Current status of motorcycle accidents and emergency transport

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1. Purpose of the study

The conditions surrounding motorcycles and motorcycle accidents have been undergoing a drastic transformation in these past few decades. This is thought to have been backed by a number of factors, including: (1) the decline in the population of young people, (2) the diversification in people's interests, and (3) the adoption of motorcycling as an interest by middle-aged and elderly people.

In light of the above, there are calls for the enactment of different traffic measures than those enacted in the past. Conceivable examples of this would include revising countermeasures against motorcycle gangs comprised mainly of minors (lifting entry restrictions to downtown urban areas) and awareness-raising activities for middle-aged and elderly return riders who are taking up motorcycling again after an absence (with measures including rechecking of any decline in their capabilities, etc.). Among these one can glimpse measures that are being handled, even if only in a partial manner.

This paper will reaffirm the changes in motorcycle accidents and their recent conditions and characteristics, thereby clarifying the orientation for traffic measures and getting the word on this out to the public that will serve to provide backup in promoting effective traffic measures.

One recent initiative begun by the Institute for Traffic Accident Research and Data Analysis (hereafter abbreviated as ITARDA) is an attempt to develop traffic analyses based on a new approach of combining the various traffic accident data possessed by ITARDA with other data (national geographical information, emergency transport information, etc.).

This paper will use emergency transport data obtained via the Fire and Disaster Management Agency (FDMA) at the beginning of the fiscal year and match this with individual data found amongst the data on motorcycle accidents. This was done in an attempt to engage in new analyses and deduce problems that were not possible with past analyses. Some of this will be introduced to the reader, albeit in the form of small tidbits of information.

2. Changes in and the current status of motorcycle accidents

This section lays out the changes in the status of motorcycle accidents since 1990, mainly with regard to accidents by age group and type of motorcycle.

2.1 Changes in the number of traffic accident fatalities (1990 - 2017)

To begin, the changes in the number of traffic accident fatalities will be discussed by condition. The phrase "by condition" refers to the conditions present when the accident occurred. In this paper said conditions will be broadly classified into "while riding in a four-wheel vehicle," "while riding on a motorcycle," "while riding on a bicycle, etc." and "while walking." The phrase "bicycle, etc." used here includes motor-assisted bicycles and so forth.

Fig. 1 shows trends in the number of traffic accident fatalities for each type of condition (1990 - 2017).

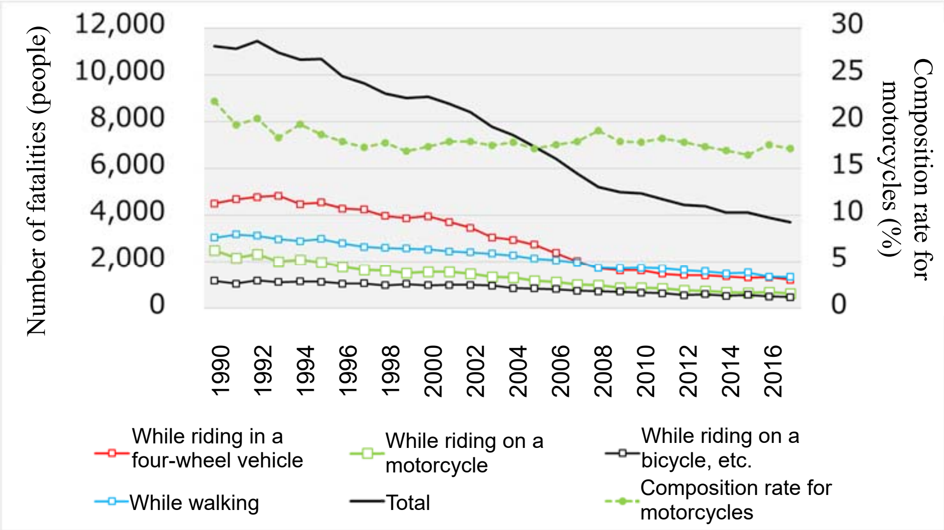

Fig. 1. Trends number of traffic accident fatalities for each type of condition (1990 - 2017)

The number of fatalities for all conditions over the 27-year period from 1990 to 2017 came to 3,694 people, falling by 7,533 from 11,227 (△67.1%). The period around 1990, which is referred to as the "Second Traffic War," saw a number of traffic accident fatalities in excess of 10,000 people. However, it has fallen since then, to the point of dipping below 4,000 people. This is believed to have come about as a result of measures against traffic accidents and the dissemination of safety technologies on vehicles.

The number of fatalities while riding in a four-wheel vehicle over the 27-year period from 1990 to 2017 came to 1,221 people, falling by 3,280 from 4,501 (△72.9%). While this was the condition with the greatest number of fatalities up through 2007, from 2008 onward it fell to second place behind fatalities while walking.

The number of fatalities while riding on a motorcycle over the 27-year period from 1990 to 2017 came to 632 people, falling by 1,860 people from 2,492 (△74.6%). This is the greatest rate of decrease over this 27-year period seen among the four types of conditions discussed in this paper. Looking at trends in the composition rate for the number of fatalities while riding on a motorcycle as a proportion of all of the conditions reveals that this was slightly higher around the year 1990 at around 20%. Yet while it has since decreased, this condition has not seen any extreme changes, as it has hovered between 15 - 20%.

The number of fatalities while riding on a bicycle, etc. over the 27-year period from 1990 to 2017 came to 486 people, falling by 690 people from 1,176 (△58.7%). This remains the condition with the fewest number of fatalities out of the four types of conditions.

The number of fatalities while walking, over the 27-year period from 1990 to 2017 came to 1,347 people, falling by 1,695 people from 3,042 (△55.7%). Of the four types of conditions discussed in this paper, this one had the smallest rate of decrease over this 27-year period. Moreover, this was the condition with the second highest number of fatalities up through 2007 after the condition of while riding in a four-wheel vehicle. But since 2008 it has remained the condition with the highest number of fatalities.

If we were to summarize the above findings, the claim could be made that the number of fatalities while riding on a motorcycle is similar to those from the other conditions in that they have been trending downward over these past few decades. It could also be said that its composition rate out of all of the conditions has not changed significantly.

2.2. Changes in the number of fatalities while riding a motorcycle by age group (1990 - 2017)

Next, we will take a look at trends in the number of fatalities while riding on a motorcycle by age group. Age groups were divided up into seven ranges, including the ages of “16 - 24,” 25 - 34,” up to “75 and older.” The reason that people age 16 and older were made the focus of this study is because 16 years old is the established minimum age at which one can obtain a license for a motor-assisted bicycle or standard motorized two-wheel vehicle.

Fig. 2 shows trends in the number of fatalities by age group (1990 - 2017).

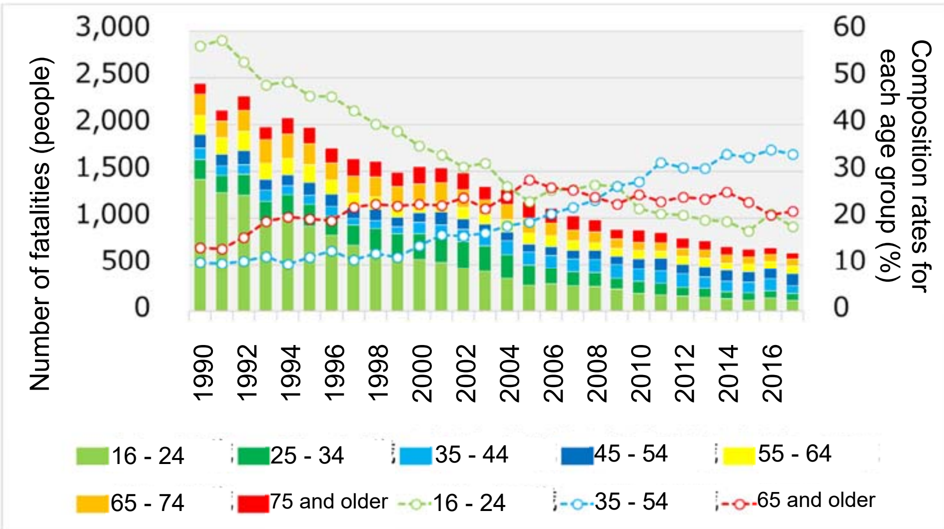

Fig. 2. Trends in the number of fatalities by age group (1990 - 2017)

The number of fatalities among people age 16 - 24 over the 27-year period from 1990 to 2017 came to 115 people, falling by 1,300 people from 1,415 (△91.9%). This accounts for 69.9% of the total decrease for motorcycles as a whole. As such, the decline in the number of fatalities while riding on a motorcycle could be claimed to have been largely attributable to the decline in the number of fatalities among people age 16 - 24.

The number of fatalities among people age 25 - 34 over the 27-year period from 1990 to 2017 came to 77 people, falling by 137 people from 214 (△64.0%). However, the number of fatalities for this group peaked at 284 people in 2002. So compared with the fact that the number of fatalities among people age 16 - 24 has continued to decline since peaking in 1990, it followed this same trajectory more than ten years later.

The number of fatalities among people age 35 - 44 over the 27-year period from 1990 to 2017 came to 80 people, falling by 43 people from 123 (△35.0%). However, the number of fatalities for this group peaked at 149 people in 2004. So compared with the fact that the number of fatalities among people age 16 - 24 has continued to decline since peaking in 1990, it followed this same trajectory even later than the 25 - 34-year-old group did.

The number of fatalities among people age 45 - 54 over the 27-year period from 1990 to 2017 came to 133 people, falling by 8 people from 141 (△5.7%). However, this has begun trending upward once again after bottoming out at 81 people in 2005.

The number of fatalities among people age 55 - 64 over the 27-year period from 1990 to 2017 came to 88 people, falling by 117 people from 205 (△57.1%).

The number of fatalities among people age 65 - 74 over the 27-year period from 1990 to 2017 came to 73 people, falling by 150 people from 223 (△67.3%).

The number of fatalities among people age 75 and older over the 27-year period from 1990 to 2017 came to 63 people, falling by 58 people from 121 (△47.9%).

Synthesizing the above together reveals that the number of fatalities among people age 16 - 24 have fallen substantially, which has contributed to the drop in the number of fatalities while riding on a motorcycle. It is also believed that as these people age from this point in time, this will also influence the change in the number of fatalities among people age 25 - 34, then 35 - 44 and 45 - 54.

People age 16 - 24 were categorized as young people, those age 35 - 54 (including the 35 - 44 and 45 - 54 groups) were categorized as middle-aged people, and those 65 and older (including the 65 - 74 and 75+ groups) were categorized as elderly people. Looking at trends in the composition rates for each of these reveals that in 1990 young people accounted for more than half of the number of fatalities at 56.8%, yet only 18.2% in 2017. Taking their place were the middle-aged group at 33.7% and elderly group at 21.5%, both of which exceeded the share accounted for by young people.

2.3 Changes in the number of fatalities by motorcycle engine displacement (1990 - 2017)

Next, we will look at the trends in the number of fatalities while riding on a motorcycle by engine displacement. Engine displacement was broadly classified into five categories: 401cc and above, 251 - 400cc, 126 - 250cc, 51 - 125cc, and 50cc and below. Table 1 shows the classification of motorcycle types, while Fig. 3 shows trends in the number of fatalities by engine displacement (1990 - 2017).

Table 1. Classification of motorcycle types

Classification on the accident ledger			50cc and below	51-125cc	126-250cc	251-400cc	401-750cc	751cc and above
Name in the Road Transport Vehicle Act			Class I moped	Class II moped	Light motorcycle	Motorcycle		
Required driver's license	Moped		Can operate	Cannot operate				
	Ordinary vehicle		Can operate	Cannot operate				
	Ordinary motorcycle	Limited to small sizes	Can operate		Cannot operate			
		No limitations	Can operate				Cannot operate	
	Large motorcycles		Can operate					
Number	Municipality		White	Yellow / Peach				
	Transport Bureau				White	Green edging		
Vehicle inspection			Not required			Required		
Obligation to wear helmet?			Yes					
Riding tandem			Not allowed	Allowed (except for cases where the license was obtained less than one year ago)				
Speed limit			30km/h	No limitations based on vehicle type				
National expressways			Cannot enter		Can enter			
Classifications in this research presentation			50cc and below	51-125cc	126-250cc	251-400cc	401cc and above	

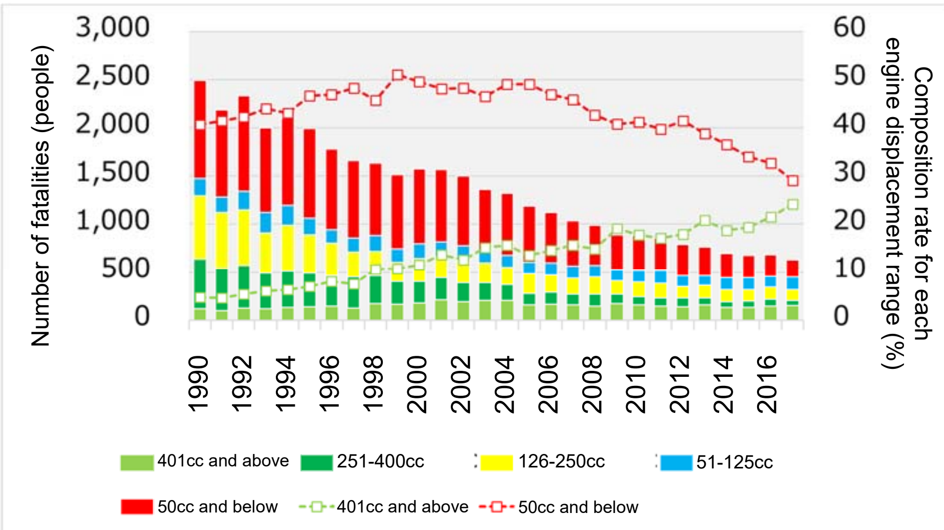

Fig. 3. Trends in the number of fatalities by engine displacement (1990 - 2017)

The number of fatalities involving motorcycles with an engine displacement of 401cc and above over the 27-year period from 1990 to 2017 came to 153 people, increasing by 34 people from 119 (+28.6%). However, after peaking at 214 people in 2001 this number began to decline, and has remained steady in recent years.

The number of fatalities involving motorcycles with an engine displacement of 251 - 400cc over the

27-year period from 1990 to 2017 came to 50 people, falling by 468 people from 518 (△90.3%). This was the highest rate of decrease seen among all of the engine displacements.

The number of fatalities involving motorcycles with an engine displacement of 126 - 250cc over the 27-year period from 1990 to 2017 came to 112 people, falling by 546 people from 658 (△83.0%).

The number of fatalities involving motorcycles with an engine displacement of 51 - 125cc over the 27-year period from 1990 to 2017 came to 133 people, falling by 49 people from 182 (△26.9%). However, this has begun trending upward once again after bottoming out at 103 people in 2013.

The number of fatalities involving motorcycles with an engine displacement of 50cc and below over the 27-year period from 1990 to 2017 came to 184 people, falling by 831 people from 1,015 (△81.9%). This accounts for 44.7% of the total decrease for motorcycles as a whole. As such, the decline in the number of fatalities while riding on a motorcycle could be claimed to have been largely attributable to the decline in the number of fatalities involving motorcycles with an engine displacement of 50cc and below.

Looking at the changes in the composition rates for each engine displacement reveals that the 50cc and below category, which was 40.7% in 1990 and accounted for more than half at 51% in 1999, fell to a share of 29.1% in 2017. The 401cc and above and 51 - 125cc categories took its place at 24.2% and 21.0%, respectively. As this indicates, the 50cc and below category no longer accounts for the majority of the number of fatalities compared with how things stood before.

2.4 Comparison of past and present characteristics for motorcycle engine displacement and age groups

A comparison of past and present characteristics for each age group and engine displacement was performed based on the previous section and the section before it. The sum total for the number of fatalities over the five-year period from 1990 - 1994 was regarded as past data and compared against the sum total from the five-year period from 2013 - 2017, which was taken as recent data.

2.4.1. Characteristics by engine displacement and age group from 1990 - 1994

Fig. 4 shows the number of fatalities by age group and engine displacement (sum total from 1990 - 1994).

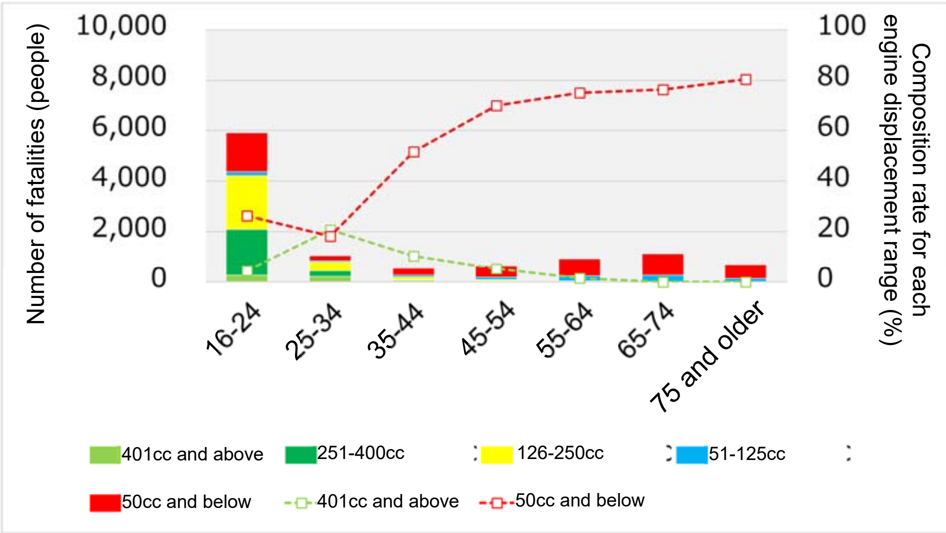

Fig. 4. Number of fatalities by age group and engine displacement (sum total from 1990 - 1994)

The first characteristic that can be mentioned here is that people age 16 - 24 accounted for a majority of the whole at 53.4%. As for characteristics of the engine displacement among these, the 126 - 250cc category accounted for over one-third at 36.2%, followed by 251 - 400cc at 30.5% and 50cc and below at 24.4%. Motorcycles with an engine displacement of 125 - 250cc, which did not need to undergo inspections, could drive on national expressways, while those with an engine displacement of 251 - 400cc had to undergo inspections, but could be driven with a mid-size vehicle license (license exclusively for mid-sized motorcycles) back then. These and other such reasons are thought to be behind why they had become increasingly popular among young people (See Table 1).

The composition rate for 401cc and above motorcycles was low on the whole at 20.9% among people age 25 - 34, 10.5% for those age 35 - 44, and single digits for the other age groups.

As opposed to this, for the composition rate for 50cc and below motorcycles, people age 35 - 44 accounted for more than half at 51.7%, with all age groups age 45 and older accounting for the vast majority at over 70%.

2.4.2. Characteristics by engine displacement and age group from 2013 - 2017

Fig. 5 shows the number of fatalities by age group and engine displacement (sum total from 2013 - 2017). Since the number of fatalities here has decreased substantially compared with that from 1990 - 1994, the scale of the vertical axis was shrunk by one-tenth (the full scale for Fig. 4 is 10,000 people, which was reduced to 1,000 people for Fig. 5).

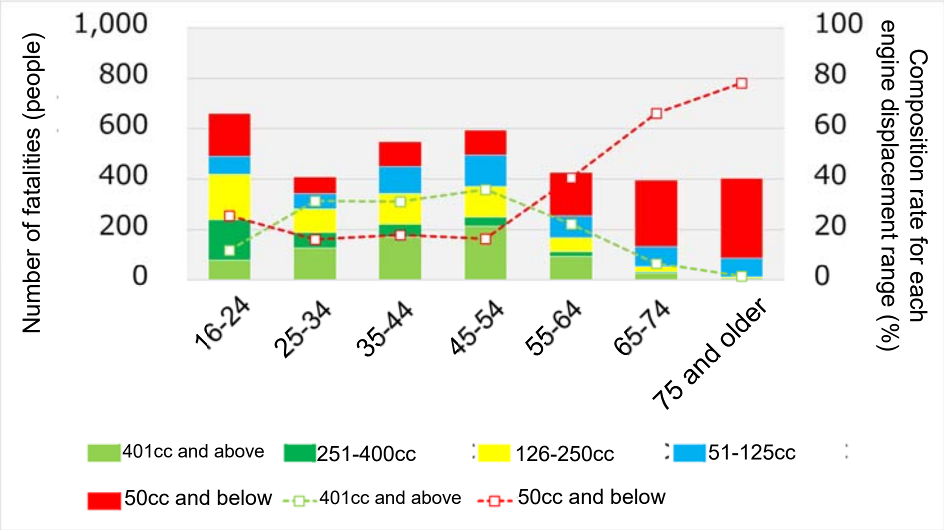

Fig. 5. Number of fatalities by age group and engine displacement (sum total from 2013 - 2017)

The first thing that can be perceived is the fact that the conspicuously large number of fatalities among young people (age 16 - 24) that was a characteristic from 1990 - 1994 went away, and the conditions are such that all age groups are roughly equally represented.

The composition rate for motorcycles with an engine displacement of 50cc and below was 40.7% among people age 55 - 64, with the vast majority of the age group of people age 65 and older riding such motorcycles at roughly 70%. Age groups other than those mentioned above (age 54 and younger) had a comparatively low composition rate at around 20%. The trend for those in the middle-aged and older groups closely resembled a 23-year shift of the trends from 1990 - 1994 with the passage of time.

The composition rates for motorcycles with an engine displacement of 401cc and above were 31.5% among people age 25 - 34, 31.2% for those 35 - 44, and 36.0% for those 45 - 54, with each representing roughly one-third of the total. This is the engine displacement category with the largest number of fatalities for these age groups, thus constituting one of the major segments.

2.5. Summary of the changes in and current status of motorcycle accidents

The number of fatalities from motorcycle accidents has continued along its downward trajectory in the same way as fatalities from the other conditions (while riding in four-wheel vehicles and light vehicles, while walking, etc.). While the number of fatalities was 2,492 people in 1990, this had fallen to 632 by 2017. This is a large rate of decrease compared with those of the other conditions.

One of the age group-based characteristics is that young people age 16 - 24 once (in the 1990s) accounted for more than half of the number of fatalities. But as a result of this continuing along its downward trajectory, recently the middle-aged group (35 - 44 and 45 - 54 age groups) and elderly group (65 - 74 and 75 and older age groups) have surpassed young people in terms of their number of fatalities.

One of the engine displacement-based characteristics is that the 50cc and below category had continued on as the condition accounting for nearly half of the number of facilities for a time (1990s - 2000s).

But as a result of this continuing along its downward trajectory, recently the gap with the number of fatalities from other engine displacement categories, such as 401cc and above, has grown smaller.

Recent trends with the number of fatalities based on engine displacement have exhibited unique characteristics for each age group. For the groups from young adult to middle-aged people (including the 25 - 34, 35 - 44, and 45 - 54 groups) the 401cc and above category accounted for the greatest number of fatalities, while for the elderly age group (including the 65 - 74 and 75 and older groups) the 50cc and below category accounted for the greatest number.

3. Integration with emergency transport data

An attempt was made to perform a new type of analysis by matching the data on emergency transport times and other topics obtained via the FDMA with the traffic accident data retained by ITARDA and using the integrated data thus obtained (but only in relation to motorcycles).

3.1. Emergency transport times

Fig. 6 shows a schematic overview of emergency transport times. It offers a schematic representation of the sequence of events that occurs at the scene of the accident after an accident until the victim(s) are admitted to an emergency hospital or similar facility.

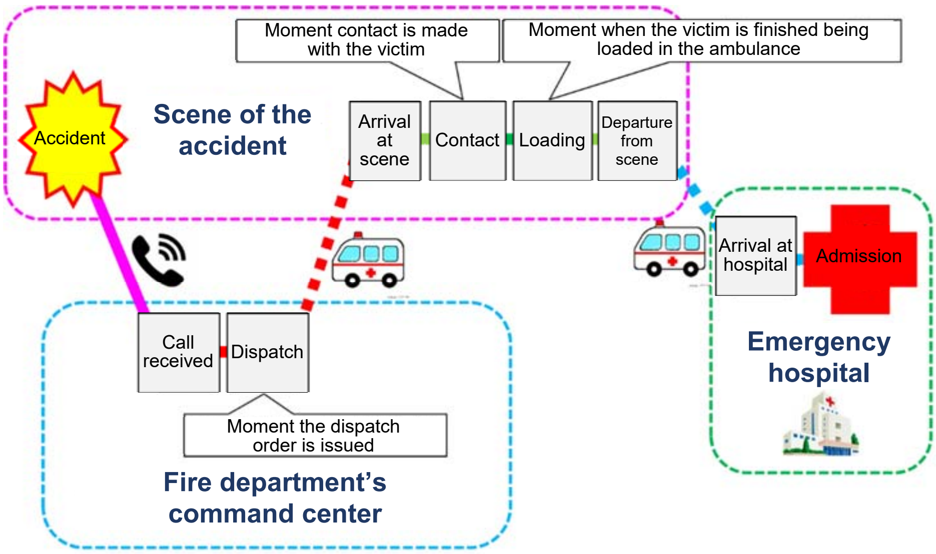

Fig. 6. Emergency transport times

Definitions for the terms found in Fig. 6 are listed below.

- Accident : Moment when the traffic accident occurred
- Call received : Moment when the accident report is received (by the fire department's command center)
- Dispatch : Moment the order to dispatch an ambulance is issued (by the fire department's command center)

・Arrival at scene : Moment the ambulance arrives at the scene of the accident
・Contact : Moment the emergency rescue workers made contact with the victim
・Loading : Moment when the victim is loaded in the ambulance
・Departure from scene : Moment when the ambulance departs from the scene of the accident
・Arrival at hospital : Moment the ambulance arrives at the hospital
・Admission : Moment the victim is admitted to the hospital

In some cases, terms that are slightly different may be used for each area. The reader is asked to please pardon any differences with terms that are in common use.

3.2. Connection between the accident data and emergency transport data

An attempt was made within ITARDA to perform matching between the emergency transport data obtained via the FDMA with the traffic accident data retained by ITARDA for data related to motorcycle accidents. Since the emergency transport data obtained covered the two years of 2015 and 2016, it was matched with similar data covering two years.

Requirements for performing the matching are defined as follows:

- Same prefecture
- Same age / gender
- Approximately the same occurrence date / time within the traffic accident data and call received date / time within the emergency transport data

For the requirement of having approximately the same time, efforts were made to improve accuracy through trial and error.

As a result, the number of valid data points came to approximately 58,000 points. This represents approximately 40% of the motorcycle accident data points for the year in question.

Fig. 7 shows an image of the connections between the accident data and emergency transport data.

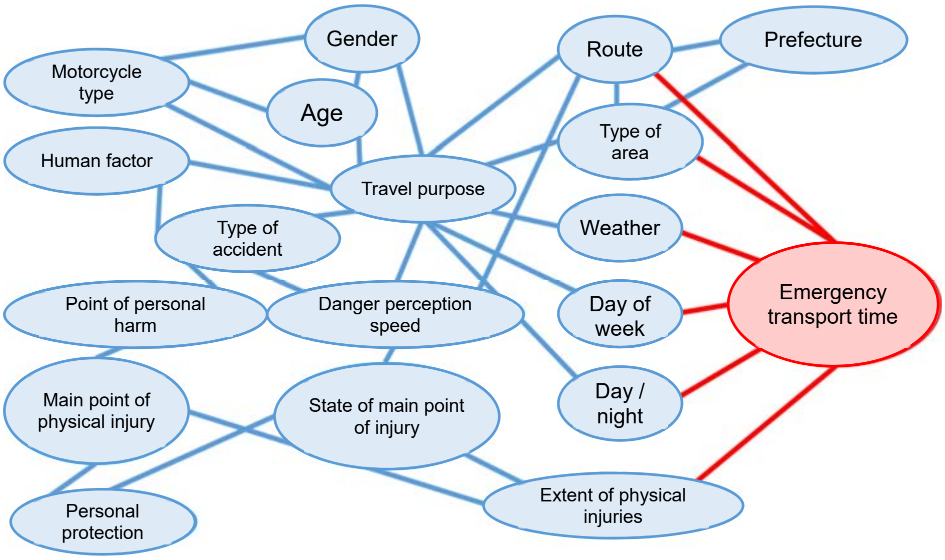

Fig. 7. Image of the connections between the accident data and emergency transport data

The blue ovals indicate the major parameters for the traffic accident data retained by ITARDA, while the blue lines connecting the parameters indicate the connections between the respective parameters. The connections between respective parameters were derived from the results obtained by performing analyses on past motorcycle accidents and the like.

The following terms warrant caution:

- Personal protection: When riding a motorcycle, this refers to the state of wearing a helmet or having it come off
- Type of area: This refers to the type of land use, including categories such as urban areas with concentrated populations, other urban areas, and non-urban areas

Estimates regarding how this data on emergency transport times relates to the parameters for this traffic accident data are expressed via the red oval and red lines. This diagram makes it possible to visually perceive how the data on emergency transport times and the parameters for the various accident data are ultimately related to one another.

Next, predictions for the connection between the data on emergency transport times and accident data were organized. The predicted connections between the accident data and emergency transport data are shown in Fig. 8.

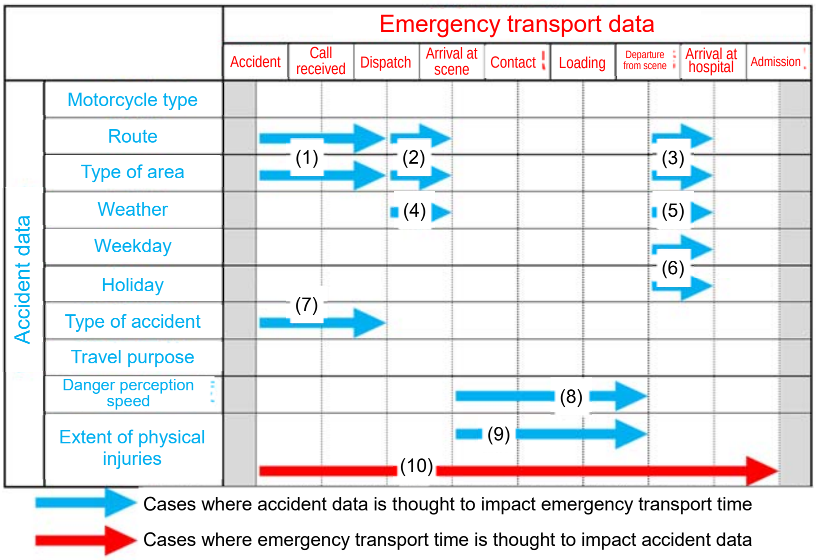

Fig. 8. Predicted connection between the accident data and emergency transport data

The blue arrows express instances where the accident data is believed to affect the emergency transport data, while the red arrow expresses a case where the emergency transport data is believed to affect the accident data.

The reasons for why these are assumed to be related are described below.

(1) The accident may be delayed in being discovered depending on the route and type of area at the scene of the accident, which could potentially lead to delays in the time between accident and when the call is received, as well as in the time between accident and dispatch (this includes routes with minimal traffic volume and non-urban areas with minimal traffic volume and pedestrian traffic, etc.).

(2) Depending on the route and type of area at the scene of the accident (such as in areas deep within mountains, etc.), if the fire station is located far away from the scene of the accident then this could potentially lead to delays in the time between dispatch and arrival at scene (time it takes for the ambulance to head to the scene).

(3) Depending on the route and type of area, if the scene of the accident is located far away from an emergency hospital (such as in areas deep within mountains, etc.), this could potentially lead to delays in the time between departure from scene and arrival at hospital (time it takes for the ambulance to head from the scene to the emergency hospital).

(4) Reasons such as poor road conditions on the route taken to travel from the fire station to the scene of the accident as a result of weather (such as during torrential downpours or when there is snowfall, etc.) can potentially lead to delays in the time between dispatch and arrival at scene (time it takes for the ambulance to head to the scene).

(5) Reasons such as poor road conditions on the route taken to travel from the scene of the accident to the emergency hospital as a result of weather (such as during torrential downpours or when there is snowfall, etc.) can potentially lead to delays in the time between departure from scene

and arrival at emergency hospital (time it takes for the ambulance to head from the scene to the emergency hospital).

(6) Depending on the day of the week, or if the day is a national holiday, then this could potentially cause discrepancies with other days regarding the hospital's admission structure. By limiting the options for hospitals to which the patient can be admitted, this ultimately increases the possibility of delays arising in the time between departure from scene and arrival at hospital.

(7) With single vehicle accidents where the parties have suffered serious injuries and cannot secure a means of communication, this may increase the possibility of delays in the time between accident and when the call is received and the time between accident and dispatch.

(8) When the danger perception speed increases the extent of physical injuries to the parties grows more severe, a fact that has led to the institution of a policy to shorten response times at the scene of the accident (called "load and go"). This may shorten the time between arrival at scene and the departure from it and other time intervals.

(9) Similar to (8), when the extent of physical injuries is severe, load and go serves as a policy for shortening the response time at the scene of the accident, which may shorten the time between arrival at scene and the departure from it and other time intervals.

(10) Delays in the time between accident and admission (the total for all of the transport times) may diminish the possibility that patients in critical condition can receive the help they need.

Based on the above, analyses were performed to see whether there are any connections between the accident data and the emergency transport data. Fig. 9 shows the connections between the accident data and the emergency transport data.

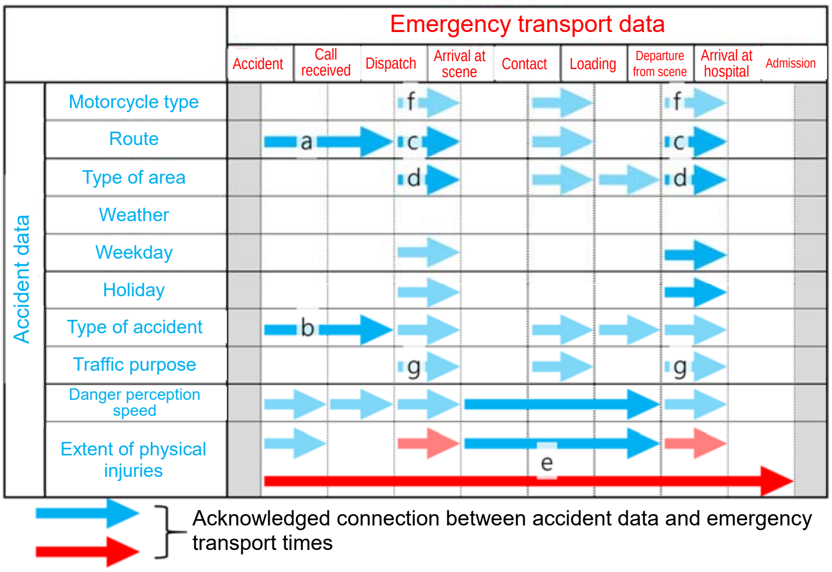

Fig. 9 Connection between the accident data and emergency transport data

The number of arrows has increased compared with Fig. 8. This suggests that the accident data and emergency transport data were more closely connected than had been initially anticipated.

Starting from the next section, seven items from a - g in Fig. 9 will be introduced from among these connections.

3.3. Characteristics of the time between the accident and dispatch (a, b)

3.3.1. Connection between the time between accident and dispatch and the route (a)

Routes were broadly classified into two types: "Expressways" and "general roads." The term "expressways" as used here covers both national expressways and motorways. Table 2 shows examples of national expressways and motorways. In addition, "general roads" refer to roads other than expressways as defined above.

Table 2. Examples of national expressways and motorways

Route	Region	Route name (indicated by their common names)
National expressways	Hokkaido	Do-o Expressway / Hokkaido Expressway …
	Tohoku	Tohoku Expressway / Akita Expressway …
	Kanto	Tomei Expressway / Kan-Etsu Expressway
	Chubu	Hokuriku Expressway / Chuo Expressway …
	Kinki	Meishin Expressway / Chugoku Expressway …
	Chugoku	Sanyo Expressway / Okayama Expressway …
	Shikoku	Takamatsu Expressway / Matsuyama Expressway …
	Kyushu	Kyushu Expressway / Nagasaki Expressway …
	Okinawa	Okinawa Expressway
Motorways	Hokkaido	Hidaka Expressway …
	Tohoku	Sendai Tobu Road …
	Kanto	Metropolitan Expressway / Ken-O Expressway / Odawara-Atsugi Bypass …
	Chubu	Noetsu Expressway / Tokai-Kanjo Expressway / Nagoya Expressway …
	Kinki	Hanshin Expressway / Meihan Expressway / Kakogawa Bypass …
	Chugoku	Seto-Chuo Expressway / Matsue-Dandan Road …
	Shikoku	Matsuyama Soto-Kanjo Road / Ozu Road …
	Kyushu	Fukuoka Expressway / Usa-Beppu Road …
	Okinawa	Naha Airport Expressway

Fig. 10 shows the time between accident and dispatch by route. The horizontal axis shows the time, expressed as the average value of all of the corresponding data (the same holds true hereafter).

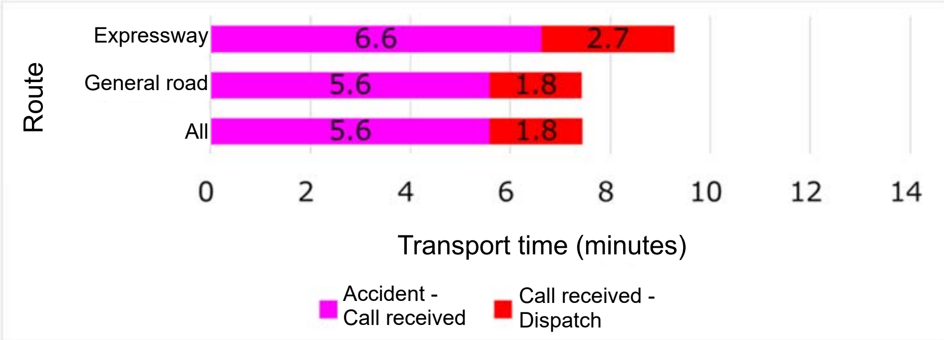

Fig. 10. Time between accident and dispatch by route

The first characteristic that can be mentioned is the lengthy time between accident and when the call is received and the time between when the call is received and dispatch on expressways. Whereas the time between accident and when the call is received is 5.6 minutes on general roads, this is one minute longer, or 6.6 minutes, on expressways. As for the time between when the call is received and dispatch, while this is 1.8 minutes on general roads it is 0.9 minutes longer, or 2.7 minutes, on expressways. The results of this indicate that the time between accident and dispatch is 1.9 minutes longer on expressways as opposed to general roads.

There are a number of conceivable reasons for this, including:

(1) Since emergency call phones that are installed at fixed intervals serve as the means of reporting when accidents occur along expressways, a considerable time lag may arise.

(2) If people choose the option of stopping their vehicle and reporting the accident from their personal cell phone, it may take them a certain amount of time to stop their vehicle (along the road shoulder, etc.) while checking to confirm that it is safe to do so since the traffic along expressways moves at high speeds.

3.3.2. Connection between the time between accident and dispatch and the accident type (b)

Accidents were broadly divided up into four accident types: pedestrian-vehicle, vehicle-vehicle, single vehicle, and train. Table 3 shows an overview of the categories for each accident type (partially omitted).

Table 3. Overview of the categories for each accident type (partially omitted)

<table>
<tr><td>Broad category</td><td>Intermediate category</td><td>Small category</td></tr>
<tr><td rowspan="4">Pedestrian-vehicle</td><td colspan="2">While walking facing vehicle</td></tr>
<tr><td colspan="2">While walking parallel to vehicle</td></tr>
<tr><td>While crossing the road</td><td>Pedestrian crossing / Vicinity of pedestrian crossing …</td></tr>
<tr><td colspan="2">…</td></tr>
<tr><td rowspan="8">Vehicle-vehicle</td><td colspan="2">Head-on collision</td></tr>
<tr><td>Collision</td><td>While passing / Other</td></tr>
<tr><td colspan="2">Crossing</td></tr>
<tr><td colspan="2">While passing or overtaking</td></tr>
<tr><td colspan="2">While passing</td></tr>
<tr><td colspan="2">While turning left</td></tr>
<tr><td>While turning right</td><td>Collision between a vehicle turning right and a vehicle going straight on / Other</td></tr>
<tr><td colspan="2">Other</td></tr>
<tr><td rowspan="5">Single vehicle</td><td>Roadside structure</td><td>Utility pole / Signpost / Median strip / Central reserve / Median reserve …</td></tr>
<tr><td colspan="2">Parked vehicle</td></tr>
<tr><td>Running off the road</td><td>Fall / Other</td></tr>
<tr><td colspan="2">Overturn</td></tr>
<tr><td colspan="2">Other</td></tr>
<tr><td colspan="3">Train</td></tr>
</table>

Fig. 11 shows the time between accident and dispatch by type of accident.

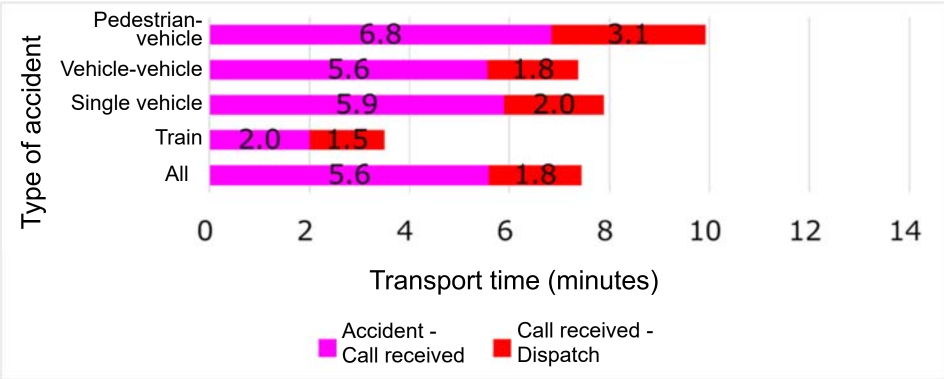

Fig. 11. Time between accident and dispatch by type of accident

The first characteristic that can be mentioned is the lengthy time between accident and when the call is received and the time between when the call is received and dispatch for pedestrian-vehicle accidents. Whereas the time between accident and when the call is received is 5.6 minutes for all accidents, it is 1.2 minutes longer, or 6.8 minutes, for pedestrian-vehicle accidents. Moreover, while the time between when the call is received and dispatch is 1.8 minutes for all accidents, it is 1.3 minutes longer, or 3.1 minutes, for pedestrian-vehicle accidents. The results of this indicate that the time between accident and dispatch is 2.5 minutes longer for pedestrian-vehicle accidents than it is for all accidents.

The next thing that can be affirmed from this is the lengthy time between accident and when the call is received and the time between when the call is received and dispatch for single vehicle accidents. Whereas the time between accident and when the call is received is 5.6 minutes for all accidents, it is 0.3 minutes longer, or 5.9 minutes, for single vehicle accidents. As for the time between when the call is received and dispatch, while this is 1.8 minutes for all accidents, it is 0.2 minutes longer, or 2.0 minutes, for pedestrian-vehicle accidents. The results from this indicate that the time between accident and dispatch takes 0.5 minutes longer for pedestrian-vehicle accidents than it does for all accidents, which is a minor discrepancy when compared with the time for pedestrian-vehicle accidents.

There are a number of conceivable reasons for this, including:

(1) With pedestrian-vehicle accidents, pedestrians tend to suffer more serious injuries than motorcyclists do, and there is a strong possibility that the pedestrian will be the secondary party. Therefore, accident reports for the sake of the pedestrian are prioritized, while those for the motorcyclist are put off.

(2) With single vehicle accidents, there is the possibility that accident reports will be delayed for reasons such as minimal traffic volume in the surrounding area and the victim being unable to secure a means of reporting this because they are in critical condition or in shock from the accident. However, it is not likely that this will lead to substantial delays in the average times.

3.4. Characteristics of the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital (c, d)

3.4.1. Connection between the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital and the route (c)

Similar to the previous section, routes were broadly divided up into expressways and general roads. Fig. 12 shows the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital by route.

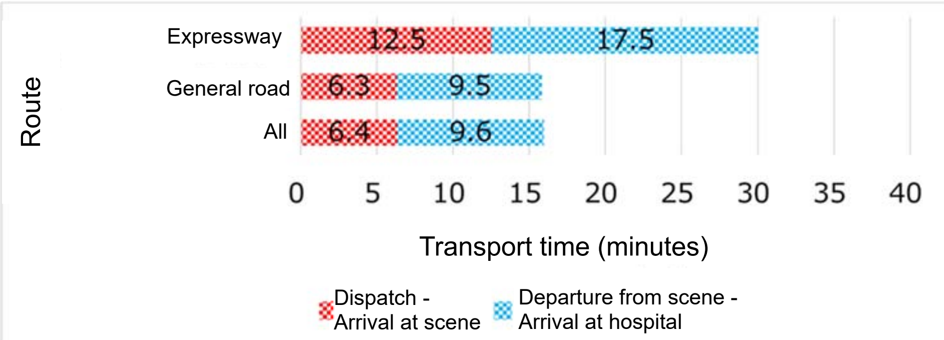

Fig. 12. Time between dispatch and arrival at scene and time between departure from scene and arrival at hospital by route

The first characteristic that can be mentioned is the lengthy time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital for expressways. Whereas the time between dispatch and arrival at scene is 6.3 minutes for general roads, it is 6.2 minutes longer, or nearly twice as long, on expressways at 12.5 minutes. In addition, while the time between departure from scene and arrival at hospital is 9.5 minutes for general roads, it is 8.0 minutes longer, or 17.5 minutes, for expressways. The results of this indicate that the travel time by the ambulance (the total of the above time intervals) is 14.2 minutes longer on expressways than it is on general roads.

There are a number of conceivable reasons for this, including:

(1) When heading to the scene of an accident on an expressway, the ambulance must travel through an interchange from a general road, which inevitably forces it to travel in a roundabout manner in many cases.

(2) In addition to (1) above, when the lanes heading in either direction are completely cut off from one another, the interchanges and so forth that vehicles must pass through are restricted to areas that are farther up the road, further adding to the possibility that they will have to take a roundabout route.

(3) When congestion occurs on the expressway as a result of the accident occurring, this could potentially serve as a factor for why it takes more time as it is more difficult to avoid congestion than it is with general roads.

(4) When heading to the emergency hospital or similar facility from the scene of an accident on an expressway, just like with (1) the ambulance must pass through an interchange or the like to exit

onto a general road, which inevitably forces it to travel in a roundabout manner in many cases.

(5) In addition to (4) above, when the lanes heading in either direction are completely cut off from one another, the interchanges and so forth that vehicles must pass through are restricted to areas that are farther down the road, further adding to the possibility that they will have to take a roundabout route.

Fig. 12 shows a comparison of the time distributions for each transport time designed to further confirm the status quo, as we only know the difference in the average values. Fig. 13-1 shows the distribution for the time between dispatch and arrival at scene by route, while Fig. 13-2 shows the distribution for the time between departure from scene and arrival at hospital by route.

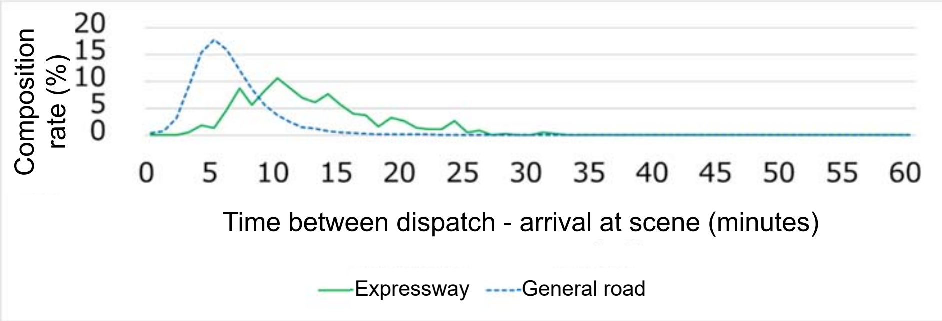

Fig. 13-1. Distribution for the time between dispatch and arrival at scene by route

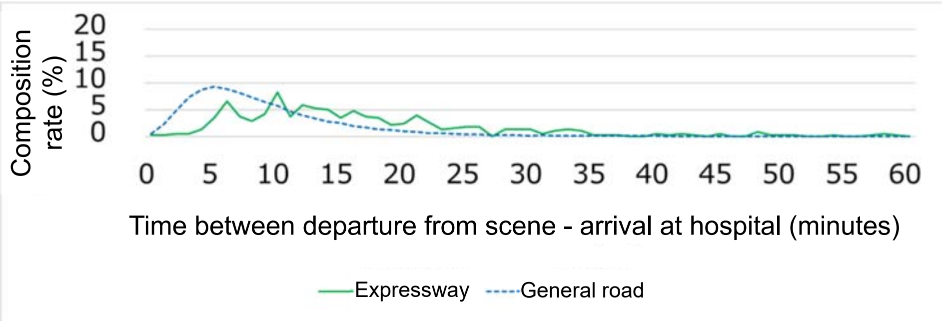

Fig. 13-2. Distribution for the time between departure from scene and arrival at hospital by route

For both the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital, expressways have a low composition rate when it comes to short times of five minutes or less. This stands in stark contrast with general roads, for which the distribution peaks in the vicinity around five minutes. Conversely, general roads have a composition rate that is close to zero when it comes to long times for the time between dispatch and arrival at scene of 15 minutes or longer and the time between departure from scene and arrival at hospital of 23 minutes or longer. As opposed to this, expressways feature a considerable composition rate within these ranges, which can be read as a shift towards longer times on the whole.

3.4.2. Connection between the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital and the type of area (d)

The type of area can be divided up into three categories: urban areas with concentrated populations, other urban areas, and non-urban areas. Table 4 shows the definitions of terms used for the type of area categories, while Fig. 14 shows examples of districts with concentrated populations as a supplement to Table 4.

Table 4. Definitions of terms used for the type of area categories

Broad category	Sub-category	Definition, etc.
Urban areas	Regions featuring conditions whereby residences, offices, factories, or other structures are lined up side by side, or where these are lined up side by side in an intermingled manner, for roughly 500m or more along the side of a road. Such regions also feature so-called urban area-type configurations in that they consist of at least 80% structures and plots	
	Urban areas with concentrated populations	Districts with concentrated populations from among urban areas (according to the national census)
	Other urban areas	Areas other than districts with concentrated populations from among urban areas
Non-urban areas	Areas other than urban areas	

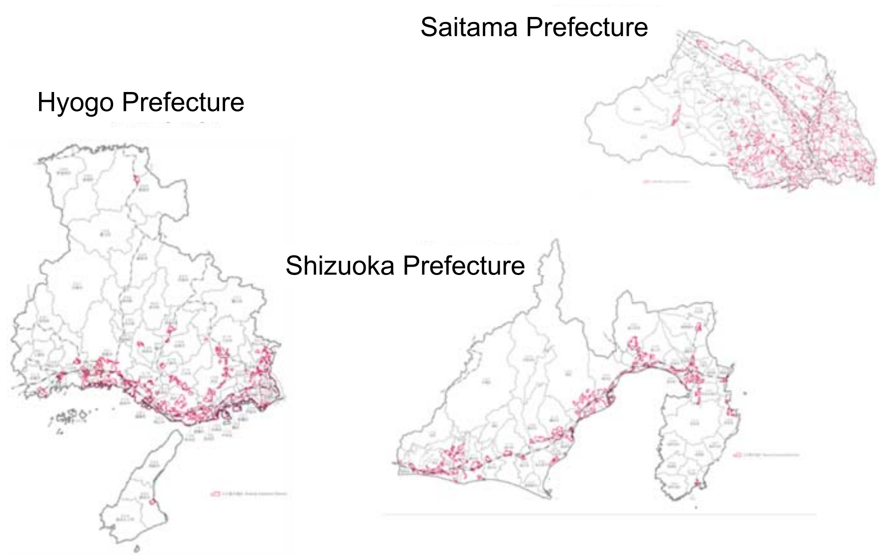

Fig. 14. Examples of districts with concentrated populations

Fig. 15-1 shows the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital by type of area.

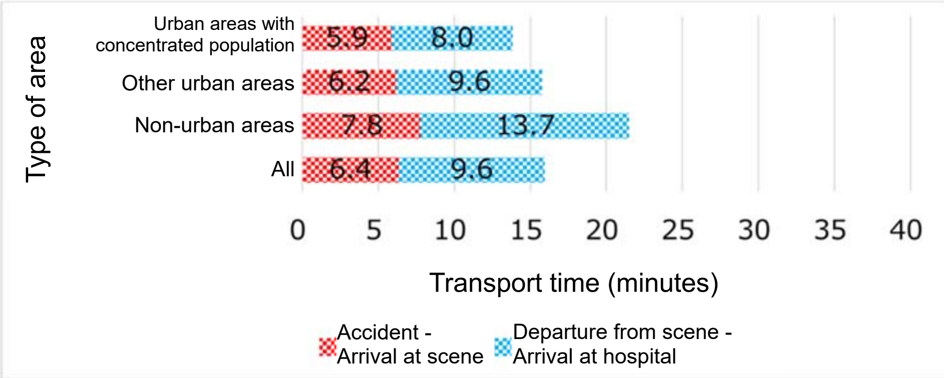

Fig. 15-1. Time between dispatch and arrival at scene and time between departure from scene and arrival at hospital by type of area

The first characteristic that can be mentioned is the fact that as you move from urban areas with concentrated population → other urban areas → non-urban areas, the times between dispatch and arrival at scene and the times between departure from scene and arrival at hospital both grow longer. If urban areas with concentrated population are taken as the baseline, then the time between dispatch and arrival at scene is 0.3 minutes longer in other urban areas and 1.9 minutes longer in non-urban areas. Similarly, the time between departure from scene and arrival at hospital is 1.6 minutes longer in other urban areas and 5.7 minutes longer in non-urban areas.

One reason that could be offered for this is that:

(1) The farther you travel into non-urban areas the lower the population density, which in turn is accompanied by a lower density of the fire stations, emergency hospitals, and other facilities serving as bases for ambulances and other emergency vehicles. As a result, there is a strong tendency for the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital to be longer.

Furthermore, the ratio between non-urban areas / other urban areas is 1.4-fold for the time between dispatch and arrival at scene and 1.8-fold for the time between departure from scene and arrival at hospital, indicating a pronounced tendency regarding the time between departure from scene and arrival at hospital. The trend described in (1) above is more pronounced with emergency hospitals, which is believed to provide the backdrop for this.

3.5. Characteristics of the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital (e)

While this is slightly removed from the combination of accident data and emergency transport data, this section will confirm the connection between the emergency transport times and the extent of physical injuries of the injured parties.

Fig. 15-2 shows the time between the accident and admission by the extent of physical injuries.

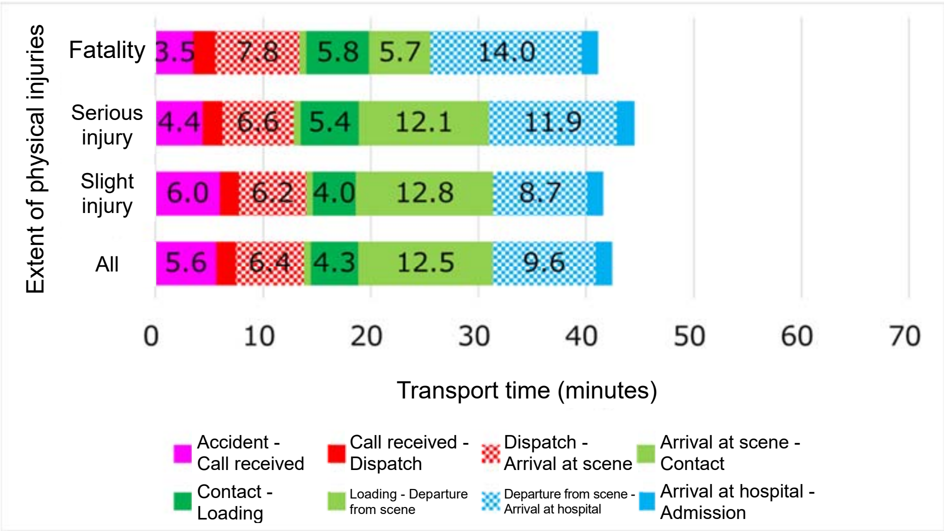

Fig. 15-2. Time between the accident and admission by the extent of physical injuries

The findings that can be read from the figure include the following:

(1) With slight injuries, the less injured they are the longer the time between the accident and when the call is received

(2) The shorter the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital the slighter the injuries tend to be

(3) The shorter the time between contact and loading the slighter the injuries tend to be

(4) In fatal cases, the time between loading and departure from scene is short

When these are compared by their average values, the extent of physical injuries is acknowledged as being related to each respective constituent element for the transport times, but no connection was recognized with the total transport time (meaning the time between the accident and admission).

For (4) above, this is thought to be a result that is rooted in “load and go.” As such, the extent of physical injuries was investigated for each of the times between contact and departure from the scene, which is the time from contact, when the extent of the patient’s critical condition can presumably be visually confirmed, until they depart the scene of the accident.

Fig. 16 shows the distribution for the times between contact and departure from scene and the fatality rate.

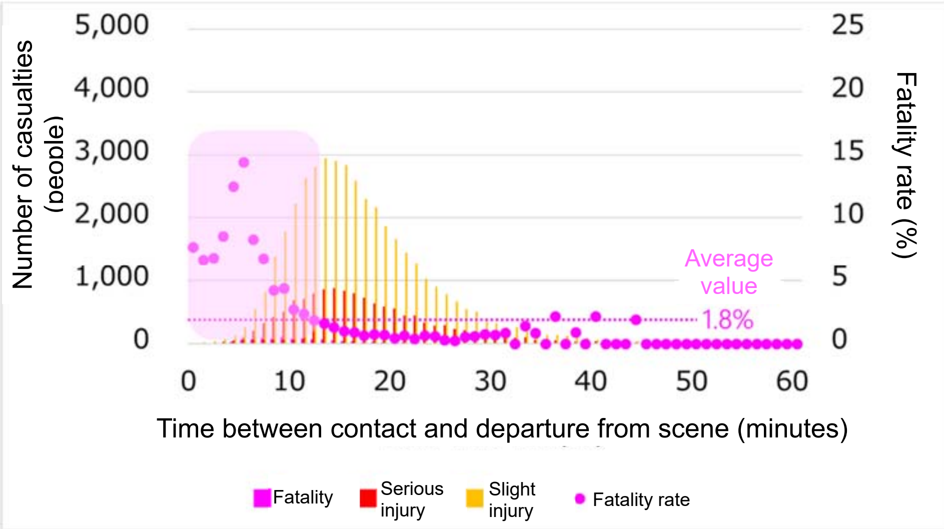

Fig. 16. Distribution for the times between contact and departure from scene and the fatality rate

The first characteristic that can be mentioned is that regions with a short time between contact and departure from scene have high fatality rates. This is presumed to be an indication of the fact that for patients in critical condition who ultimately suffer a high fatality rate, the time between contact and departure from scene tends to be shorter, which is in accordance with load and go.

The fatality rate for all of the data used is 1.8%. As such, with intersecting points taken as the boundary, the data was divided up into two cases by whether the time between contact and departure from scene was 12 minutes or less and 13 minutes or more, and for each of these the fatality rate for each of the times between the accident and admission was calculated.

Fig. 17 shows the fatality rate for each time between the accident and admission by the time between contact and departure from scene.

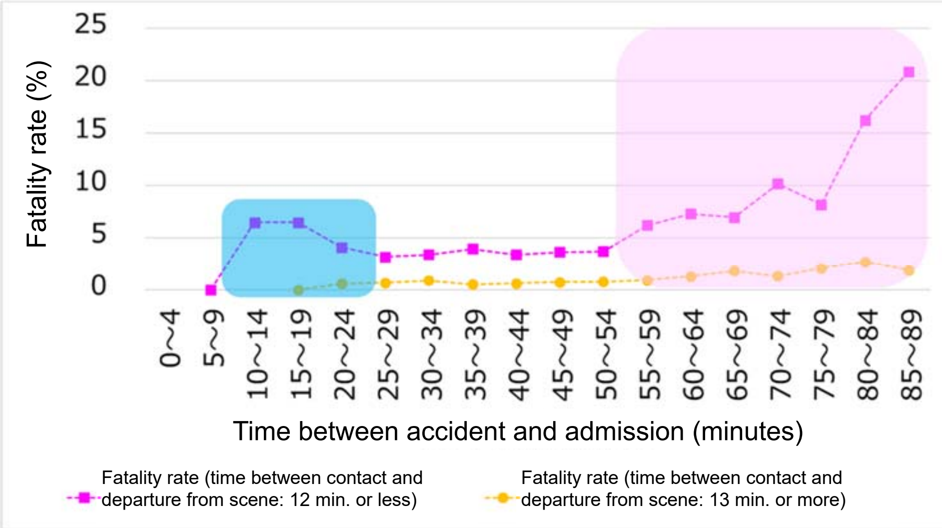

Fig. 17. Fatality rate for each time between accident and admission by the time between contact and departure from scene

The findings that can be read from the figure include the following:

(1) The high fatality rate in regions with short times between the accident and admission involved cases where the time between contact and departure from scene was 12 minutes or less.

(2) In every case for the times between contact and departure from scene, the longer the time between the accident and admission the higher the fatality rate tended to be.

The above reveals that load and go is being properly practiced at the scenes of accidents, and that shortening the emergency transport time lowers the fatality rate.

3.6. Indirect characteristics (f, g)

3.6.1. Connection between the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital by type of motorcycle (f)

Fig. 18 shows the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital by type of motorcycle.

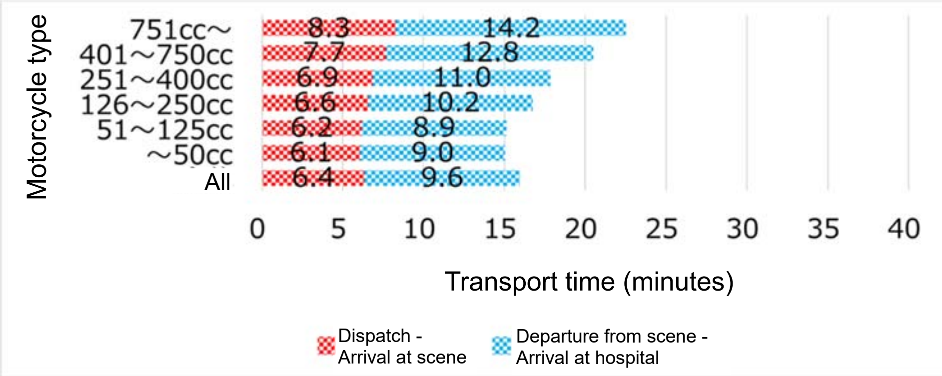

Fig. 18. Time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital by type of motorcycle

One characteristic that can be mentioned is that the larger the engine displacement of the motorcycle, the longer the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital.

Taking the overall figure as the baseline, the time between dispatch and arrival at scene was 1.3 minutes longer for 401 - 750cc motorcycles and 1.9 minutes longer for 751cc and above motorcycles. Similarly, the time between departure from scene and arrival at hospital was 3.2 minutes longer for 401 - 750cc motorcycles and 4.6 minutes longer for 751cc and above motorcycles.

The reason for this is that the larger the motorcycle’s engine displacement the longer the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital, with the presumption being that there are many trips taken under these conditions. The non-urban area category under type of area and expressway category under routes falls under the aforementioned description.

3.6.2. Connection between the time between dispatch and arrival at scene / time between departure from scene and arrival at hospital and the travel purpose (g)

The travel purposes were broadly divided up into five categories: Business, commuting to work, commuting to school, touring, etc., and personal. Table 5 shows an overview of the categories for each traffic purpose (partially omitted).

Table 5. Overview of the categories for each travel purpose (partially omitted)

Broad category	Sub-category	Categories used in 3.6.2
Business	Driving for occupational reasons	Business
Commuting to work	Going to / leaving the office	Commuting to work
Commuting to school	Going to school / during class / leaving school	Commuting to school
Personal	Tourism / recreational travel / driving	Touring, etc.
	Strolling / dining / shopping / visiting / pick-up / going to hospital …	Personal

Fig. 19 shows the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital by travel purpose.

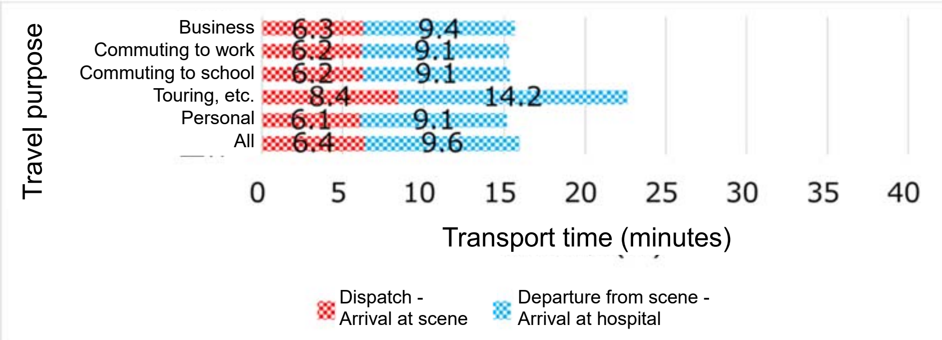

Fig. 19. Time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital by travel purpose

One characteristic that can be mentioned is that both the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital are extremely long for touring, etc.

Taking the overall figure as the baseline, the time between dispatch and arrival at scene is 2.0 minutes longer for touring, etc., while similarly the time between departure from scene and arrival at hospital is 4.6 minutes longer for this.

The reason for this is presumed to be because in many cases travelers prefer to travel to non-urban areas for touring, etc.

3.7. Connection with the current status of motorcycle accidents

We will now take a look at the connection between the results mentioned above (3.3 - 3.6) and the current status of motorcycle accidents. Based on the results from 3.6.1, the conditions for accidents for the 401cc and above engine displacement range that was touched on in Section 2.4 will be analyzed in terms of the characteristics for motorcycles with large engine displacements.

3.7.1. Characteristics of the type of area for 401cc and above motorcycles

Fig. 20 shows the number of fatalities by age group and type of area for 401cc or above motorcycles (sum total from 2013 - 2017).

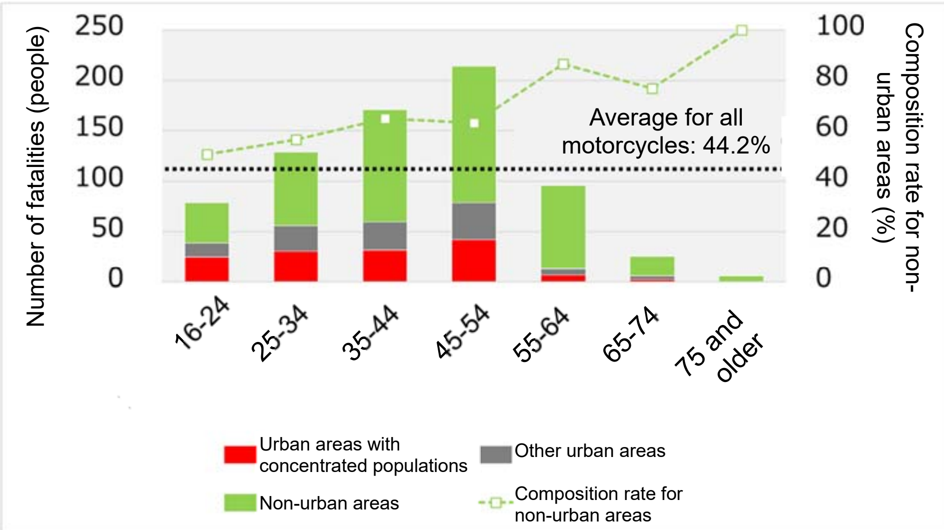

Fig. 20. Number of fatalities by age group and type of area for 401cc or above motorcycles (sum total from 2013 - 2017)

One characteristic that could be mentioned is that non-urban areas account for a high share of the composition rate for the number of fatalities for 401cc and above motorcycles. This tendency becomes more pronounced as you go from young people to the elderly age group. The average value for motorcycles as a whole is 44.2%, whereas for people age 16 - 24 it is approximately 50% and for people age 55 and older it is around 80%.

Section 3.4.1 indicated the tendency for the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital to be longer in non-urban areas. This suggests that with motorcycles that are 401cc and above there is a high probability that their transport times will be longer when there is an accident, which is thought to tie in with the results from section 3.6.1.

3.7.2. Characteristics of the travel purpose for 401cc and above motorcycles

Fig. 21 shows the number of fatalities by age group and travel purpose for 401cc or above motorcycles (sum total from 2013 - 2017).

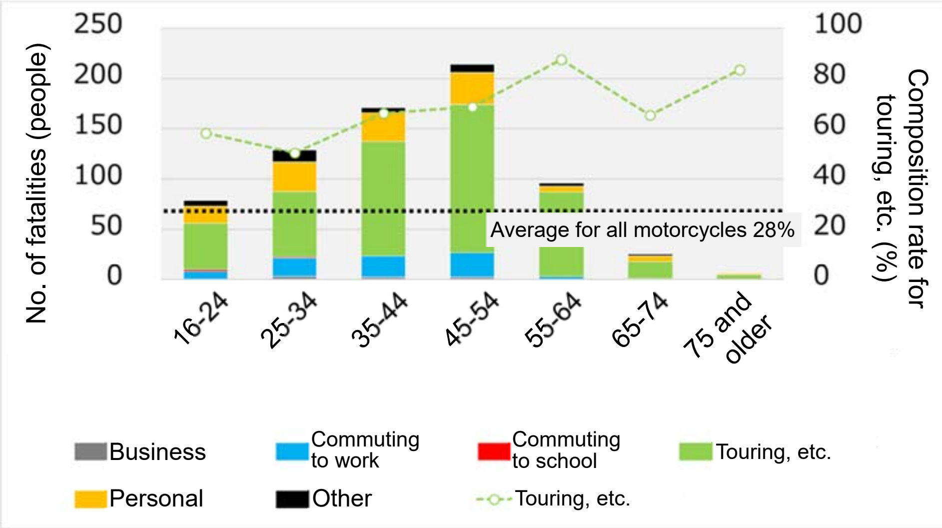

Fig. 21. Number of fatalities by age group and travel purpose for 401cc or above motorcycles (sum total from 2013 - 2017)

One characteristic that could be mentioned is the high composition rate for touring, etc. among the number of fatalities for 401cc and above motorcycles. This tendency becomes more pronounced as you go from young people to the elderly age group. The average value for motorcycles as a whole is 28.0%, whereas for young people (people age 16 - 24 and 25 - 34) it is over 50% and for people age 55 – 64 it is higher than 80%.

Section 3.6.2 indicated the tendency for the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital to be longer with touring, etc. This suggests that with motorcycles that are 401cc and above there is a high probability that their transport times will be longer when there is an accident, which is thought to tie in with the results from section 3.6.1.

3.7.3. Characteristics of the routes for 401cc and above motorcycles

Fig. 22 shows the composition rates for the number of fatalities for expressways and all routes by engine displacement (sum total from 2013 - 2017).

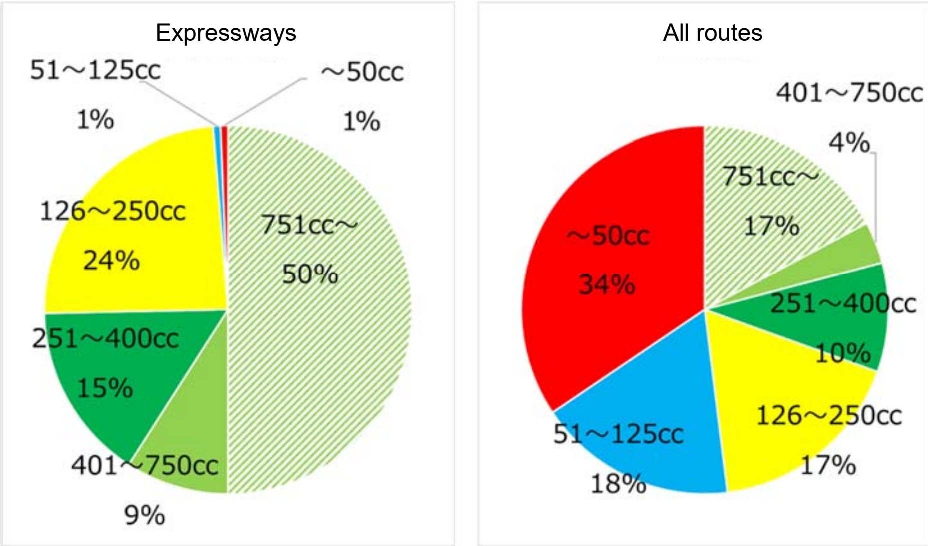

Fig. 22. Composition rates for the number of fatalities for expressways and all routes by engine displacement (sum total from 2013 - 2017)

The composition rate for motorcycles of 401cc and above accounts for over half of the total number of fatalities at 59% on expressways, whereas this is 21% for all routes (expressways + general roads). The reason for this is believed to be because motorcycles with an engine displacement of 125cc or less cannot drive on national expressways, which are included among expressways. It is also thought to be backed by factors like the fact that vehicles with large engine displacements and enormous engine power output can easily make the most of their advantages on expressways.

Section 3.3.1 indicated the tendency for the time between accident and dispatch to be longer on expressways, while Section 3.4.1 indicated the tendency for the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital to be longer on expressways. This suggests that with motorcycles that are 401cc and above there is a high probability that their transport times will be longer when there is an accident, which is thought to tie in with the results from section 3.6.1.

3.8. Conclusion from combining the accident data with the emergency transport data

This study affirmed that there are a great many direct and indirect connections between the emergency transport data and accident data.

A characteristic example found among these is the tendency for the time between accident and dispatch to be longer on expressways versus general roads. The reason for this is believed to be due to the difficulty in reporting when accidents occur on expressways.

Similarly, the time between dispatch and arrival at scene and the time between departure from scene and arrival at hospital tends to be longer on expressways as opposed to general roads. The reason for this is believed to be because accidents on expressways have a tendency to lead to congestion, which presumably tends to hinder the travel of ambulances and other emergency vehicles. It is also believed to be because passing through interchanges and the like carries with it a high possibility of leading to detours.

In addition, it could be mentioned that as opposed to urban areas, non-urban areas tend to have longer times between dispatch and arrival at scene and times between departure from scene and arrival at hospital. The reason for this is presumed to be because the fire stations, emergency hospitals, and other facilities that serve as bases for ambulances and other emergency vehicles, are sparse compared with urban areas, and tend to be located far apart.

The above represents a direct connection between the emergency transport data and accident data, with indirect connections observed with the type of motorcycle and travel purpose, for which the connections are striking.

First off, with the type of motorcycle the larger the engine displacement the longer the time between dispatch and arrival at scene and time between departure from scene and arrival at hospital tended to be. This is presumed to be backed by the fact that the larger the engine displacement, the greater the rate of usage in places like non-urban areas and expressways.

As for the travel purpose, as opposed to business and commuting to work and so forth, touring, etc. and other such cases where the objective is traveling in itself tend to have longer times between dispatch and arrival at scene and times between departure from scene and arrival at hospital. The reason for this is thought to be because with touring, etc. people prefer traveling in non-urban areas, and thus do a greater share of driving there.

With regards to the aforementioned trends with motorcycles with large engine displacements and touring, etc., when this was compared against recent trends with motorcycle accidents it was found that the middle-age group of people driving 401cc and above motorcycles constituted a major segment for these categories. It was also confirmed that the rate of usage on expressways for the purpose of touring, etc. in non-urban areas was higher than for the other categories. This indicates that the aforementioned major segment frequently rides their motorcycles under conditions that are unfavorable for emergency transport.

4. Conclusion and notes

The circumstances surrounding motorcycles have changed significantly compared to the period around 1990, with such trends having become particularly manifest among certain age groups and types of motorcycles. Around the beginning of the 1990s motorcycles were a young person’s vehicle, with other age groups mainly preferring mopeds, and when viewed on the whole they were frequently employed for practical usage purposes. In recent years this has changed such that motorcycles are no longer necessarily viewed as a young person’s vehicle, with a rising share of people from youths to middle-aged people who enjoy riding motorcycles with relatively large engine displacements. As for the background to this, it is surmised that this trend is partially due to the decline in the population of young people, and their tendency to drift away from riding motorcycles due to the diversification of youth-oriented hobbies. It is also partially due to the generation that experienced the motorcycle boom of the 1980s and 1990s continuing to ride motorcycles, or else returning to motorcycles and newly acquiring motorcycle licenses upon gaining some financial leeway.

One recent trend that warrants special mention is the fact that motorcycles with engine displacements of 401cc and above occupy a large share of the total, with this type of motorcycle accounting for the largest composition rate among people age 25 - 55. For this domain, the government policy in the past obligated a need to partially lift the mid-sized restrictions on motorcycle licenses in order to be able to drive a motorcycle with an engine displacement larger than 401cc. The fact that as a result of the changes to the licensing system in 1996, it became possible to obtain licenses that formerly required taking an extremely difficult test by ordinary means, is believed to be one of the reasons behind this (this was changed to ordinary two-wheel licenses: 400cc and below; large- two-wheel licenses: unrestricted).

The emergency transport data obtained via the FDMA was matched with the traffic accident data retained by ITARDA, from which it could be ascertained that just under 40% of the total was valid data. This made it possible to quantitatively perceive phenomena that up until now could only be discussed qualitatively.

To give one example, there is the extent of the difference in the ambulance travel time (to the scene / to the hospital) depending on the type of area and route, as well as the extent of the difference in the time from when the accident occurs until the ambulance or other emergency vehicle is dispatched depending on factors like the route and type of accident. There is a lack of information on these reasons and background factors at this point in time, so all that can be done is to conjecture. However, for the future information must be collected and analyzed in order to reduce the number of fatalities by supplementing the shortcomings in emergency transport that were quantified above. For this, greater efforts should be made to request the cooperation of each of the concerned parties.

Moreover, as was described above, for recent major segments a large share of accidents occurs under conditions that are disadvantageous from an emergency transport perspective, which is believed to be because a great deal of driving takes place under such situations. It is important that riders bear in mind the fact that much of their driving is done under such disadvantageous conditions, and make efforts to drive safely and take personal protection into consideration (helmets, clothing, and protective equipment) on the basis of this.

Moreover, those in administrative positions should be encouraged to carry out system revisions to enable efficient responses when accidents occur, particularly to shorten the delays with ambulances arriving and transporting patients to hospitals, in order to do everything in their power to do away with said disadvantageous conditions for emergency transport.