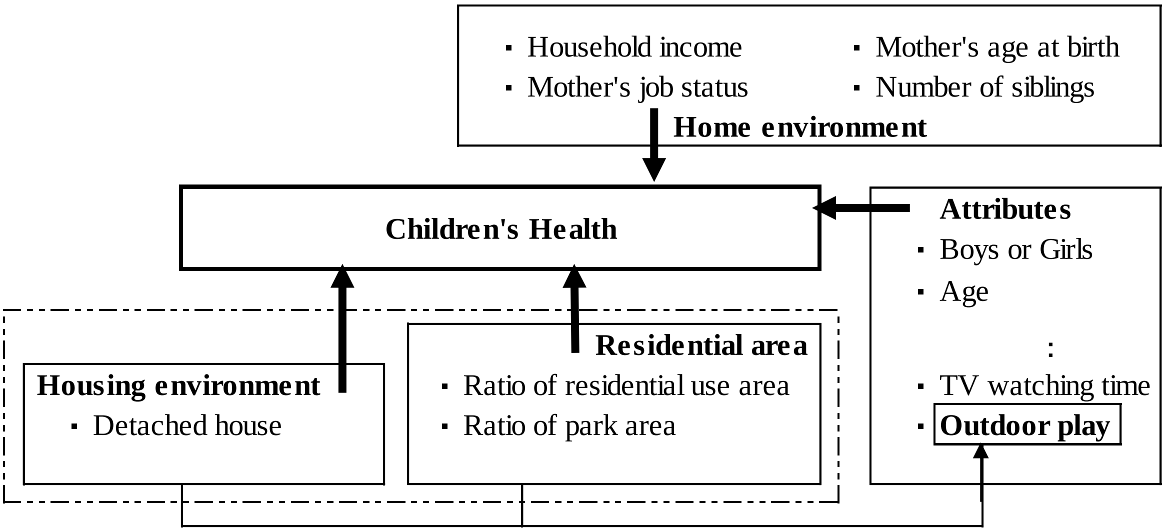


Figure 1 The factors of environments for children's health

## 3. Method

In this study, all data are first pooled and then analyzed by logistic regression using maximum likelihood. The dependent variable of our model is a binomial variable that takes the value "0" when the child is not infected (from cold, influenza, or similar diseases), and "1" when infected. The estimation equation is as follows:

$$Y_i^* = \alpha + \sum_{k=1}^{n} \beta_k X_{ik} + u_i \qquad (1)$$

$$Y_i = \begin{cases} 1 & (Y_i^* > 0) \\ 0 & (Y_i^* \leq 0) \end{cases}$$

Here, $Y$ represents the dependent variable, $\alpha$ represents the constant term, $\beta$ represents the regression coefficient, $k$ represents the number of explanatory variables, $X$ represents the explanatory variable, and $u$ represents the error term.

Next, the panel analysis allows for unobserved individual effects, including effects in error terms, to be observed (Morris et al., 2017; Boyle, 2002; Haurin et al., 2002). The model formula for such individual effect ($Ai$) is as follows.

$$Y_{it}^{*} = \alpha + \sum_{k=1}^{n} \beta_k X_{itk} + A_i + \varepsilon_{it} \qquad (2)$$

$$Y_{it} = \begin{cases} 1 & (Y_{it}^{*} > 0) \\ 0 & (Y_{it}^{*} \leq 0) \end{cases}$$

Here, $t$ represents the year of the survey (2004 and 2009), while $\varepsilon$ represents the error term.

Table 1 shows the descriptive statistics of the dependent and independent variables. The independent variables are divided into three categories, residential area, home environment, and attributes, as shown in Figure 1.

The residential area factor has two types: area and housing. Area has three variables: *Ratio of residential ground*, *Ratio of park area*, and *Regional average rent*. These were used to indicate the quality of the surrounding environment, based on Midouhas and Platt (2014). The newborns' data includes the municipality code, which allows us to know the location of subjects. The data provides complementary information about surrounding environments, thus making it possible for us to assess the impact of housing location on children. Using the municipality code, we identified the area where each child is living, and the *Ratio of residential ground* is calculated by dividing the area of the residential ground by the total area of the particular area, and it was used as a variable to express the density of residential housing in the area. Similarly, we calculated the *Ratio of park area*, which is used to measure the relation between natural surroundings and children's developmental problems (Feng and Astell-Burt, 2017). Moreover, the *Regional average rent* (unit price converted per square meter) was used to grasp city facilities, area density, and so on in the region, following Harkness and Newman (2005). Table 2 presents the sources from which data were obtained on residential area variables. Some data were obtained through hearing from municipalities and were confirmed. Furthermore, housing has one variable: *Detached house dummy*. This dummy variable is coded as “1” if the child lived in a detached house and “0” otherwise.

Table 1: Descriptive statistics

| **Variable name** | **Mean** | **Standard deviation** | **Minimum** | **Maximum** |
|---|---|---|---|---|
| Cold or influenza (binomial variables) | 0.708 | 0.455 | 0.000 | 1.000 |
| Cold and influenza (Ordinal variables) | 0.136 | 0.343 | 0.000 | 1.000 |
| **Residential area** | | | | |
| Ratio of residential ground | 0.277 | 0.239 | 0.000 | 0.979 |
| Ratio of park area | 1.080 | 0.415 | 0.161 | 3.099 |
| Regional average rent [thousand yen] | 0.019 | 0.020 | 0.000 | 0.158 |
| Detached house dummy | 0.577 | 0.494 | 0.000 | 1.000 |
| **Home environment** | | | | |
| Number of siblings [persons] | 1.018 | 0.792 | 0.000 | 8.000 |
| Household income [one million yen] | 5.860 | 3.155 | 1.000 | 48.680 |
| Mother’s employed dummy | 0.442 | 0.497 | 0.000 | 1.000 |
| Mother’s age at birth [age] | 30.651 | 4.275 | 16.000 | 48.000 |
| **Attribute** | | | | |
| Boys dummy | 0.513 | 0.500 | 0.000 | 1.000 |
| Duration of Breastfeeding [months] | 0.985 | 0.120 | 0.000 | 1.000 |
| School-aged children dummy | 0.480 | 0.500 | 0.000 | 1.000 |
| Watching TV time [hours per day] | 2.189 | 1.159 | 0.000 | 5.000 |

Table 2: Source of residential area variables

| Variable name | Source |
|---|---|
| **Ratio of residential ground** | Residential ground: Ministry of Land, Infrastructure, Transport and Tourism (MLIT), "City planning annual report." Total area: MLIT Geographical Survey Institute, "Statistical reports on the land area by prefectures and municipalities" |
| **Ratio of park area** | Park area: MLIT, "City park improvement level report." Inhabitable land area: MLIT Geographical Survey Institute, "Statistical reports on the land area by prefectures and municipalities" |
| **Regional average rent** | Ministry of Internal Affairs and Communications (MIC), "Housing and land survey" |

The variables under home environment factor are *Number of siblings*, *Household income*, *Mother's job status dummy,* and *Mother's age at birth*. The *Number of siblings* is a tally of all brothers and sisters. The *Household income* variable is the sum of both parents' annual income as well as other annual income received by the household. The *Mother's job status dummy* is a dummy variable corresponding to the mother's employment situation. It is coded as "1" when the mother was: looking for a job, employed full-time, employed part-time, self-employed, or otherwise working. Since fathers worked full-time in over 90% of cases, fathers' employment status was not considered as a variable. The *Mother's age at birth* is a numerical variable of the mother's age when the child was born. This variable is also a proxy for the mother's education level, because in Japan there is a correlation between educational background and childbearing age[4].

The attribute factor has two types: basic information and miscellaneous childhood circumstances. The former type comprises the variables *Boys dummy*, *Breastfeeding dummy*, and *School-aged children dummy*. The latter type consists of *Watching TV time*. The *Boys dummy* was coded as "1" if the child is a boy. The *Duration of breastfeeding* refers to the number of months a child was breastfed. The *Boys dummy* and *Breastfeeding dummy* are time-invariant variables. The

[4] Osaka City https://www.city.osaka.lg.jp/kodomo/cmsfiles/contents/0000459/459136/P391-416zentaiban_Part11.pdf (21 October 2022)

*School-aged children dummy* was used to distinguish between the 3rd and 8th survey data. By the time of the 8th survey, the children had entered elementary school. *Watching TV time* was surveyed by time zone; its actual value was obtained by converting the obtained value to the central value or central tendency. Concretely, if the child did not watch TV at all, it was converted to 0 hours and less than 1 hour into 0.5 hours. After this, it was measured in hours, and the maximum value was five hours. The variables of the home environment and attribute factors were mainly adopted based on the estimated results of Nakamuro et al. (2015) and Nozaki and Matsuura (2020), which used the same survey this study used.

In this analysis, multiple municipality dummy were set as explanatory variables to identify the municipality in which each survey subject resided. The municipal codes were used to control for the impact of epidemics of infectious diseases.

## 4. Analysis Results

The results of analysis and test for colds and influenza are described below, respectively.

### 4.1 Analysis results for colds

Table 3 shows the results of the pooled and variable effects model's analyses. Following the analysis, we performed the Log Likelihood Ratio-test to verify whether individual effects could be significantly detected. The null hypotheses without individual effects were then rejected; the chi-square test statistic of cold models is 216.561 (Prob>chi2 = 0.000). As a result, the random effects model was adopted. Hence, the following results focus primarily on the results of the random effects model.

Variables that suppress children's infection are *Detached house dummy*, *Number of siblings*, and *School-aged children dummy*. On the other hand, variables that facilitate infections in children are *Mother's age at birth*, *Breastfeeding dummy*, and *Watching TV g time*.

Table 3 Estimated Results (Dependent variable: Colds)

| Models | Pooled | | Random effects | |
|---|---|---|---|---|
| | Coefficient (Standard error) | Marginal effect (Standard error) | Coefficient (Standard error) | Marginal effect (Standard error) |
| Ratio of residential ground | -0.153 | -0.031 | -0.192 | -0.033 |
| | (0.113) | (0.023) | (0.139) | (0.024) |
| Ratio of park area | -0.025 | -0.005 | 0.01 | 0.002 |
| | (0.984) | (0.197) | (1.208) | (0.205) |
| Regional average rent | 0.063 | 0.013 | 0.091 | 0.015 |
| | (0.071) | (0.014) | (0.087) | (0.015) |
| Detached house dummy | -0.050* | -0.010* | -0.063* | -0.011* |
| | (0.030) | (0.006) | (0.037) | (0.006) |
| Number of siblings | -0.102*** | -0.020*** | -0.110*** | -0.019*** |
| | (0.018) | (0.004) | (0.022) | (0.004) |
| Household income | -0.004 | -0.001 | -0.005 | -0.001 |
| | (0.004) | (0.001) | (0.005) | (0.001) |
| Mother’s job status dummy | -0.006 | -0.001 | -0.006 | -0.001 |
| | (0.028) | (0.006) | (0.034) | (0.006) |
| Mother’s age at birth | 0.008** | 0.002** | 0.010** | 0.002** |
| | (0.003) | (0.001) | (0.004) | (0.001) |
| Boys dummy | -0.01 | -0.002 | -0.009 | -0.002 |
| | (0.027) | (0.005) | (0.034) | (0.006) |
| Breastfeeding dummy | 0.374*** | 0.075*** | 0.444*** | 0.075*** |
| | (0.108) | (0.022) | (0.136) | (0.023) |
| School-aged children dummy | -1.018*** | -0.204*** | -1.221*** | -0.207*** |
| | (0.030) | (0.006) | (0.038) | (0.006) |
| Watching TV time | 0.076*** | 0.015*** | 0.080*** | 0.014*** |
| | (0.013) | (0.003) | (0.015) | (0.003) |
| Constant term | 0.779*** | | 0.953*** | |
| | (0.202) | | (0.251) | |
| City Dummies | Yes | | Yes | |
| Obs. | 28,564 | | 28,564 | |
| Groups | - | | 17,755 | |
| psedo-R2 | 0.057 | | - | |
| chi2_c | - | | 216.561 | |
| p | 0.000 | | 0.000 | |

Note: (1) Superscripts ***, **, * denote significance at the level of 1%, 5%, and 10%, respectively.
(2) The estimation results of the municipality dummy are not displayed.
(3) The marginal effect was calculated using the averaged data of each variable.

Table 4 Estimated Results (Dependent variable: Influenza)

| Models | Pooled | | Random effects | |
|---|---|---|---|---|
| | Coefficient (Standard error) | Marginal effect (Standard error) | Coefficient (Standard error) | Marginal effect (Standard error) |
| Ratio of residential ground | -0.05 | -0.006 | -0.05 | -0.006 |
| | (0.148) | (0.017) | (0.148) | (0.017) |
| Ratio of park area | 0.018 | 0.002 | 0.018 | 0.002 |
| | (1.293) | (0.149) | (1.293) | (0.149) |
| Regional average rent | 0.002 | 0.000 | 0.002 | 0.000 |
| | (0.094) | (0.011) | (0.094) | (0.011) |
| Detached house dummy | -0.038 | -0.004 | -0.038 | -0.004 |
| | (0.038) | (0.004) | (0.038) | (0.004) |
| Number of siblings | 0.048** | 0.005** | 0.048** | 0.005** |
| | (0.023) | (0.003) | (0.023) | (0.003) |
| Household income | -0.006 | -0.001 | -0.006 | -0.001 |
| | (0.006) | (0.001) | (0.006) | (0.001) |
| Mother's job status dummy | 0.189*** | 0.022*** | 0.189*** | 0.022*** |
| | (0.037) | (0.004) | (0.037) | (0.004) |
| Mother's age at birth | 0.0000 | 0.000 | 0.000 | 0.000 |
| | (0.004) | (0.000) | (0.004) | (0.000) |
| Boys dummy | 0.116*** | 0.013*** | 0.116*** | 0.013*** |
| | (0.035) | (0.004) | (0.035) | (0.004) |
| Breastfeeding dummy | -0.153 | -0.018 | -0.153 | -0.018 |
| | (0.139) | (0.016) | (0.139) | (0.016) |
| School-aged children dummy | -0.403*** | -0.046*** | -0.403*** | -0.046*** |
| | (0.039) | (0.004) | (0.039) | (0.005) |
| Watching TV viewing time | -0.028* | -0.003* | -0.028* | -0.003* |
| | (0.015) | (0.002) | (0.015) | (0.002) |
| Constant term | -1.484*** | | -1.484*** | |
| | (0.257) | | (0.257) | |
| City Dummies | Yes | | Yes | |
| Obs. | 28,477 | | 28,477 | |
| Groups | - | | 17,698 | |
| psedo-R2 | 0.014 | | - | |
| chi2_c | - | | 0.003 | |
| p | 0.000 | | 0.000 | |

Note: (1) Superscripts ***, **, * denote significance at the level of 1%, 5%, and 10%, respectively.
(2) The estimation results of the municipality dummy are not displayed.
(3) The marginal effect was calculated using the averaged data of each variable.

### 4.2 Analysis results for influenza

Table 4 shows the results of the analysis for influenza. Following the analysis, the Log Likelihood Ratio-test was performed to verify whether individual effects could be significantly detected. The null hypotheses without individual effects were then rejected; the chi-square test statistic of influenza models is 0.003 (Prob>chi2 = 0.000). As a result, the random effects model was adopted. Hence, the following results focus primarily on the results of the random effects model.

Variables that suppress children's infection are *Watching TV time* and *School-aged children dummy*. On the other hand, variables that facilitate infections in children are *Mother's job status dummy*, *Number of siblings*, and *Boys dummy*.

### 4.3 Discussion

Children's infections in both the cold and influenza data show a negative relationship with the *School-aged children dummy*, confirming that the probability of getting infected decreases with age. This is a novelty of this study as it was only possible to confirm this through panel analysis.

There are many differences between the cold and influenza analysis results, with the only common influential variable being the *School-aged children dummy*. According to Moore et al. (2020), living in detached houses improves children's health. Our estimates showed that it was also significant for colds infection. Many previous studies have verified that detached houses encourage children to play outdoor, which has a positive effect on their health. This implies that colds can be prevented by improving children's physical fitness. However, influenza was not related to an individual's physical fitness because our results showed no significant improving effect of detached houses on influenza infection.

In addition, the effect of *Watching* TV time on children's infection rate suggested that not playing outside may also be detrimental to children's health. Therefore, the significant effect of *Watching TV time* on increasing children's colds may be related to the fact that children who watch TV for a long time tend to be unhealthy due to a lack of exercise. This result is related to the findings of Nakamuro et al. (2015) and Hinkley et al. (2018). For influenza, shorter *Watching TV time* has been shown to prevent sicknesses. Conversely, the more opportunities there are for going out, the higher the risk of infection through increased opportunities of coming in contact with people. Similarly, for influenza, having a working mother and more siblings meant more contact with people, making it likely that there was an increased chance of transmission. On the one hand, more siblings mean denser housing, which corresponds to the findings of Evans et al. (2002), who found that highly dense housing worsens children's health. On the other hand, it is assumed that having many siblings suppresses colds because of increased physical activity from playing with siblings.

In the colds analysis, duration of breastfeeding was found to have a positive effect, which is contrary to Baker et al. (1998), who found a negative relationship between duration of breastfeeding and children's health. There was also a correlation between the mother's age at birth and children's likelihood of catching colds. Since neither of these values is significant for influenza, this suggests that factors related to physical fitness and constitution are only related to the onset of colds. Furthermore, the Boy dummy was statistically significant for influenza. This could be because boys engage in a wider range of outdoor physical activities than girls. However, more data would be required to confirm this.

Similar to the findings of Quihui et al (2006), household income had a negative sign, indicating that the higher the income of a household, the less likely its children are to be infected. However, unlike previous studies, the results were not statistically significant. We presume this could be because there is not much variation by social class in this regard in Japan, because of the high level of hygiene awareness, regardless of income. This could be one reason why the regional environment variables were not statistically significant in both analyses. It is possible to analyze individual effects arising from hierarchical regional characteristics, but this requires a separate detailed investigation.

## 5. Conclusion

This study confirmed whether residential area or home environment has a greater effect on children's health through a panel analysis of data that included housing moves. According to the analysis, we learned the following things.

This analysis clarified that there are separate influencing factors for colds and influenza. It was suggested that detached houses have a positive impact on children's health only in the case of colds, whereas for influenza, increased opportunities for human contact may induce the onset of this disease. Therefore, it was suggested that in the case of influenza, it is necessary to be careful and avoid going outdoors or interacting with people during an epidemic. This study also revealed that children become less susceptible to infectious diseases as they grow older. This result indicates that it is important to prevent infectious diseases in preschool-aged children. In the case of the colds, physical exercise may also be a preventive measure.

The above results of our analysis indicate that the influence of the home environment is greater than the influence of the residential area. Moreover, even after controlling for individual effects, the influence of attributes still exists.

This study targeted children born in 2001 and analyzed changes in the third and eighth surveys. As the analysis was a two-point point panel analysis, rather than a cross-section analysis, it allowed for more robust results to be obtained. Therefore, it is desirable to reverify the results by setting the data in a multi-point panel format using the newborns' data and it may fill further the gaps between this study and the previous ones. This is a potential prospect for future studies.

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