

SIMILARITIES AND DIFFERENCES BETWEEN JAPAN AND THE U.S. DISTRIBUTION OF FACTORS INFLUENCING INJURIES IN FRONTAL COLLISIONS USING FIELD ACCIDENT DATA

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ABSTRACT

Traffic accident analysis using accident database can indicate important causes and useful countermeasures. Japan has an in-depth accident investigation database: Institute for Traffic Accident Research and Data Analysis (ITARDA) Micro Data; however, the number of investigated accidents is limited. On the contrary, the National Automotive Sampling System/Crashworthiness Data System (NASS/CDS) in the U.S. is the largest and many researchers utilize it. In this study, research questions are clarified by studying similarities and differences between Japan and the U.S. distribution of factors influencing occupant injuries in frontal collisions using these databases, and presenting new utilization of the NASS/CDS for accident analysis.

Accident types compared are head-on collisions and frontal single-vehicle collisions occurred in 2000-2009. Appropriate eleven variables on occupant injuries in frontal collisions are selected, and Mahalanobis distance (MD) of discriminant analysis shows the similarities for each accident database. In this analysis, the variables are classified into four groups: injury prediction factors, vehicles factors, occupant factors, and injury outcome factors; furthermore, the multidimensional distribution is compared using these groups.

In results, the NASS/CDS data has similar distribution of MD to the ITARDA Micro Data in the injury prediction factors such as delta-V, seat belt use, multiple impact, occupant age etc.; however, conditions which include vehicle factor such as vehicle curb weight, and occupant factors such as occupant height have different distribution. Therefore, the NASS/CDS is useful for statistical analysis such as injury prediction for Japan; however, it cannot be utilized as it is for small vehicles crashes, or short statured occupants because of the differences in vehicle factors and occupant factors. It is necessary to consider these differences in case of using these factors. Furthermore, new weighting method for the NASS/CDS using the MD can create closer weighted database to traffic accidents in Japan. This method needs further improvements; however, it is useful in Japan for analyses using the NASS/CDS.

INTRODUCTION

In Japan, the numbers of traffic accident fatalities are 4,612 occurring within 24 h; furthermore, 859,105 casualties occurred in 2011. The casualties have decreased over the past decade; however, the rate in a few years has slowed down over the past few years. The Japanese government has set a new target for traffic accidents, 3,000 fatalities or fewer and 700,000 casualties or fewer by 2015, with the aim of achieving the safest road traffic in the world. To achieve these targets, more contributory aspects for traffic accidents need to be identified and studied, and more effective countermeasures are needed.

Accident analyses using accident database can indicate priority issues and validate effects of countermeasures. The National Automotive Sampling System/Crashworthiness Data System (NASS/CDS) is the largest and the most utilized database of crash outcomes. Many researchers produce statistical accident analysis such as injury prediction analysis [1, 2] because of its abundant number. However, the outcomes basically represent field accident data in the U.S.

There are two major traffic accident databases in Japan. One is the Institute for Traffic Accident Research and Data Analysis (ITARDA) Macro Data which is the police reported database for all traffic accidents that occur throughout Japan. The other is in-depth accident investigation database (ITARDA Micro Data). The ITARDA Macro Data has many accident data; however, the detailed information is limited such as AIS (Abbreviated Injury Scale) code and delta-V. On the contrary, the ITARDA Micro Data has detailed information of accidents; however, the number of investigated accidents is limited. The ITARDA Micro Data may have bias issues and errors in statistical analyses; therefore, analyses using the ITARDA Micro Data are utilized with the validation by the ITARDA Macro Data [3, 4], or lack of information is covered by additional analyses using the NASS/CDS [5].

In the NASS/CDS, there is a weighting factor for each accident case to estimate accident attributes for national data in the U.S [6]. The U.S. has in-depth accident investigation database: Crash Injury Research and Engineering Network (CIREN). For the

CIREN, the similarity to the NASS/CDS is discussed [7]; furthermore, pseudo-weighting method is studied to countermeasure the bias issue between the CIREN and the NASS/CDS [8]. In these ways, there are many studies to deal with bias issues using weighting methods.

This study investigates similarities and differences of influential factors between the ITARDA Micro Data in Japan and the NASS/CDS in the U.S. using statistical analysis. Moreover, points of attention and the effectiveness using the NASS/CDS data for Japanese accident analyses are indicated, and new utilization of the NASS/CDS for Japan is presented. Accident types are frontal crashes of head-on collisions and frontal single-vehicle collisions. Drivers in front seats are analyzed in this study.

METHODS

Flow of the Study

The goal of this study is to clarify the similarities and differences between Japan and the U.S. distribution of factors influencing injuries in frontal collisions. That indicates points of attention when analyzing accidents occurring in other areas, and new utilization of accident database in other countries. In this study, databases compared are the ITARDA Micro Data for Japan, and the NASS/CDS for the U.S. The flow of the study used is as follows: first, sampling accidents from each database. Second, the evaluated factors are selected and grouped into a few groups. Third, Mahalanobis distance (MD) of discriminant analysis indicates the similarities of multidimensional distribution for each database in combinations of the groups. Fourth, uncommon accidents are extracted from each database using MD. These show the differences, and these accidents should be excluded in analyses for the other countries. Finally, a new weighting method to create similar distribution of MD between the two presents new utilization of accident database.

Data Sources

Object data sources are 2000-2009 accidents, involving small and regular passenger vehicles, vans, SUVs and pickup trucks. For Japan, they include Kei cars (light vehicles with an engine displacement of 660 cc or less), and Kei trucks (light trucks with an engine displacement of 660 cc or less), which are standards unique to Japan. The analyzed accident types are head-on collisions (H-on) and frontal single-vehicle collisions (f-SVC) with the impact direction of Collision Deformation Classification (CDC) codes: 11F, 12F, and 01F. The analyzed occupants are drivers in frontal seats.

The author examines the injury prediction model

using the ITARDA Micro Data, and the model can correspond to the documented accident data in the ITARDA Macro Data [3, 4]. Therefore, in this study, the ITARDA Micro Data is used as the representative accidents in Japan. The total sampling number without missing values is 216. The numbers of each accident type are shown in Table 1.

In the NASS/CDS, there is weighting variable called the *ratio inflation factor* for each case sample, which estimates the converted number of accidents as national data in the U.S. In this study, the NASS/CDS weighted is used as the representative accidents in the U.S. The total sampling number is 2,104 sample, which, when weighted, becomes 486,680 without missing values. The numbers of each accident type are also shown in Table 1.

Table 1.
Data sources of Japan and the U.S.

	ITARDA Micro Data 2000-2009		NASS/CDS 2000-2009		
	CDC code	unweighted	CDC code	unweighted	weighted
H-on	11F – 01F	108	11F – 01F	585	79,410
f-SVC	11F – 01F	108	11F – 01F	1,519	407,270
Total		216		2,104	486,680

Analysis of Mahalanobis Distance

The MD is a distance measure in statistics. It is used in discriminant analysis, which discriminates the attributes using the nearness of stochastic distance in multidimensional distributions. The MD is based on correlations between variables and inclines to the average of variables, and defined as follows:

$$D^2 = (\mathbf{x} - \boldsymbol{\mu})^T \mathbf{S}^{-1} (\mathbf{x} - \boldsymbol{\mu}) \quad (1).$$

where D is Mahalanobis distance, \mathbf{x} is multivariate vector of variables, $\boldsymbol{\mu}$ is mean vector of \mathbf{x} , and \mathbf{S} is variance-covariance matrix.

For instance, when D_j and D_u represent the MD from group Japan and group the U.S. in case of two dimensional variables x_1 and x_2 , the curves with equal MD show ellipses in Figure 1. An accident case is discriminated into the group with the minimum of D_j and D_u . If the data conform to k -dimensional multivariate normal distribution, the distribution of D^2 fits the chi-squared distribution with degree of freedom k [9]. As variables have different measurements in this study, all the variables are standardized by their means and standard deviations.

Explanatory Variables and Grouping

In this study, fifteen explanatory variables are selected, and grouped into four groups. These

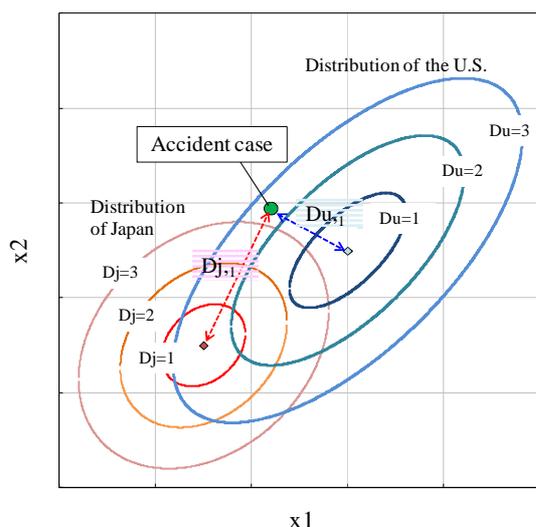


Figure 1. Image of distributions of MD for two databases.

variables are considered to evaluate occupant injuries in frontal collisions refer to injury prediction methods [1–4]. These variables and groups are shown in Table 2. Group A consists of major injury prediction factors used in URGENCY algorithm etc [2, 3]. Group B consists of vehicle factors indicating vehicle attributes and performance. Group C consists of occupant factors indicating occupant attributes. Group D consists of injury outcome factors indicating injury severity. Category data are converted into dummy variables of 0 or 1.

Prior to performing the MD analysis, variables that have multicollinearity are excluded using Pearson’s product-moment correlation coefficients. The standard of exclusion is a multicollinearity coefficient greater than 0.5. EBS, occupant gender, occupant weight, and ISS are excluded by this standard; therefore, eleven variables are analyzed in combinations of the groups for each database.

Japanese Weighting Method to the NASS/CDS

The MD of accident cases indicates the nearness from each database. The NASS/CDS accident cases with small MD from the ITARDA Micro Data are similar accident cases to the ITARDA Micro Data, in other words, these accident cases in the NASS/CDS frequently occur in Japan. Moreover, the distribution of MD basically fits the chi-squared distribution with degree of freedom k . As a consequence, the weighting method that selects accident cases with nearness in the NASS/CDS and distribute them to fit the chi-squared distribution can create new weighted database with similar distribution to Japan.

At first, accident cases in the NASS/CDS within 95% distribution of MD from the ITARDA Micro Data are selected. In case of degree of freedom $k = 11$, it means D^2 is less than 19.7 by the chi-squared

Table 2. Explanatory variables and grouping

Group	Factors	Categories	
A	Injury prediction factor	Delta-V, km/h	
		Seat belt use	Belted/Unbelted
		Multiple impact	Yes/No
		Rollover	Yes/No
		Extent of damage code	1–9
		Occupant age, yrs	
B	Vehicle factor	Vehicle curb weight, kg	
		Vehicle registration year	
		EBS ^{a)} , km/h	
C	Occupant factor	Occupant gender	Male/Female
		Occupant height, cm	
		Occupant weight, kg	
		Occupant BMI ^{b)}	
D	Injury outcome factor	MAIS	1–6
		ISS ^{c)}	1–75

a) EBS: Equivalent Barrier Collision Speed

b) BMI: Body Mass Index

c) ISS: Injury Severity Score

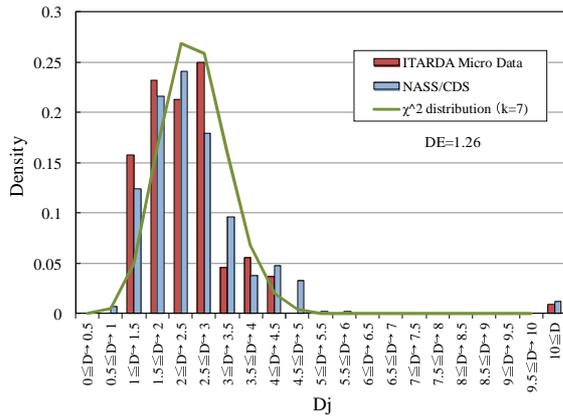
distribution. Secondly, the weight for each accident case is determined so that the distribution of D^2 from the ITARDA Micro Data corresponds to the chi-squared distribution. In this process, case weight is the average of five steps to smoothen the weight. Finally, the distribution of D^2 is compared to the ITARDA Micro Data, and validated as new weighted accident database for Japan using the NASS/CDS data. It is called “J-weighted” to the NASS/CDS.

RESULTS

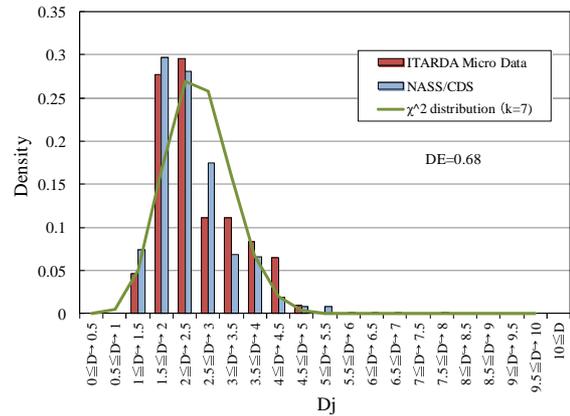
Comparison of Mahalanobis Distance

Figure 2–4 show the comparison of MD from the ITARDA Micro Data for each combination of groups. In these figures, D_j means the MD from the ITARDA Micro Data. For A+D group in Figure 2, which injury prediction factors and injury outcome factor, the distributions of MD between the ITARDA Micro Data and the NASS/CDS data are same in each crash type. Therefore, the NASS/CDS data are similar to the ITARDA Micro Data, that is, the NASS/CDS data are useful for accidents in Japan on statistical analysis such as injury prediction. The discriminant efficiency (DE), which means the distance between the each mean of MD, are 1.26 for head-on collision, and 0.68 for frontal single-vehicle collision. The discriminant efficiency is smaller, these databases are more similar.

For A+B+D group in Figure 3, which is added vehicle factors to A+D groups, the distribution of MD are somewhat different between the two. The DE

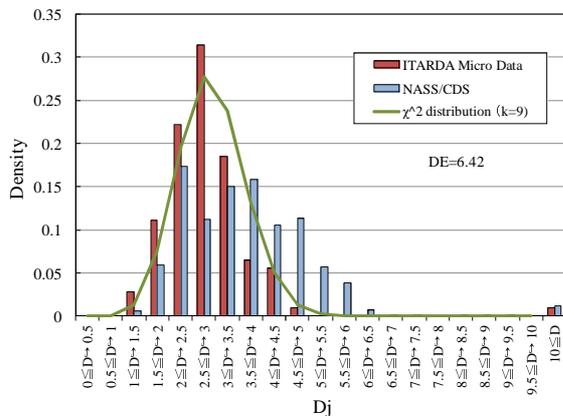


(a) Head-on collisions

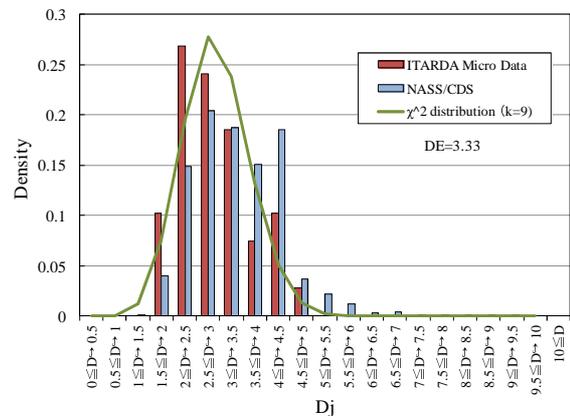


(b) Frontal single-vehicle collisions

Figure 2. Distributions of MD from the ITARDA Micro Data, A+D factors (k=7).

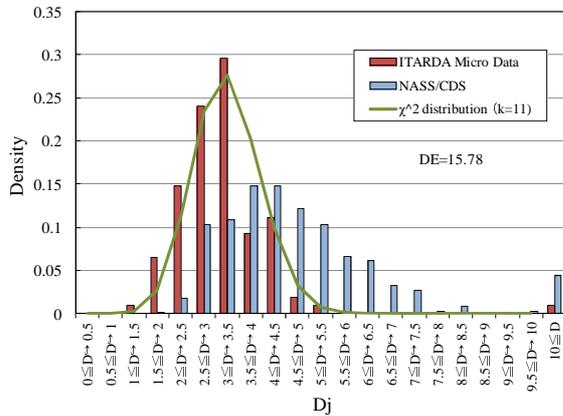


(a) Head-on collisions

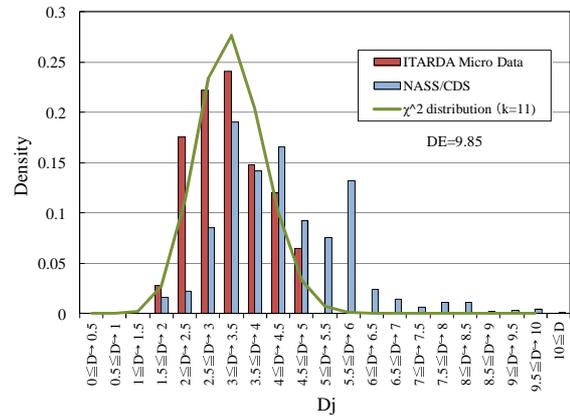


(b) Frontal single-vehicle collisions

Figure 3. Distributions of MD from the ITARDA Micro Data, A+B+D factors (k=9).



(a) Head-on collisions



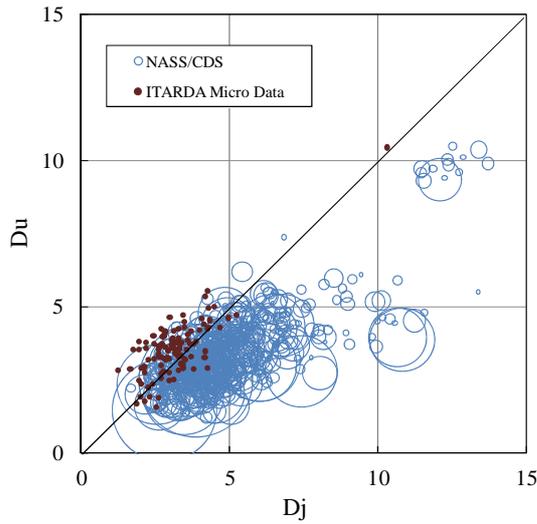
(b) Frontal single-vehicle collisions

Figure 4. Distributions of MD from the ITARDA Micro Data, A+B+C+D factors (k=11).

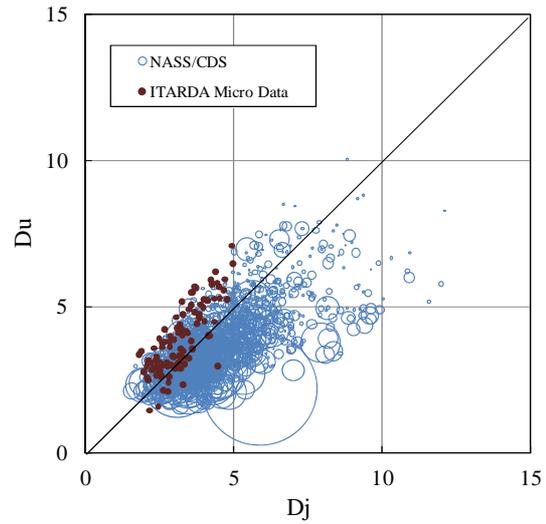
are 6.42 for head-on collision, and 3.33 for single-vehicle collision. These values are higher than that in A+D group. Furthermore, for A+B+C+D group (all factors) in Figure 4, the distribution of MD is different between the two. The DE is 15.78 for head-on collision, and 9.85 for single-vehicle collision. This means that the NASS/CDS data cannot be utilized as it is in case of analyses using vehicle factors such as vehicle weight and occupant

factors such as occupant height as Japanese traffic accidents.

Figure 5 shows the distributions of MD from each database using A+B+C+D group. The D_j means the MD from the ITARDA Micro Data, and the D_u means the MD from the NASS/CDS. For the NASS/CDS, each area of a circle means weight value. On the contrary, for the ITARDA Micro Data, each

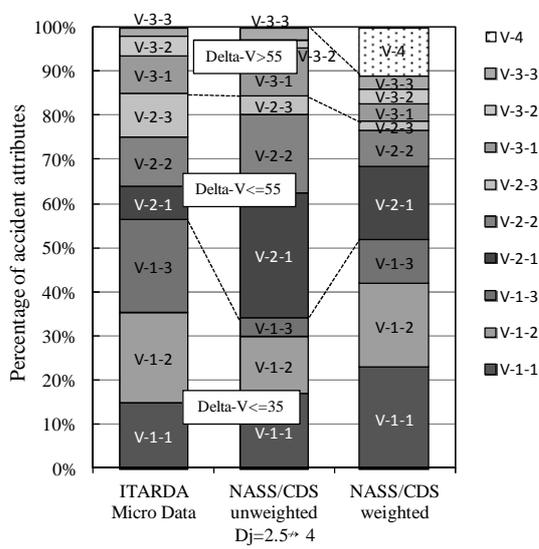


(a) Head-on collisions

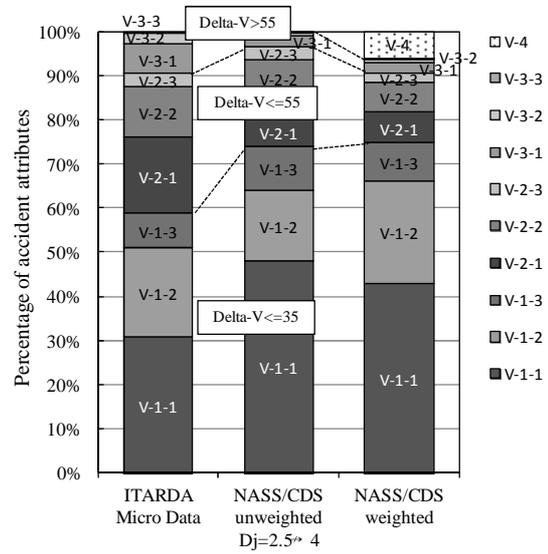


(b) Frontal single-vehicle collisions

Figure 5. Distributions of MD from the ITARDA Micro Data (D_j) and the NASS/CDS (D_u), $A+B+C+D$ factors ($k=11$).



(a) Head-on collisions



(b) Frontal single-vehicle collisions

Figure 6. Percentage of accident attributes in the ITARDA Micro Data and the NASS/CDS.

circle means an accident case. The ITARDA Micro Data are involved in part of the NASS/CDS data; however, The ITARDA Micro Data does not occupy the center of the NASS/CDS. In case of using the NASS/CDS data for analyses of Japan, it is important for the analyses to exclude the far accident cases from Japanese distribution.

Validation of Accident Cases with Same Mahalanobis Distance

The accident cases with small D_j in the NASS/CDS are similar accidents in Japan. In Figure 4, majority of D_j in the ITARDA Micro Data is in the range $2.5 \leq D_j < 4.0$; therefore, the accident cases with $2.5 \leq D_j < 4.0$ are selected, and analyzed on the accident attributes. Figure 6 shows the comparison

Table 3. Codes of accident attributes in Figure 6

Code	Delta-V	Occupant age	BMI
V-1-1	≤ 35 km/h	< 30	< 35
V-1-2		< 55	< 35
V-1-3		≥ 55	< 35
V-2-1	≤ 55 km/h	< 30	< 35
V-2-2		< 54	< 35
V-2-3		≥ 55	< 35
V-3-1	> 55 km/h	< 30	< 35
V-3-2		< 55	< 35
V-3-3		≥ 55	< 35
V-4	ALL	ALL	≥ 35

between the ITARDA Micro Data and the NASS/CDS with $2.5 \leq D_j < 4.0$. The codes in Figure 6 are defined in Table 3. The NASS/CDS with $2.5 \leq D_j < 4.0$ are removed high BMI occupants (BMI ≥ 35) from the original NASS/CDS weighted data, and the balance of each delta-V range is similar to that in the ITARDA Micro Data. In these results, the nearness of D_j means the similarity to accidents in Japan. However, the balance of occupant age is different between the two. The ITARDA Micro Data have higher rate of elderly occupants (55 yrs or older); on the contrary, The NASS/CDS with $2.5 \leq D_j < 4.0$ data have higher rate of younger occupants (under 30 yrs). A weighting method is required to create closer database to Japanese accidents.

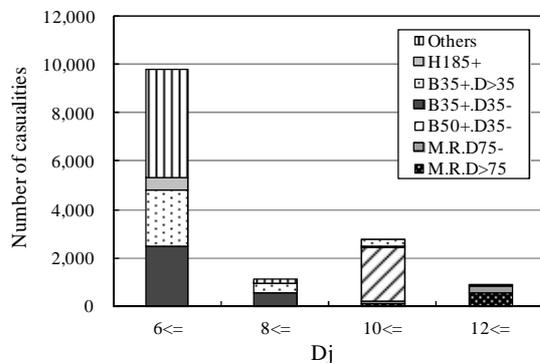
The Accident Cases in the U.S. Far from Japan

The accident cases in the NASS/CDS with long MD from the ITARDA Micro Data are uncommon for Japanese accidents. These accident cases are called as “far accident cases from Japanese distribution”. Figure 7 shows the accident cases with long MD over 6 (out of 99.98 %) from the ITARDA Micro Data, i.e. far accident cases in the U.S. from Japanese distribution. In head-on collisions, there are multiple impacts with rollover in high delta-V ($>75\text{km/h}$) (M.R.D >75), multiple impacts with rollover in lower delta-V ($\leq 75\text{km/h}$) (M.R.D75-), high BMI (50+) drivers in low delta-V ($\leq 35\text{km/h}$) (B50+.D35-),

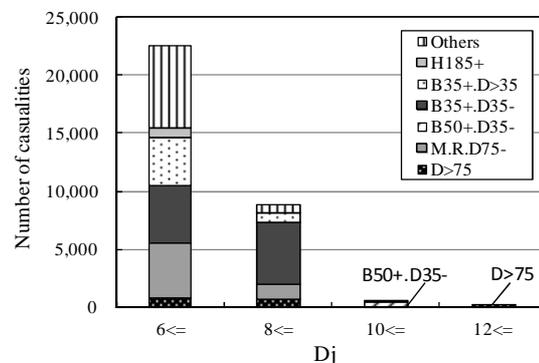
high BMI (35+) drivers in low delta-V ($\leq 35\text{km/h}$) (B35+.D35-), high BMI (35+) drivers in higher delta-V ($>35\text{km/h}$) (B35+.D >35), and tall (185cm+) drivers (H185+). In frontal single-vehicle collisions, there are the same accident cases as head-on collisions except for high delta-V ($>75\text{km/h}$) (D >75), which are not limited of multiple impacts and rollover. These far accident cases should be noted in case of analyses for Japan using the NASS/CDS.

The Accident Cases in Japan Far from the U.S.

On the contrary, the accident cases in the ITARDA Micro Data with long MD from the NASS/CDS are uncommon for accidents in the U.S. These accident cases are called as “far accident cases from the U.S. distribution”. Figure 8 shows the accident cases with long MD over 5 (out of 99.10 %) from the NASS/CDS, i.e. far accident cases in Japan from the U.S. distribution. In head-on collisions, there are light vehicle (900kg-, including Kei car) by short statured persons ($<155\text{cm}$) (LV.H <155), and high delta-V ($>90\text{ km/h}$) impact with heavy duty truck (D >90). In frontal single-vehicle collisions, there are other crash types i.e. light vehicle (900kg-, including Kei car) by taller drivers (155cm+) (LV), low delta-V ($\leq 10\text{km/h}$) impact (D10-), and short statured persons ($<155\text{cm}$) (H <155). It is difficult to analyze these far accident cases from the U.S. using the NASS/CDS. These cases need inherent accident

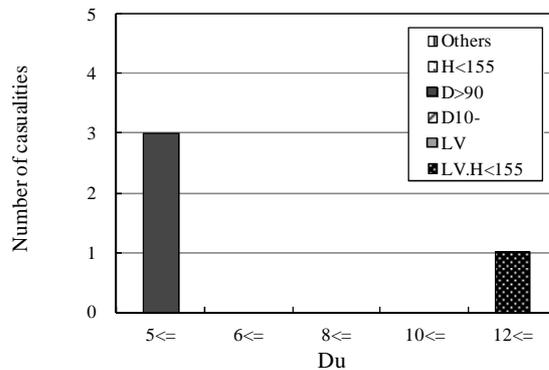


(a) Head-on collisions

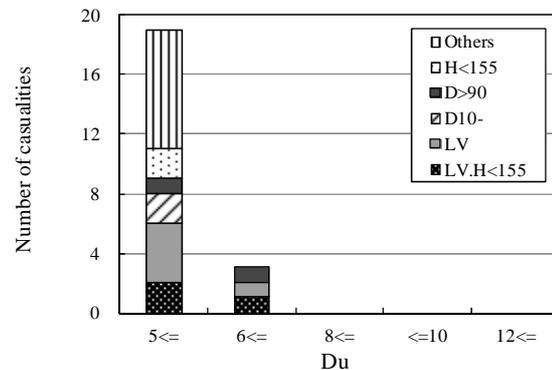


(b) Frontal single-vehicle collisions

Figure 7. The far accident cases in the NASS/CDS from the ITARDA Micro Data using A+B+C+D factors.



(a) Head-on collisions



(b) Frontal single-vehicle collisions

Figure 8. The far accident cases in the ITARDA Micro Data from the NASS/CDS using A+B+C+D factors.

analyses using Japanese in-depth accident investigations.

Japanese Weight to the NASS/CDS

The NASS/CDS data are processed using the “J-weighted” method. Figure 9 shows the comparison of distribution between the NASS/CDS J-weighted and the ITARDA Micro Data using A+B+C+D group (k=11). These data have good agreement between the two, and correspond to the chi-squared distribution. This result indicates the NASS/CDS J-weighted are similar to the ITARDA Micro Data.

Figure 10 shows the comparison of percentage between the NASS/CDS J-weighted and the ITARDA Micro Data. The components of the NASS/CDS J-weighted data are improved, and have good balance; in addition, the NASS/CDS J-weighted data are more similar to the ITARDA Micro Data especially for frontal single-vehicle collisions.

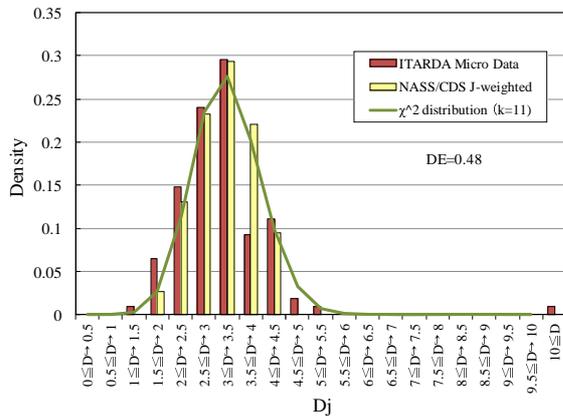
However, there are some differences of occupant age balance in head-on collisions. This method can stand further improvements.

DISCUSSION

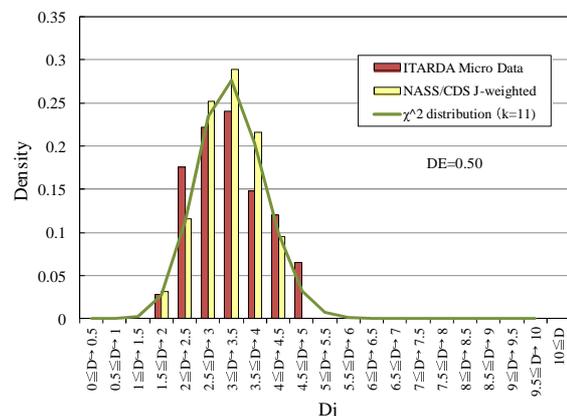
Distribution of Each Accident Database

The MD shows the multidimensional distributions for each database. The database which has near MD is similar to the other database which has the same MD comprehensively. However, each factor has somewhat different distribution in each database respectively. In this discussion, the further detail distributions for delta-V and occupant age, which are major injury prediction factors, are investigated.

Delta-V Figures 11–12 show the histograms of delta-V for each database respectively. Also the NASS/CDS J-weighted is compared in Figures 11–12. The ITARDA Micro Data have many cases

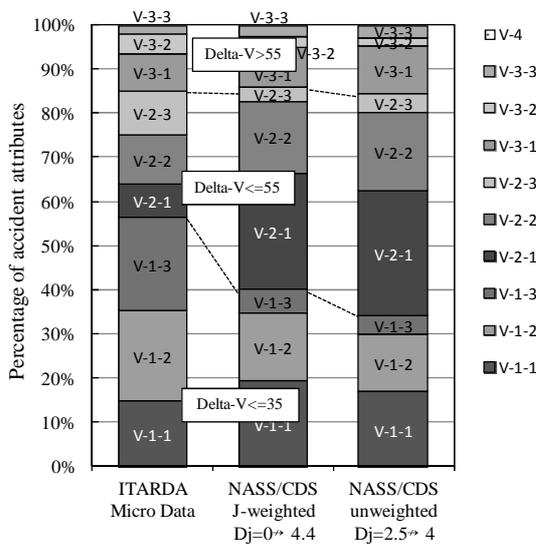


(a) Head-on collisions

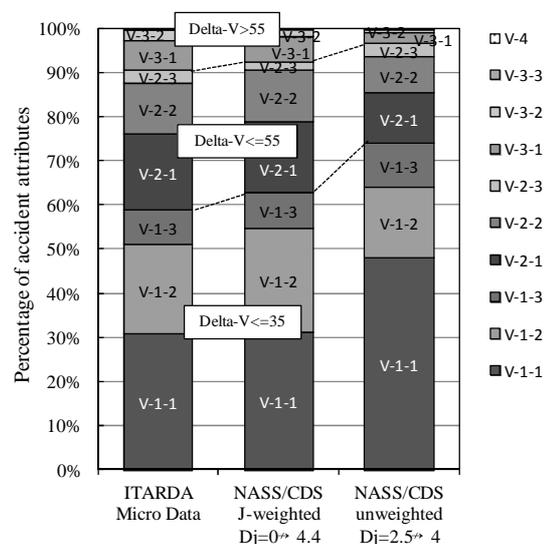


(b) Frontal single-vehicle collisions

Figure 9. Comparison of distribution between the NASS/CDS J-weighted and the ITARDA Micro Data, A+B+C+D factors (k=11).

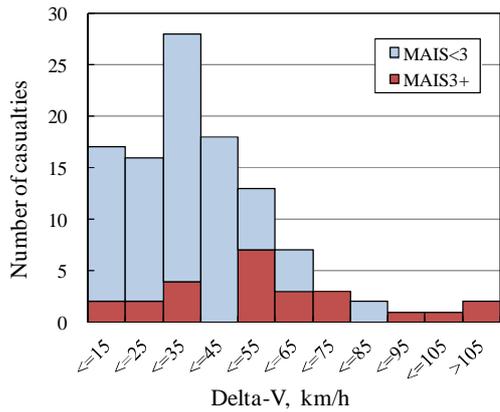


(a) Head-on collisions

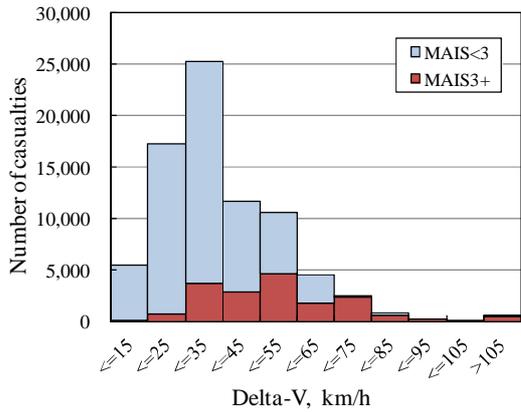


(b) Frontal single-vehicle collisions

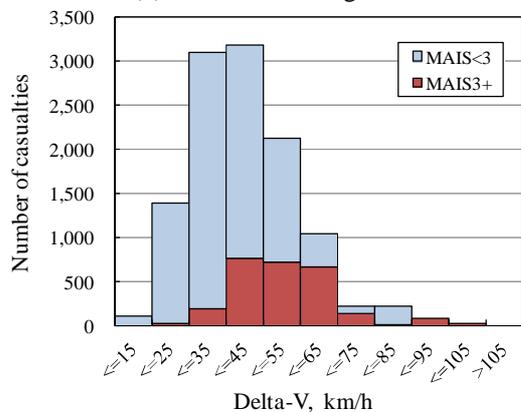
Figure 10. Comparison of percentage between the NASS/CDS J-weighted and ITARDA Micro Data.



(a) ITARDA Micro Data



(b) NASS/CDS weighted

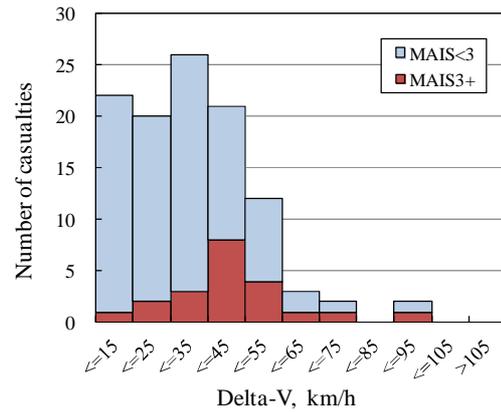


(c) NASS/CDS J-weighted

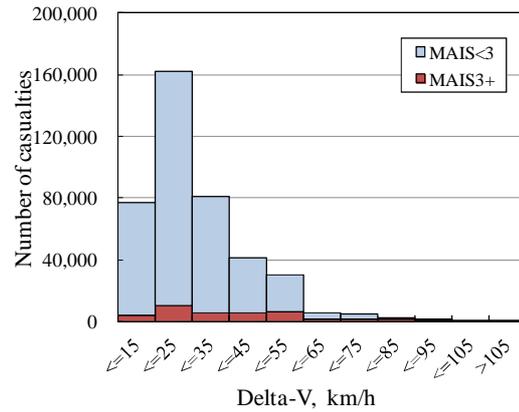
Figure 11. Histogram of delta-V, head-on collisions.

with delta-V under 15 km/h. The delta-Vs in Japan are lower than that in the U.S. This indicates the impact speed in the U.S. is higher than that in Japan. The delta-Vs in the NASS/CDS J-weighted are lower than that in the original NASS/CDS weighted; however, the percentage of lower delta-V cannot be improved sufficiently.

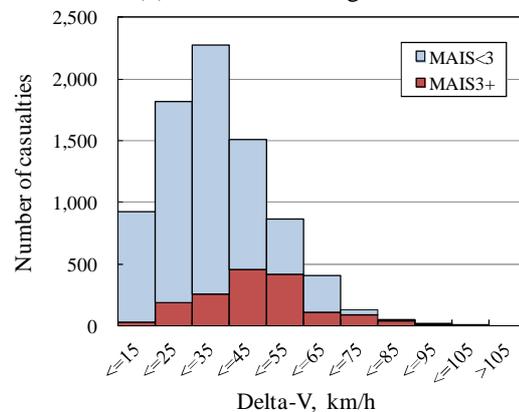
Occupant age Figures 13–14 show the histograms of occupant age for each database respectively, also the NASS/CDS J-weighted. The ITARDA Micro Data have two peaks of distribution.



(a) ITARDA Micro Data



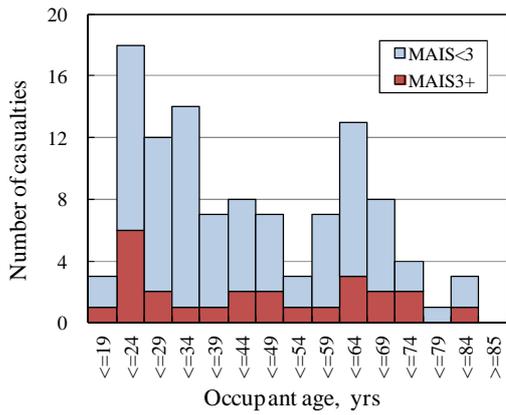
(b) NASS/CDS weighted



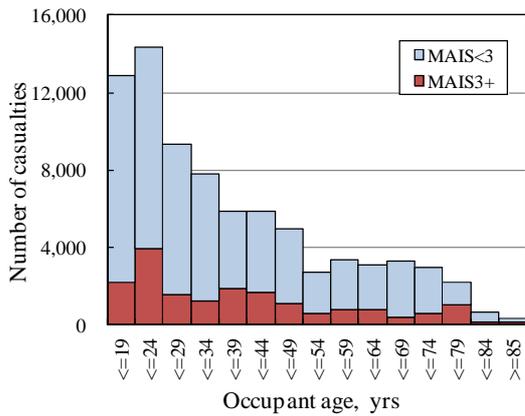
(c) NASS/CDS J-weighted

Figure 12. Histogram of delta-V, frontal single-vehicle collisions.

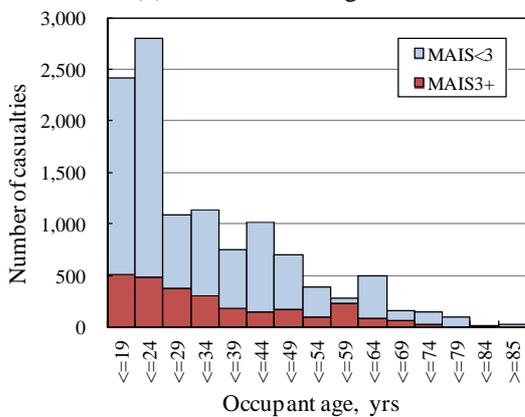
One is younger occupants and the other is elderly occupants. On the contrary, the NASS/CDS weighted data has many teenagers and not so many elderly occupants in relative rates. It is hard to fit the NASS/CDS J-weighted to the ITARDA Micro Data because of this distribution of the NASS/CDS weighted. There are limitations of similarities for the factors which have large different distribution. Furthermore, the MD analysis in this study basically assumes the normal distribution for every factor. In this point of view, further improvements for this method need to study.



(a) ITARDA Micro Data



(b) NASS/CDS weighted

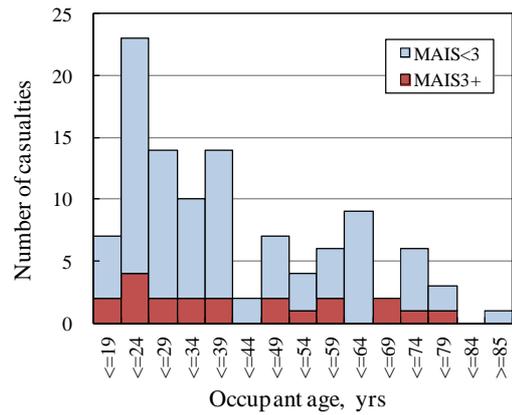


(c) NASS/CDS J-weighted

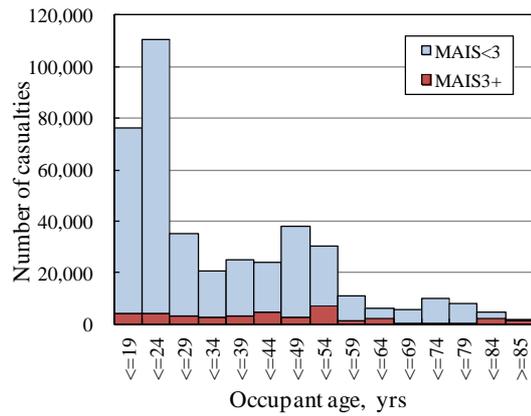
Figure 13. Histogram of occupant age, head-on collisions.

Comparison of Odds Ratio

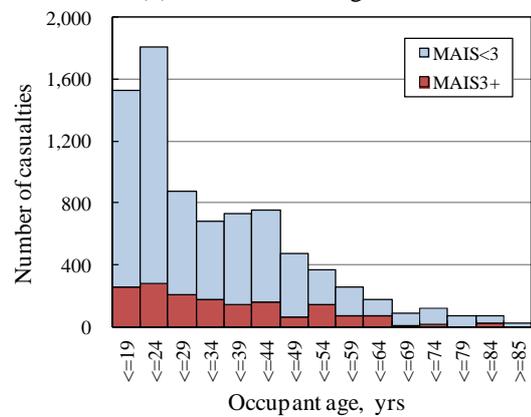
Figures 15–17 show the comparison of log odds ratio for each factor between Japan and the U.S. The references of each factor are set at majority conditions or conditions with lower odds ratios. The factors are compared in each group. For injury prediction factors: group A, the odds ratios in Japan are almost similar to those in the U.S. (Figure 15). In this point of view, the NASS/CDS data are useful on statistical analyses such as injury prediction for accidents in Japan.



(a) ITARDA Micro Data



(b) NASS/CDS weighted

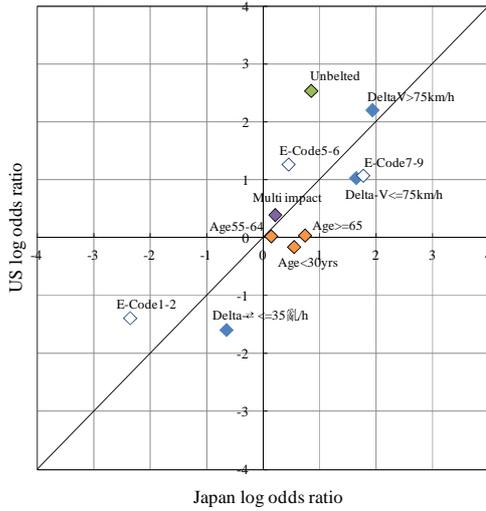


(c) NASS/CDS J-weighted

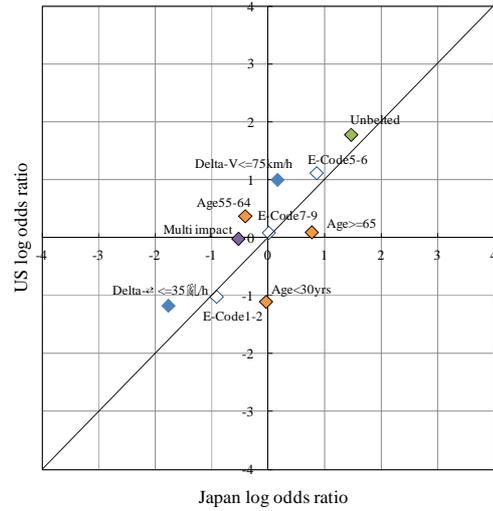
Figure 14. Histogram of occupant age, frontal single-vehicle collisions.

On the other hand, for vehicle factors: group B, there are some differences (Figure 16). Vehicle curb weight factor has different odds ratio between Japan and U.S. especially in light vehicles less than 900kg (V-weight <900kg). The U.S. log odds ratio is higher than Japan log odds ratio for vehicle curb weight less than 900kg.

In occupant factors: group C, occupant height factor has different odds ratio between the two (Figure 17). The U.S. log odds ratio is higher than Japan odds ratio for occupant height less than 155cm (O-height <155cm). These factors can be found in the differences of MD distributions. The analyses on the

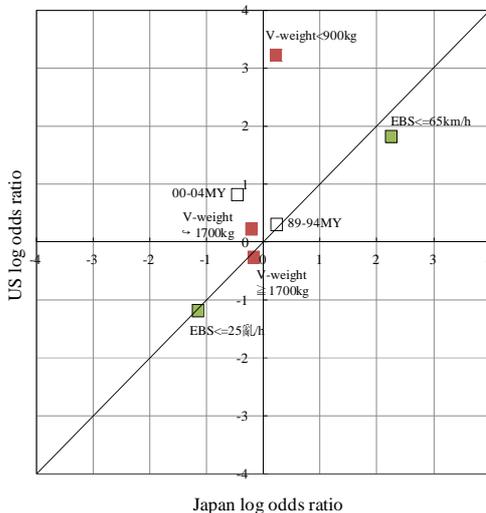


(a) Head-on collisions

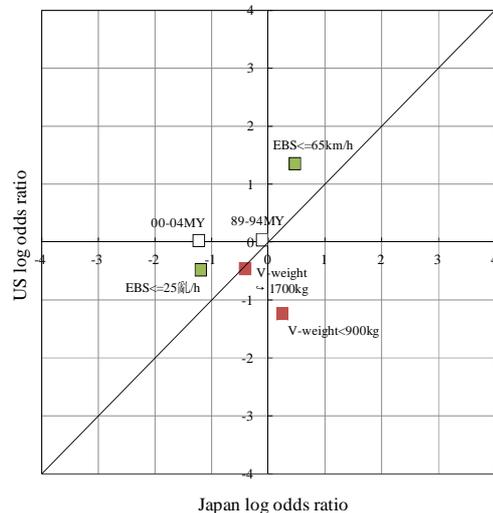


(b) Frontal single-vehicle collisions

Figure 15. Comparison log odd ratio on group A factors. E-code: Extent of damage code.

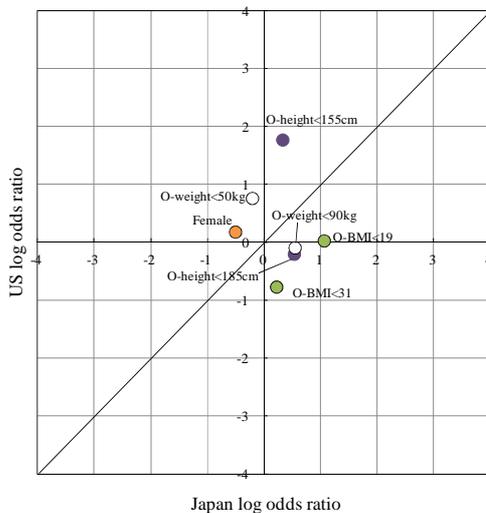


(a) Head-on collisions

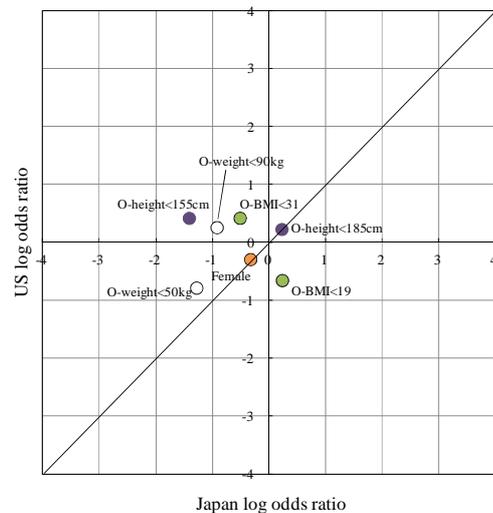


(b) Frontal single-vehicle collisions

Figure 16. Comparison log odd ratio on group B factors. V-weight: Vehicle curb weight, MY: Vehicle registration year.



(a) Head-on collisions



(b) Frontal single-vehicle collisions

Figure 17. Comparison log odd ratio on group C factors. O-height: Occupant height, O-BMI: Occupant BMI.

vehicle weight or occupant height should be noted using the NASS/CDS; moreover, should be added Japanese in-depth accident investigations.

CONCLUSIONS

This study presents the evaluation method of similarities for traffic accident databases using Mahalanobis distance (MD), and shows the similarities and differences between Japan and the U.S. distribution of factors influencing injuries in frontal collisions. Furthermore, the points of attention and useful utilization using the NASS/CDS in analyses for Japanese traffic accidents are indicated. The conclusions of this study are as follows:

- (1) The NASS/CDS data has similar distribution of MD to the ITARDA Micro Data in the injury prediction factors: delta-V, seat belt use, multiple impact, rollover, extent of damage code and occupant age. Therefore, the NASS/CDS can be utilized as it is for Japanese statistical analyses such as injury prediction for Japan.
- (2) Conditions which include vehicle factors such as occupant height have different distribution of MD. Therefore, the NASS/CDS cannot be utilized as it is for Japan in case of using these factors.
- (3) The accident cases in the U.S. far from Japanese distribution indicate uncommon accidents in Japan such as high delta-V (over 75km/h) with multiple impacts and rollover, or high BMI (50+) drivers in low delta-V (≤ 35 km/h) etc. These far accident cases should be noted in case of analyses for Japan using the NASS/CDS.
- (4) The accident cases in Japan far from the U.S. distribution indicate characteristic accidents in Japan such as light vehicle (900kg-, including Kei car) by short statured persons (<155cm) etc. These cases need inherent accident analyses using Japanese in-depth accident investigations.
- (5) New weighting method for the NASS/CDS which fits the distribution of MD to Japan presents useful utilization of the analyses in Japan using the NASS/CDS. However, it needs further improvements on occupant age balance.

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