Original article

Relationship between out-of-facility deliveries and distance and travel time to delivery facilities in Hokkaido, Japan: an ecological study

Author

Yoshihiro Saito[a], Toshiaki Asakura[b], Takashi Kimura[b], Takeshi Umazume[a], Hidemichi Watari[a], Akiko Tamakoshi[b]

Author's affiliations

[a]Department of Obstetrics and Gynecology, Hokkaido University Graduate School of Medicine, Sapporo, Japan

[b]Department of Public Health, Hokkaido University Faculty of Medicine, Sapporo, Japan

Corresponding author

Akiko Tamakoshi, M.D.,

Department of Public Health, Hokkaido University Faculty of Medicine, Sapporo, Japan,

N15W7, Kita-ku, Sapporo 060-8638, Japan

Email Address: tamaa@med.hokudai.ac.jp

19 Telephone No.: +81-11-706-5068

20 Fax No: +81-11-706-7805

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22 **Running title:** Out-of-facility delivery

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24 **Word count:** manuscript 3,922 words, abstract 248 words

25

Abstract

Aim: This study aimed to investigate the relationship between the distance and travel time from each municipality to the nearest delivery facilities in the other municipalities and the frequency of out-of-facility deliveries in Hokkaido.

Methods: Vital Statistics from 2016 to 2020 were used. For municipalities without delivery facilities, the distance and travel time from the town office of each municipality to the nearest delivery facility was measured using Google maps. Negative binomial regression with an offset term was used to calculate the relative risks (RRs) and 95% confidence intervals (CIs) of out-of-facility delivery for distance (<30 , 30–59 , ≥60 km), and travel time by car (<30, 30–59, and ≥60 min) from the town office to the nearest delivery facility compared with the presence of delivery facilities.

Results: The overall rate of out-of-facility deliveries in Hokkaido was 2.1‰; in municipalities with delivery facilities, 1.8‰, and in municipalities without delivery facilities, 3.1‰. The adjusted RRs (95% CIs) for out-of-facility deliveries were significantly higher in municipalities with less than 30 km and travel time of less than 30 min to delivery facilities, 2.63 (1.34–5.17) and 2.76 (1.36–5.58), respectively, compared to municipalities with delivery facilities. However, the adjusted RR of out-of-facility delivery for municipalities ≥30 km was higher, although the difference was not significant.

Conclusions: Even in municipalities with a distance to delivery facilities of less than 30 km or travel time of less than 30 min, we should keep in mind the occurrence of out-of-facility deliveries.

Keywords: Hokkaido, out-of-facility delivery, out-of-hospital delivery, unplanned home birth, Vital Statistics in Japan

Introduction

An out-of-facility delivery is a delivery that occurs outside of a hospital or midwifery center, which should be avoided because it can cause hypothermia of the newborn in those born at low environmental temperatures and hyperbilirubinemia due to delayed umbilical cord ligation.[1,2] In Japan, Miyazono et al.[3] reported a mortality rate of 4.7% in 2015 for prehospital births, which is a risk that is more than ten times higher than the 3.7‰ perinatal mortality rate in Japan in the same year.

The incidence of out-of-facility deliveries has been reported in different countries, with Australia reporting 4.6‰[4], France 3.0‰[5], and Israel 15‰[6]. In recent years, most Japanese have given birth in hospitals or midwifery centers, and those who deliver at home or in other facilities are rare. In a Japanese report, Yoshii et al.[1] in Osaka and Hanaki et al.[7] in Tsukuba reported that the percentages of out-of-facility deliveries in their limited areas were 5.9‰ and 5.5‰, respectively. However, there is currently no report on the number of out-of-facility deliveries in Hokkaido, which is the largest prefecture in Japan with relatively low population density, and where the long distances to delivery facilities are problematic for pregnant women.

In Japan, the number of delivery facilities has been slowly decreasing along with the number of births. In 2021, the number of facilities for delivery was 985, a decrease of 23.1% from 14 years earlier.[8] It is clear that the decrease in the number of delivery facilities increased the distance and travel time to hospitals for pregnant women, especially when the only delivery facility in a municipality had

closed. Similar change have also occurred in Hokkaido; thus, it is significant to investigate the relationship between out-of-facility delivery and distance or travel time from municipalities to delivery facilities in Hokkaido, which has many rural areas. This study aimed to determine the number of out-of-facility deliveries in Hokkaido using Vital Statistics in Japan[9] and to investigate the relationship between the distance and travel time from each municipality without a delivery facility to the nearest delivery facilities in the other municipalities and the proportion of out-of-facility deliveries.

Materials and methods

Data collection

We used Vital Statistics in Japan[9] from 2016–2020. Japanese Vital Statistics are publicly available on the Internet and can be used free of charge by anyone. Vital Statistics on births are published annually and created by collecting and reorganizing birth certificates, which must be submitted within two weeks of the births in question. These statistics do not offer individual-level data but are published as data grouped at the municipality level. There is also a stratified version of birthplace at the municipality level, and the categories of birthplace are hospitals, clinics, midwifery centers, homes, and others. In this paper, out-of-facility deliveries were defined as births that occurred at home and at other places (excluding hospitals and midwifery centers) in each municipality and were picked from Vital Statics. It should be notified that the number of out-of-facility deliveries might include a small number of

planned home deliveries with midwives and the number of hospital deliveries might include a non-negligible number of planned hospital deliveries due to non-medical indications such as the distance between home and the delivery facility in Hokkaido.

In Hokkaido, pregnant women who live far from delivery facilities are sometimes either instructed to stay at hotels near delivery facilities after 36 weeks of gestation or induced to deliver.[10] The number of births in each municipality is determined based on the place of residence; so, even if a person who lived in a municipality without delivery facilities delivers in another municipality, it will be counted as a birth that occurred in the municipality of her own residence.

The total number of records from 179 municipalities was 162,372 births from 2016 to 2020. Four remote island municipalities, in which pregnant women cannot be transported by car to delivery facilities, were excluded from the analysis. A total of 162,114 births were included in this analysis after excluding 258 births that occurred in the four remote island municipalities (Figure 1).

Definition of the distance and travel time from municipalities to delivery facilities

Although we did not have individual-level of birthplace data and residence data, we tried to assess the impacts of distance or travel time to delivery facilities on out-of-facility deliveries. We defined them by municipality as follows. We divided the municipalities into those with or without delivery facilities inside their areas (Figure 2). As for municipalities without delivery facilities inside their areas, the

distance from delivery facilities was defined as the distance from the town offices of each municipality to the nearest delivery facility, and this distance was measured using Google maps. Similarly, the travel time by car was defined and calculated using Google maps. For municipalities with their own delivery facilities, the distance and travel time were not defined. The date and time using Google maps and calculated necessary values were March 10, 2022, between 16:00 and 18:00. If there were multiple delivery facilities in the most neighboring municipality, the delivery facility providing the highest level of perinatal care was selected as the nearest delivery facility.

Confounding variables

We obtained our data from the 2020 population census data[11] and 2020 specific health examination data[12]. Since nuclear family households have limited help in transporting pregnant women to delivery facilities, the percentage of nuclear families was obtained by dividing the number of nuclear families[11] by the number of private households[11] for each municipality. To evaluate whether municipalities are urban or rural, the population density and the rate of population change from 2015 to 2020 were used as they are expressed in the data[11]. As an economic indicator for each municipality, we also calculated the unemployment rate with the workforce population[11] and the employment population[11] of those aged at least 15 years. From the 2020 specific health examination data[12], the receiving rate of specific health examinations covered by national health insurance exists for the municipality level, and we

used this rate as a substitute for the degree of activities of public health nurses.

Statistical analysis

First, we summarized the basic descriptive information on births, out-of-facility deliveries, and other confounding variables by municipalities. Second, we performed univariate analyses with negative binomial regression with an offset term[13]. Counts of out-of-facility deliveries were used for the outcome, and the number of total births was used for the offset term to account for the variability between municipalities. We calculated relative risks (RRs) and 95% confidence intervals (95% CIs) of out-of-facility deliveries for delivery facility existence and the distance or travel time by car from the town office to the nearest delivery facility. We divided the distance into three categories; <30, 30–59, and ≥60 km. The threshold of 30 km was determined with reference to previous studies[14] that the rate of unplanned out-of-facility deliveries increases when the distance from the delivery facility is more than 30 km. In Hokkaido, the Hokkaido Medical Plan[15] states that the distance from all residences to delivery facilities should be within 100 km, and the allocation of delivery facilities was designed in such a policy. The setting of 60 km was arbitrarily determined between 30 km and 100 km. We also used a travel time index to help readers visualize the travel time for distances in Hokkaido, as different regions have different travel times by car for the same distance. Since the second stage of delivery takes approximately 60 min for primiparous women[16] and less than 30 min for parous

women[16], the categories of travel time were <30, 30–59, and ≥60 min. To clarify the degree of effects of distance, the predicted number of out-of-facility deliveries against total births was visualized with the univariate model.

Third, a multivariate analysis was performed to assess the relationship between the distance or travel time to delivery facilities and out-of-facility delivery, adjusting for confounding variables. The population density was transformed by the logarithm of 10 to ensure normality. There were no missing values for outcomes and explanatory variables. To validate categorical results, the restricted cubic spline was performed for the distance with the multivariate model. For knot positions, we used one or two knots and all patterns of knots from 5 km to 95 km. Those with 5 km bins were tested, and the best model, based on the Akaike Information Criteria value, was selected for the main result. The 95% CI of the cubic spline curve was obtained using the basic percentile bootstrap method[17]. We estimated the valid patterns of sampling 2000 times for the bootstrap method. All analyses were performed using Python 3.9, and Statsmodels v0.13.2 was used for regression analyses.

Ethical approval

Ethical approval was waived by the local ethics committee member.

Results

Table 1 shows the characteristics of the municipalities that were surveyed. Among the 175 municipalities surveyed in Hokkaido, 28 (16.0%) had their own delivery facilities while 62 (35.4%) municipalities without such facilities of their own had the nearest delivery facilities less than 30 km away from their town offices; 67 (38.3%) of them had ones between 30 and 59 km away, and 18 (10.3%) had ones at a distance of 60 km or more. The total number of births in Hokkaido, Japan, from 2016 to 2020, was 162,114, and the number of out-of-facility deliveries was 339 (2.1‰). In municipalities with delivery facilities, the total number of deliveries during the five-year period was 129,932, of which 240 (1.8‰) were out-of-facility deliveries. However, in municipalities without delivery facilities, the total number of deliveries was 32,182, of which 99 (3.1‰) were out-of-facility deliveries, a higher proportion than that in municipalities with delivery facilities.

Compared to municipalities with delivery facilities, the highest percentage of out-of-facility deliveries was found in municipalities that were ≤30 km away from delivery facilities (3.4‰, 66/19,542), and the percentage of out-of-facility deliveries was slightly higher in municipalities that were 30–59 km away (2.6‰, 27/10,449), and ≥60 km away (2.7‰, 6/2,191) (Table 1). Figure 3 is a plot of the total number of deliveries against the number of out-of-facility deliveries for each municipality. Each dashed line represents the predicted number of out-of-facility deliveries against the total number of births, obtained from the results of the univariate analysis, for the categories of distance

from town offices of each municipality to the delivery facilities, within 30 km, between 30 km and 59 km, and more than 60 km. The relationship between the total number of deliveries and the proportion of out-of-facility deliveries and the distance to delivery facilities is presented in Supplementary Figure 1. Compared to municipalities with delivery facilities, a higher percentage of out-of-facility deliveries occurred in municipalities without delivery facilities; however, the category of municipalities with the highest percentage of out-of-facility deliveries was municipalities in which the delivery facilities were <30 km away. However, the further away the delivery facilities were, the lower the total numbers of deliveries and of out-of-facility deliveries tended to be. The distance from each municipality to its nearest delivery facility was approximately proportional to the travel time by car and the Pearson's correlation coefficient between the distance and time was 0.96.

Table 2 shows the RRs (95% CIs) of out-of-facility delivery with reference to the municipalities with delivery facilities stratified by distance and travel time categories. Univariate analyses revealed that the risk of out-of-facility delivery was significantly higher for municipalities that did not have their own delivery facilities than for ones that had their own delivery facilities. Also, after the categorization of distance or travel time, the tendency of higher risk of out-of-facility delivery was maintained for the point estimates although the 95% CIs were wide. The adjusted RR (95% CI) for out-of-facility delivery was higher, 2.28 (1.15–4.52), in municipalities where there were no delivery facilities than in those where there were delivery facilities. When the distance from each

municipality office to the delivery facility was divided into categories, municipalities whose delivery facilities were less than 30 km away had significantly higher RR [2.63 (1.34–5.17)]. Conversely, even municipalities whose delivery facilities were 30–59 km or >60 km away did not show an increase in the adjusted RRs [1.31 (0.57–2.99), 1.44 (0.43–4.83)] for out-of-facility delivery. Relationship between the distance and travel time to delivery facilities were strongly correlated. Therefore, the RRs for out-of-facility delivery were higher in municipalities with a shorter travel time to delivery facilities than in those with a longer travel time.

The best model per the restricted cubic spline was the model with one knot at 75 km (Figure 4). The adjusted RR had a bi-modal shape where peaks were at approximately 15 km and 80 km, and the adjusted RR was below one from 40 km to 65 km. The 95% CI did not contain one for the left peak; however, overall, the confidence interval was relatively wide. It is noted that only six out-of-facility deliveries occurred in municipalities that were at least 60 km away from the nearest delivery facility.

Discussion

Main findings

First, the rate of out-of-facility deliveries in Hokkaido was 2.1‰. When municipalities with no delivery facilities were categorized by distance, the adjusted RR (95% CI) for out-of-facility delivery was significantly high, at 2.63 (1.34–5.17) in municipalities where the town office was less than 30 km away from the nearest delivery facility compared to municipalities with nearby delivery facilities. On the other hand, the adjusted RR for out-of-facility delivery in municipalities where the town office was ≥30 km away from the nearest delivery facility was higher, although the difference was not statistically significant.

Frequency of out-of-facility deliveries

This is the first study in Japan to use Vital Statistics[9] to deduce the relationship between the number of out-of-facility deliveries and the distance and travel time to delivery facilities. This study examined the relationship between the distance from delivery facilities and out-of-facility delivery; however, it did not distinguish between planned and unplanned out-of-facility deliveries. A key piece of information, the number of unplanned out-of-facility deliveries, is required to more accurately evaluate the relationship between the distance from delivery facilities and high-risk out-of-facility deliveries. In Japan, the number of planned home births attended by midwives, which are reported to be safe[18–21]

222 and unsafe[6,22], is not known. According to the Vital Statistics[9], midwifery center deliveries in 2016-
223 2020 accounted for 2.1‰ of all deliveries in Hokkaido, of which it is estimated that only about 10%
224 were planned home births attended by a midwife.[23] Therefore, the proportion of planned home births
225 attended by midwives in Hokkaido over the 5-year period of this study was expected to be roughly
226 0.2‰, and the proportion of unplanned out-of-facility deliveries was expected to be 1.9‰, which did
227 not differ significantly from the present results.

228 In previous Japanese studies conducted in Osaka[1] and Tsukuba[7], the rate of out-of-facility
229 deliveries was 5.5–5.9‰, estimated from the number of out-of-facility deliveries subsequently brought
230 to hospitals and the total number of deliveries in the region, and the present results were lower at 2.1‰.
231 However, the rate of out-of-facility deliveries in Japan, estimated using similar methods to those used
232 in this study, was 1.5‰, indicating that Hokkaido is a region with a relatively high percentage of out-
233 of-facility deliveries. The rates of out-of-facility deliveries in Osaka prefecture and Ibaraki prefecture,
234 where Tsukuba City is located, were 1.0‰ and 1.8‰, respectively, using the same method as was
235 employed in the present study; therefore, it is necessary to interpret the proportion of out-of-facility
236 delivery while paying attention to the study design, data collection method, and period covered.

237 Several national population-based studies similar to this one have been conducted abroad.
238 It was similar to the unplanned out-of-facility delivery rate of 1.4‰ for Finland with 1,052,559
239 deliveries[23] and 3.0‰ for France with 1,999,453 deliveries[5]. Delivery facilities are becoming

centralized in Finland and France, with 9.9% and 25.3%[5,24], respectively, living in locations more than 30 km and 35 km away from the delivery facility. In the present study, 7.8% of the deliveries in Hokkaido were performed at a minimum distance of approximately 30 km away from delivery facilities, which might be a shorter travel distance than that in France and Finland. In Finland, the government is involved in discussions about the centralization of the delivery facilities and uses an accessibility survey[25] to ensure the safety of centralizing delivery facilities. A study[26] noted the importance of education and protocol development for emergency medical services (EMS), which contributes to decreasing the hospitalization rate at birth for out-of-facility delivery facilities.[27] A survey of Japanese EMS in 2017 described a prehospital perinatal emergency as one existing in the border region between the perinatal and general emergency systems, which highlights the need to improve the prehospital perinatal system of medical care and education.[3] In Japan, research on centralization and out-of-facility delivery facilities should be conducted, and when centralization is carried out, the education of EMS and the establishment of a prehospital perinatal care system should be offered in collaboration with the government at the same time. In Hokkaido, we are now working with local governments to focus on perinatal education for EMS.

Relationship between the distance from the nearest delivery facility and the proportion of out-of-facility deliveries

It is fascinating to note that the rate of out-of-facility delivery was significantly higher in municipalities that were less than 30 km and 30 min away from delivery facilities than in municipalities with delivery facilities. There are three possible reasons for this observation. First, both pregnant women living near (less than 30 km) delivery facilities and perinatal staff may not have paid as much attention to unplanned out-of-facility delivery, which is not safe, as pregnant women living farther away did. Second, it is possible that there were more planned home births, which may be safe, were attended by midwives in municipalities relatively close to delivery facilities than in other areas. Finally, it is possible that planned home deliveries without the presence of medical providers, which is not safe, were clustered in municipalities around large cities where delivery facilities were located.

There are no reports in Japan that clarify the relationship between distance or travel time to delivery facilities and the proportion of out-of-facility deliveries; however, there are several reports from other countries. In a study of 1,517,599 births using French Vital Statistics,[14] the odds of out-of-hospital delivery were doubled for pregnant women who lived more than 30 km away from delivery facilities than for those who lived less than 5 km away from them. The same French nationwide population-based-study reported that the RR (95% CI) was 1.5 (1.4–1.5) for 16–30 km, 2.6 (2.4–2.9) for 31–45 km, and 3.9 (3.2–4.8) for 46–90 km with a reference of 0–15 km distance from the closest maternity unit.[5] However, contrary to those reports, the present results revealed that there was no significant increase in the rate of out-of-facility delivery in municipalities that were more than 30 km

away from delivery facilities. In our study, the total number of deliveries was lower in municipalities that were farther away from delivery facilities, which may have made it difficult to find statistically significant differences.

However, an urban-only report in Finland indicated that the increase in the rate of unplanned out-of-hospital delivery could not be explained by long-distance travel.[28] Similarly, a report of 324 prehospital births in Victoria, Australia[29], found little evidence that prehospital births were more common in rural areas, suggesting that there may be differences depending on medical delivery systems. Our study covered a five-year period during which there was almost no centralization of delivery facilities; so, it is possible that the empirical systems of delivery for pregnant women living far away from their homes were sufficiently prepared. Namely, the risk of out-of-facility delivery increases as the distance from the delivery facility increases; however, the system might be able to prevent it. In this study, the number of out-of-facility deliveries did not increase in Hokkaido when the distance from the delivery facility ranged from more than 30 km to within approximately 100 km and the time required to travel to the delivery facility was more than 30 min to within 2 hours; however, we should keep in mind that this is the result of various efforts made by medical institutions, pregnant women, and local governments to prevent out-of-facility deliveries.

Strengths and limitations of this study

This study has two main strengths. Firstly, it used Japanese Vital Statistics,[9] which has extensive data on the total number of deliveries (162,372) from 2016 to 2020 in Hokkaido. During this period, there was little centralization of delivery facilities in Hokkaido. Secondly, the study used data available on the Internet, making it possible to reproduce the study in other regions of Japan. However, this study had several limitations. Firstly, the accuracy of the demographic statistics used in this study should be carefully interpreted. For example, in the case of unplanned out-of-facility deliveries, both mother and infant are often transported to the hospital for emergency care. In such cases, birth certificates are often recorded in hospitals, there is a small possibility that the number of out-of-facility deliveries may be underestimated due to the incorrect recording of the place of birth as a hospital. In the same way, there are variations in rules among municipalities and hospitals in the way the person attending the delivery is written, and accuracy is problematic; thus, this item was not used in this study. Secondly, however, treating live births and stillbirths combined after 22 weeks of gestation is inherently appropriate when treating the number of deliveries as an outcome, this study did not include stillbirths that occurred outside the delivery facilities after 22 weeks gestation as there was no such data available. For reference, according to Japanese Vital Statistics, the only published data available is the number of stillbirths after 12 weeks gestation, and there were 31 out-of-facilities stillbirths in Hokkaido in the same period. Thirdly, although the purpose of this study was to investigate the relationship between

312 distance and time to delivery facilities and the number of out-of-facility deliveries, what is truly
313 essential is the impact of distance and time to delivery facilities on maternal and infant outcomes.
314 Since only 4 maternal deaths occurred in Hokkaido during this period, and the number of infant deaths
315 (perinatal mortality: stillbirths after 22 weeks gestation and neonatal deaths within 7 days of birth) was
316 not available at the municipalities level, neither could be examined. Further research is needed to
317 clarify the relationship between the distance and time to delivery facilities and perinatal mortality.
318 Fourthly, the findings of this study can hardly be generalized to regions outside of Hokkaido in Japan.
319 A wide variety of factors influence out-of-facility delivery, including the local perinatal care system,
320 national healthcare resources, distance and travel time to delivery facilities, the background of the
321 pregnant woman, and the centralization of delivery facilities. The findings of the present study may
322 be useful in areas similar to Hokkaido. Finally, this is an ecological study based on municipalities, and
323 the backgrounds of the individual patients who experienced out-of-facility delivery are not known.
324 Further research on risk factors for out-of-facility delivery targeting individual cases of out-of-facility
325 delivery is expected to be conducted in the future.

326 In conclusion, we found no evidence of a linear positive relationship between the distance to a
327 delivery facility and the rate of out-of-facility delivery, although the proportions of out-of-facility
328 deliveries are higher in municipalities without delivery facilities than in municipalities with delivery
329 facilities. Perinatal staff should beware of the occurrence of out-of-facility deliveries, even for

330 pregnant women who live in municipalities that are less than 30 km or 30 min away from delivery

331 facilities.

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Acknowledgments

The authors thank the members of the Hokkaido Organization for the advancement of Pregnancy, Perinatal, and Infant care and Emergency treatment (HOPPIE), who together founded HOPPIE and are providing perinatal education.

Author contributions

Yoshihiro Saito, Takeshi Umazume, and Hidemichi Watari substantially contributed to the study conceptualization. Toshiaki Asakura, Takashi Kimura, and Akiko Tamakoshi significantly contributed to the data analysis and interpretation. Yoshihiro Saito and Toshiaki Asakura substantially contributed to the manuscript drafting. All authors critically reviewed and revised the manuscript draft and approved the final version for submission.

Data availability statement

All the original data used in this paper are publicly available. Data and code used in this paper can be accessed via https://doi.org/10.5281/zenodo.7068218.

Disclosure

The authors declare no conflict of interest.

Approval of the research protocol: N/A

Informed consent: N/A

Registry and the registration no. of the study/trial: N/A

Animal studies: N/A

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430

Figure legends

Figure 1. Flowchart of the participant selection process.

Figure 2. Map of municipalities with or without delivery facilities.

Green represents municipalities with one or more delivery facilities, light cyan for those without delivery facilities <30 km from delivery facilities, blue for 30-59 km, navy for ≥60 km, and gray for remote island municipalities not included in the analysis.

Figure 3. Scatter plot and the predicted number of out-of-facility deliveries in 2016–2020 against total deliveries.

Each point represents a municipality. Dashed straight lines show the predicted number of out-of-facility deliveries against total births, which were obtained from univariate analysis results. Blue, orange, green, and purple correspond to the existence of delivery facilities, distance from town offices to delivery facilities within 30 km, between 30 km and 59 km, and at least 60 km, respectively. Sapporo City, in which the number of births was 66,090 and that of out-of-facility deliveries was 140, is not shown here.

Figure 4. The adjusted relative risk of out-of-facility deliveries over distances.

449 References are municipalities with at least one delivery facility. A solid curved line represents adjusted
450 relative risk over distance, which is obtained by the restricted cubic spline. The shaded area shows the
451 95% confidence interval calculated via the bootstrap method. The green bar chart with 10-km bins
452 represents the number of municipalities without delivery facilities while the number of municipalities
453 with delivery facilities used for reference is not shown in the bar chart.
454
455 Supplemental Figure 1. The relationship between the distance to delivery facilities and the total
456 number of births and the rate of out-of-facility deliveries in municipalities without delivery facilities.
457 The bars in the 10-km bins represent the total number of deliveries in municipalities without delivery
458 facilities, and the line represents the rate of out-of-facility deliveries per 1,000 births.
459

Table 1. Demographic survey of the municipalities†

		Total $_{All}$	Delivery facility existence in municipalities				
			Exist	Non − Exist			
				Total $_{Non-Exist}$	<30 km‡	30–59 km‡	≥60 km‡
Number of municipalities, n (%)		175	28 (16.0)	147 (84.0)	62 (35.4)	67 (38.3)	18 (10.3)
Birth/2016–2020, n (%)		162,114	129,932 (80.0)	32,182 (19.9)	19,542 (12.1)	10,449 (6.4)	2,191 (1.4)
Out-of-facility delivery/2016–2020, n (‰)		339 (2.1)	240 (1.8)	99 (3.1)	66 (3.4)	27 (2.6)	6 (2.7)
Distance (km), mean (SD) ‡		35.5 (20.7)	-	35.5 (20.7)	17.1 (6.0)	41.4 (7.9)	76.9 (10.2)
Travel time, n (%) ‡	Exist	28 (16.0)	-	-	-	-	-
	<30 min.§	75 (42.9)	-	46 (31.3)	45 (72.6)	1 (1.5)	-
	30–59 min. §	46 (26.3)	-	75 (51.0)	17 (27.4)	56 (83.6)	2 (11.1)
	≥60 min. §	26 (14.9)	-	26 (17.7)	-	10 (14.9)	16 (88.9)
Primiparous, n (%)		75,714 (46.7)	-	-	-	-	-
Percentage of nuclear families, 2020 (%), mean		53.8 (5.4)	53.6 (4.1)	53.8 (5.7)	56.2 (5.8)	52.2 (5.4)	51.7 (2.5)
Population density, 2020 (/km^2), mean (SD)		65.4 (174.9)	238.1 (376.3)	32.5 (58.9)	51.1 (62.0)	20.6 (59.1)	13.0 (15.5)
Rate of population change, 2020 (%), mean (SD)		−7.9 (4.4)	−5.1 (3.5)	−8.4 (4.4)	−7.9 (4.5)	−8.3 (4.6)	−10.5 (2.3)
Unemployment rate, 2020 (%), mean (SD)		3.0 (1.5)	3.8 (1.0)	2.9 (1.5)	3.3 (1.7)	2.6 (1.2)	2.6 (1.5)
Consultation rate, 2020 (%), mean (SD)		36.5 (12.8)	28.4 (9.2)	38.0 (12.9)	38.4 (11.9)	37.9 (13.9)	37.0 (12.9)

† Data are presented as the mean ± standard deviation (SD) or as frequencies and percentages (%)

‡As for municipalities without delivery facilities, the distance to the delivery facility was defined as the distance from the town offices of each municipality to the nearest delivery facility, and these distances were measured using Google Maps. Similarly, travel time by car was defined and calculated using Google Maps. The date and time using Google Maps and calculated necessary values were March 10, 2022, between 16:00 and 18:00, respectively.

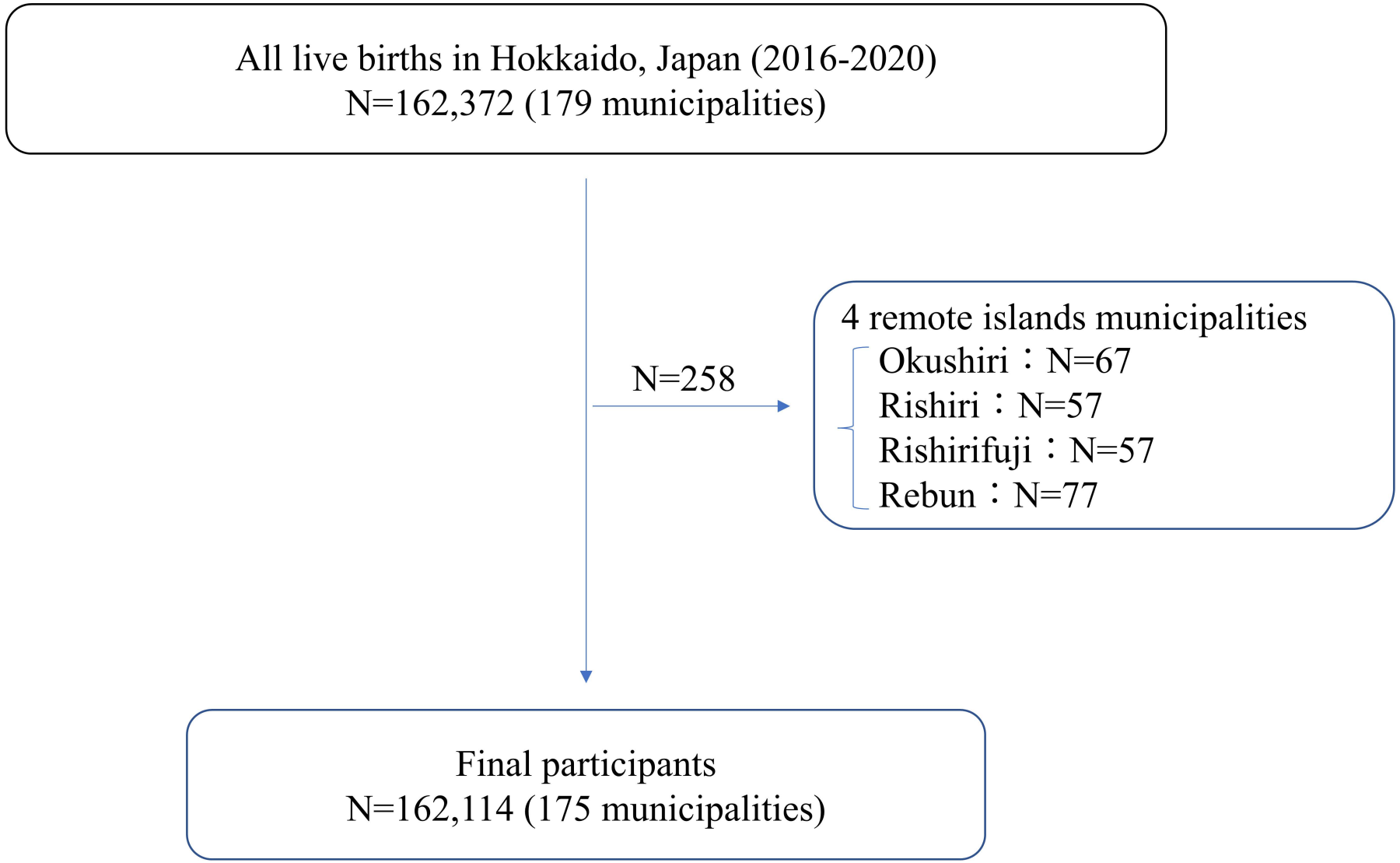
§min. represents minute(s).

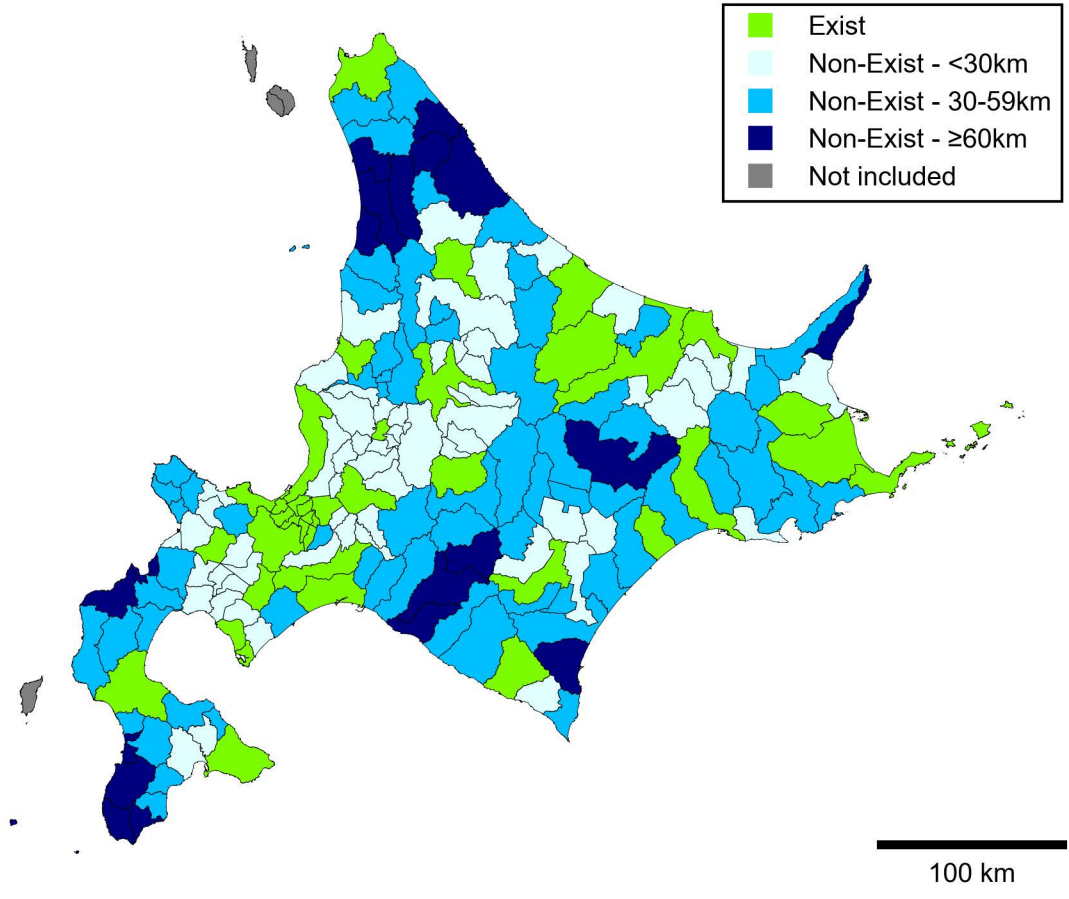
Table 2. Crude and adjusted relative risks of out-of-facility deliveries for distance and time

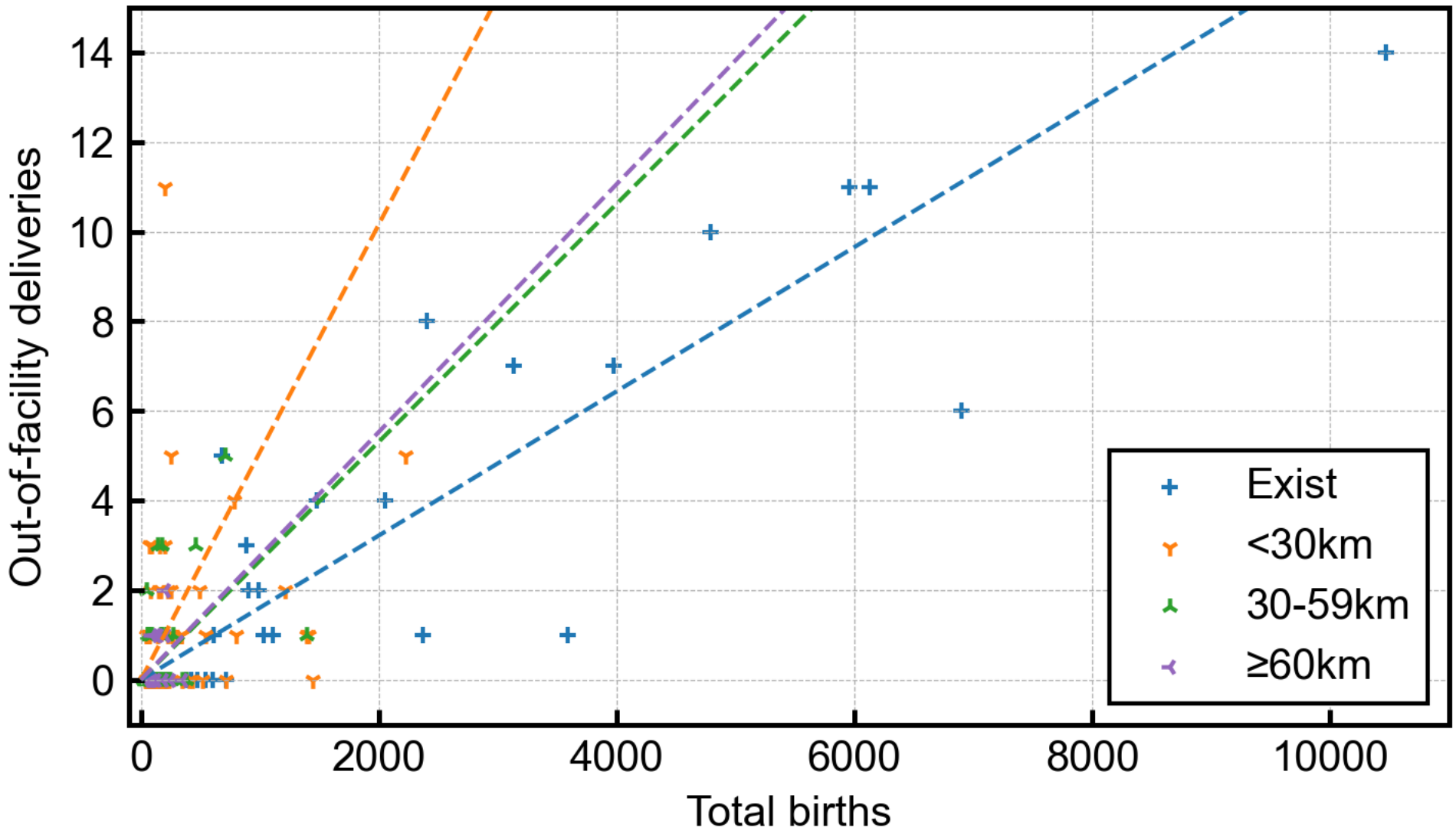
		Total delivery, N	Out-of-facility Delivery, N	Crude RR (95% CI) †	Adjusted RR (95% CI) †‡
Delivery facility	Exist	129,932	240	Ref.	Ref.
	Non-Exist	32,182	99	2.36 (1.40–3.98)	2.28 (1.15–4.52)
Distance	Exist	129,932	240	Ref.	Ref.
	<30 km	19,542	66	3.16 (1.76–5.67)	2.63 (1.34–5.17)
	30–59 km	10,449	27	1.65 (0.86–3.16)	1.31 (0.57–2.99)
	≥60 km	2,191	6	1.72 (0.60–4.89)	1.44 (0.43–4.83)
Travel time	Exist	129,932	240	Ref.	Ref.
	<30 min.	16,894	57	3.31 (1.79–6.12)	2.76 (1.36–5.58)
	30–59 min.	12,537	36	1.96 (1.06–3.62)	1.63 (0.75–3.58)
	≥60 min.	2,751	6	1.29 (0.47–3.52)	1.11 (0.34–3.61)

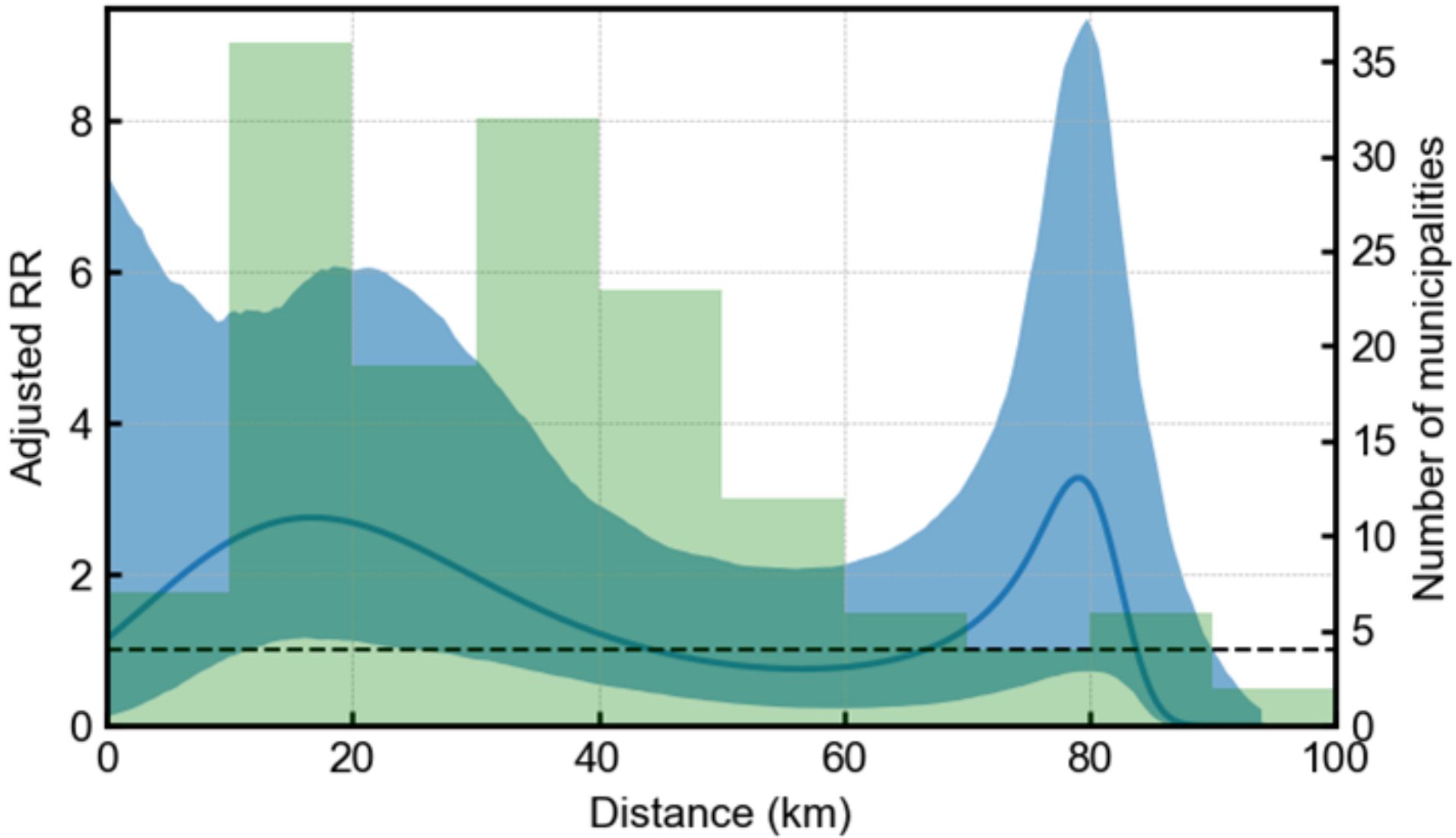
† RR (95% CI) represents the relative risk (95% Confidence Interval).

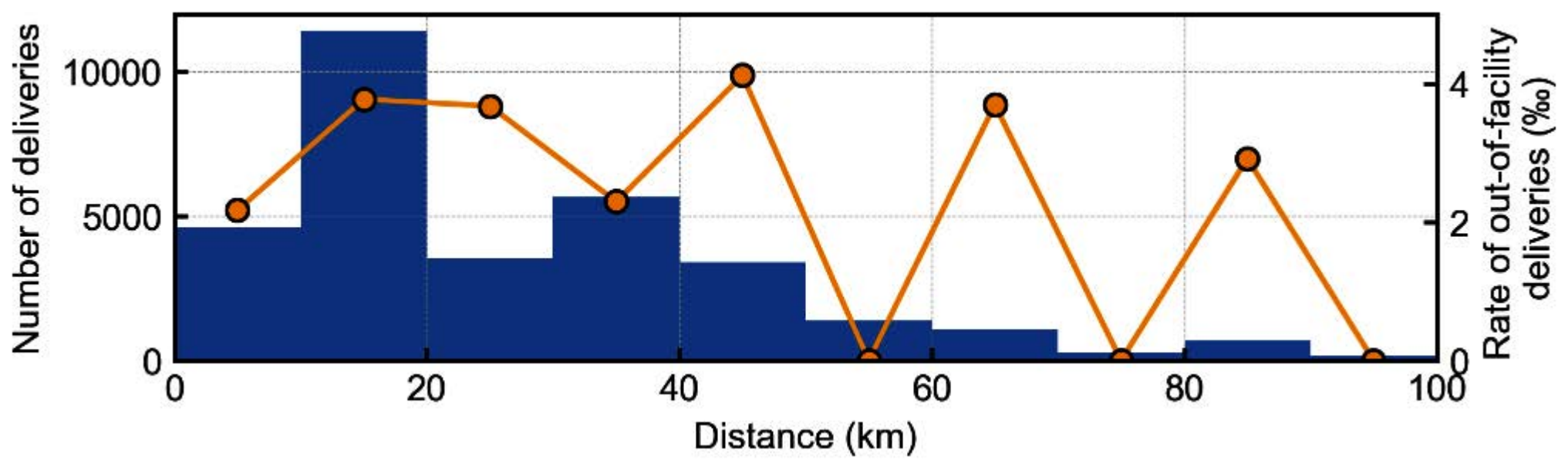
‡ The adjusted RR was adjusted by the percentage of nuclear families, population reduction rates from 2015 to 2020, unemployment rates, and special checkup consultant rate.


All live births in Hokkaido, Japan (2016-2020)
N=162,372 (179 municipalities)
N=258
4 remote islands municipalities
Okushiri：N=67
Rishiri：N=57
Rishirifuji：N=57
Rebun：N=77
Final participants
N=162,114 (175 municipalities)


Exist
Non-Exist - <30km
Non-Exist - 30-59km
Non-Exist - ≥60km
Not included
100 km


Out-of-facility deliveries
0
2
4
6
8
10
12
14
0
2000
4000
6000
8000
10000
Total births
Exist
<30km
30-59km
≥60km


Adjusted RR
0
2
4
6
8
Number of municipalities
0
5
10
15
20
25
30
35
0
20
40
60
80
100
Distance (km)


Number of deliveries
10000
5000
0
0
20
40
60
80
100
Distance (km)
Rate of out-of-facility deliveries (‰)
4
2
0