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**SURVEY OF DRIVER SEATING DISCOMFORT
AND RELATED FACTORS**

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16. Abstract A field survey of drivers of late-model vehicles traveling on two Michigan highways was conducted to determine the frequency of discomfort experienced during driving and the relative frequency of the different body regions involved. Two hundred and fifty-two drivers were interviewed with 142 reporting <i>no discomfort</i> and 110 reporting <i>discomfort</i> in at least one body region. Some drivers reported discomfort in more than one body region for a total of 240 responses among the 110 drivers with discomfort. Of these, the lumbar region was the most frequently mentioned with a total of 63 responses. The buttock region was the second most frequently reported area with a total of 35 responses, while the upper-back region was next in frequency with 23 discomfort responses. Combined, the lumbar and upper-back regions accounted for 36% of the discomfort responses. The neck region was also a major area of discomfort with 20 responses. A significant number of discomfort responses were reported for the legs with the right leg experiencing discomfort more frequently than the left leg. Most discomfort was reported as <i>mild</i> pain and characterized as a dull ache although a significant amount of the discomfort in the neck/shoulder/arm region was also characterized as <i>sharp</i> while in the buttock/hip/thigh region nearly one-half of the discomfort responses were characterized as <i>numbing</i> . Little correlation between vehicle and seat factors and the experience of discomfort was observed with the exception that the no-discomfort group included a higher percentage of subjects with power seats and seats with lumbar support, while, in the discomfort group, the percentage of subjects with bucket seats (compared to bench seats) was slightly higher.					
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SUMMARY

A field survey of drivers of late model vehicles traveling on two Michigan highways was conducted to determine the frequency of driver discomfort experienced during driving and the relative frequency of the different body regions involved. A total of 252 drivers were interviewed as they pulled into designated parking areas at highway rest areas. Of these, 142 drivers reported no discomfort and 110 drivers indicated that they were experiencing some discomfort. In both groups (i.e., comfort and no discomfort), 80 to 90 percent of the drivers had been driving for more than one hour since their last stop and almost all the drivers had been in their vehicles more than one hour since the start of their trip.

Drivers who reported discomfort were asked to describe the body regions in which the discomfort was experienced with multiple responses allowed. Of the 110 subjects in this group, there were 240 body regions of discomfort reported. Of these, the lumbar region was the most frequently mentioned with a total of 63 discomfort responses. The buttock region was the second most frequently reported area with a total of 35 responses while the upper-back region was next in frequency with 23 discomfort responses. Combined, the lumbar and upper-back regions accounted for 36% of the discomfort responses. The neck region was also a major area of discomfort with 20 responses. A significant number of discomfort responses were reported for the legs including the calves, knees, ankle, and foot, with the right leg experiencing discomfort more frequently than the left leg. In fact, the combined discomfort responses for both right and left legs was 54 which accounts for 22.5% of the total discomfort responses.

With regard to the severity of discomfort, 174 (72.5%) of the discomfort responses were described as *mild* pain, 49 (20.4%) were *moderate*, and 17 (7.1%) were severe. Most of the pain was characterized as a dull pain, particularly in the back and lumbar regions, but in the neck/shoulder/arm region a significant amount of the discomfort was characterized as *sharp* while in the buttock/hip/thigh region nearly half of the discomfort responses were characterized as *numbing*.

For each subject interviewed, information was also collected describing the vehicle and seat features. In general, little correlation between these factors and the experience of discomfort was observed in this small sample. The exceptions were the findings that the no-discomfort group included a higher percentage of subjects with power seats or seats with lumbar support, while in the discomfort group, the percentage of subjects with bucket seats (compared to bench seats) was slightly higher.

I. INTRODUCTION

As an initial step in the formulation of a research plan and methodology for investigating and determining automotive seat design criteria required for optimizing driver comfort, an on-site interview survey was undertaken. The primary goal was to define the magnitude and nature of the problem of driver discomfort related to seat design and automotive seating posture and to identify and prioritize the body regions in which discomfort is experienced. Secondary goals were to identify the types of discomfort, determine vehicle, seat, human, and environmental factors that may contribute to discomfort, and obtain information on ways in which drivers deal with discomfort.

II. SAMPLING STRATEGY AND METHODS

A. Sampling Strategy

As illustrated in Figure 1, data for this study were collected at two Michigan Department of Transportation rest areas along Michigan Interstate I-94 and Michigan limited access U.S. Highway 23. A criteria for the survey was to interview drivers who had been driving for at least one hour and it was felt that these two rest areas would encompass a cross section of the population who would be driving for both business and pleasure trips. The I-94 rest area is located on the eastbound side of the freeway, six miles west of Ann Arbor. It is a major freeway from both the western side of Michigan and the Chicago area into Ann Arbor and the Detroit metropolitan area. It was believed that the driver population at this rest area would include more sales and business people. Also included in this population were tourists returning from the Lake Michigan resort areas. The second rest area selected was southbound U.S. 23, twelve miles north of Ann Arbor. This highway draws from a number of areas both in business and recreation.

Both of the rest areas chosen had large parking areas. A block of eight angled parking spaces was selected for the target vehicles. This was done to eliminate observer bias and so that the interviewer could question each driver while he/she was still seated in the car. Model years 1980 and later were selected and only passenger cars, vans, and light trucks were included in the sample.

Time of day was also a consideration in data collection. Interviews were conducted no earlier than 10:00 A.M. and in most cases did not begin until at least 12:00 noon. There were three week-end days in which interviews were conducted. Overall, decisions on the interview location, time of day, and day of week were made to target the most drivers in one area who met the criteria of having been sitting and driving for more than one hour.

B. Data Collection

Two survey forms were developed to gather data (see Appendix). One form was for those drivers who experienced *no discomfort* and the other was for drivers who indicated they had experienced *discomfort*. Both forms were designed to gather information about vehicle and seat factors, driver demographics and general physical characteristics. The form used for respondents experiencing discomfort also gathered information about the body regions in which the discomfort was felt, the severity and type of discomfort, driver's opinions about the possible causes of their discomfort, and the ways that they tried to reduce the discomfort.

All interviews were conducted by a single interviewer with extensive experience and training in transportation-related observation and interviewing. When a vehicle drove into the target area (i.e., one of the eight selected parking spaces), the interviewer approached the driver, introduced herself, explained the survey, and asked the driver if he/she wished to



FIGURE 1. Data collection locations.

participate. If the driver agreed, they were first asked if they were currently experiencing any type of discomfort related to their car seat or the way in which they were sitting. If the driver answered that they felt no discomfort at all, they were questioned about discomfort experienced on previous trips. If the driver still indicated that he/she had no discomfort on this or previous trips, they were asked questions from Form 1 (no discomfort). If the driver answered that they were in discomfort on this trip or had been in discomfort on previous trips, Form 2 (some discomfort) was used for the remainder of the interview.

All questionnaires were reviewed, key punched, and verified to ensure data entry accuracy. The two forms were keypunched into separate files and subsequently merged for compilation and analysis by OSIRIS and ADAAS programs on The University of Michigan MTS main-frame computer system.

III. RESULTS

A. Subject and Vehicle Characteristics

Data were collected from August 20 through September 23, 1988. As shown in Figure 2, 255 drivers were approached for participation in the study. Of this number, three refused to participate, 142 reported no discomfort, and 110 reported some discomfort on this or previous trips. Of the 110 drivers indicating some discomfort, 101 respondents were currently experiencing discomfort and 9 respondents indicated discomfort on previous trips.

Table 1 summarizes the characteristics of the sample population and also gives the characteristics for the discomfort and no-discomfort segments of this population. The sample included 68.3% (172) males and 31.7% (80) females who ranged in stature (as reported by the subject) from 5'0" to 6'8". Subject weight ranged from 104 lb to 320 lb and subjects were distributed nearly evenly throughout the age range from 18 to over 60 years. It will be noted that there are no significant differences in physical characteristics for the comfort and no-discomfort groups.

Table 2 summarizes some basic information about the data collection process for the total sample and for the comfort and no-discomfort groups. Interviews were conducted on all days of the week with approximately two-thirds of the interviews being conducted on U.S. 23 and one-third on I-94. Interviews were conducted from 10 A.M. to 9 P.M. although the greatest number of interviews took place between noon and 5 P.M. The largest percentage (36.5%) of subjects were on vacation but a significant proportion (20.6%) were involved in work-related driving. Most subjects had been driving between one and four hours on the day interviewed and most had been driving between one and 2-1/2 hours since their last stop. There are no differences of significance for the discomfort and no-discomfort groups for any of these data-collection factors.

Table 3 summarizes the vehicle and seat characteristics for the total sample and the comfort and no-discomfort groups. Most vehicles were manufactured after 1983 and approximately 60% of the vehicles were equipped with bucket seats while about 40% had bench or split-bench seats. Approximately one-half of the seats had seatback recliners and approximately one-quarter of the seats had power adjustment features. It is striking that over three-fourths of all drivers were wearing their seat belts. Once again, the proportions for these characteristics are nearly the same for those experiencing discomfort compared to those not experiencing discomfort. It will be noted, however, that the no-discomfort group included a higher percentage of power-seat users (26.8% compared to 18.2%) and also a higher percentage of persons having seats with lumbar support (10.5% compared to 3.6%). Interestingly, the percentage of drivers with bucket-type seats is higher for the discomfort group than it is for the no-discomfort group (67.3% to 55.6%). It is also interesting that there were no differences in percentages of vehicles with air conditioning for the discomfort and no-discomfort groups.

SEAT DISCOMFORT SURVEY PARTICIPATION RATE

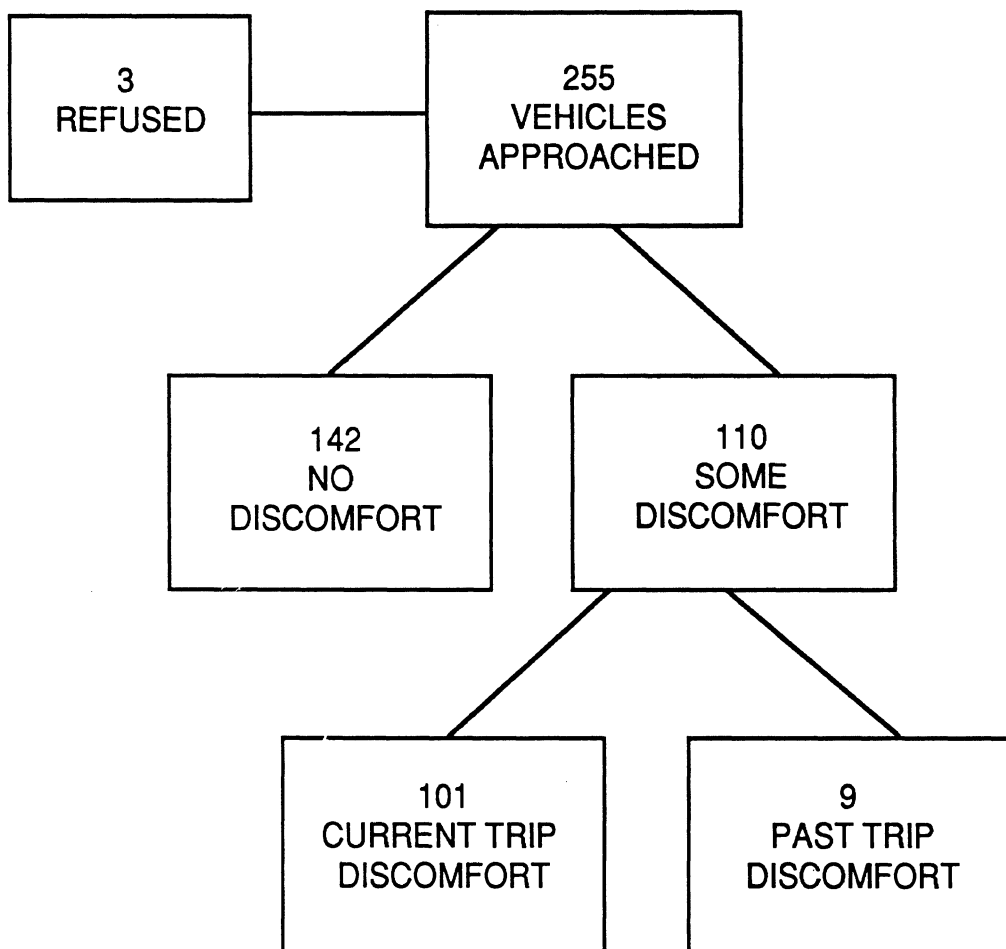


FIGURE 2. Sampling breakdown of seat discomfort survey.

B. Discomfort Regions

In the questionnaire given to respondents who were experiencing discomfort, the responses for body-area discomfort were broken down into thirty separate areas, including left, right, and central regions of the body. Each respondent was allowed up to five responses for body-area of discomfort. Of the 101 drivers who were experiencing discomfort at the time of the interview and the nine drivers who reported discomfort in the past, 240 body-area responses were identified. Table 4 summarizes these results grouped into twenty-one different body regions (by combining left, right, and central regions in some cases) and the four general body regions: arm/neck/shoulder, back/lumbar/abdomen, buttock/hip/thigh, and knee/leg/foot, while Figures 3, 4, and 5 show these results in graphical form. The lumbar region was sited most often with 63 total responses for 26.3% of the total body-area responses. The next largest source of discomfort by body region was the buttock area which comprised 14.6% (left=17, right=18) of all responses. The upper-back region was the third highest in response frequency with 23 discomfort responses. Combined, the lumbar and back accounted for a total of 35.8% of all discomfort responses. In all, the back and buttock comprised over 50% (121) of all discomfort responses.

The neck region was also a major area of discomfort with 20 responses or 8.3%. A significant number of discomfort responses were reported for the legs including the calves, knees, ankle, and foot, with the right leg experiencing discomfort more frequently than the left leg. In fact, the combined discomfort responses for both right and left legs was 54 which accounts for 22.5% of the total discomfort responses. Of these, 37 or 68.5% were for the right leg.

For each discomfort region, respondents were also asked to describe the severity and type of pain they were experiencing. As shown in Table 5, there were 174 (72.5%) responses described as mild, 49 (20.4%) as moderate, and 17 (7.1%) as severe. Nearly 80% of the back and lumbar discomfort was described as mild pain. As shown in Table 6, the type of pain was classified as sharp, burning, numbing, or dull ache. For the shoulder, neck, and arm region, most pain was described as a dull ache but a large percentage was also classified as sharp. In the back and lumbar regions, nearly 80% of the pain was described as a dull ache. In the buttock, hip, and thigh region, the discomfort was either numbing or a dull ache, the former most likely due to pressure on the buttock. In the leg and foot region (primarily the right leg), most of the pain was described as a dull ache.

C. Causes and Solutions to Discomfort

Drivers who experienced discomfort were asked to identify those features of the vehicle seat or of driving that contributed to their discomfort. The responses are summarized in Table 7 and include a wide range of explanations. Up to five responses were allowed for each subject and many drivers felt that their discomfort was due to a combination of several factors. The most frequently sited causes were the lack of lower-back support (13%) and the need to keep their foot in the same position on the accelerator pedal (11.3%). Non-adjustable seatback angle accounted for 10% of the explanations and improper location of the head support was sited in 6.9% of the responses. Many drivers who sited inability to adjust the seatback angle as a factor also noted that, because they were unable to adjust this angle, the headrest location was not in the proper position. Another common response was that there was really nothing about the seat that contributed to their discomfort but that it was simply a matter of sitting for too long in the same position (8.9% of responses).

Drivers in the discomfort group were also asked what they did to try to relieve their discomfort while driving. The results are shown in Table 8. The largest percentage (32.7%) of drivers said that they changed postures while a nearly equal percentage (27.3%) said that

they simply stopped driving and relaxed. Another 11.3% said that they relieved the discomfort by both changing postures and stopping to relax.

Table 9 summarizes the results from driver responses to the question of how long it took to develop the discomfort. Almost one-fourth of sensations of discomfort were reported to occur within the first hour of driving. Another one-third developed between one and two hours after driving so that over one-half (57.5%) of the body regions of discomfort occurred within two hours of driving. Only 5% of the drivers required more than five hours of driving to develop discomfort.

Table 10 summarizes the results with regard to the presence of chronic health problems that could be related to the experience of discomfort. The primary finding was that twenty-three of the sixty-three lumbar discomfort responses could be attributed to a chronic health (i.e., back) problem.

Drivers who were uncomfortable were asked: "Have you driven other cars in which you found the seat more comfortable than in this car?" Sixty-one subjects (55.5%) said that they had. These drivers were asked to identify up to two vehicles that were more comfortable and to explain what they thought were the reasons. Sixty-six vehicles were identified as "more comfortable," thirty-three of which had actually been driven or ridden in by the respondent. Thirty-three vehicles were identified as being more comfortable simply because they were "luxury" class cars (i.e., Lincoln Town Car, Cadillac Eldorado, Mercedes Benz). Many of the drivers who assumed there was more comfort in a luxury-class car also related comfort to cost of the vehicle. Responses to the specific question of what makes these vehicles more comfortable are shown in Table 11 and include 66 suggestions, of which 14 (21.2%) have to do with bigger seats and luxury cars, 9 (13.6%) indicate that a contoured bucket-type seat fits better, and 7 (10.6%) suggest that a better, firmer cushion was the answer.

Drivers who had no discomfort were asked how they would improve their car seat to make it more comfortable with up to three responses allowed per driver. As shown in Table 12, there were 160 suggestions, although 67 of these said there was nothing that could be done. Of the other suggestions, the most frequent included adding more cushion, adding lumbar support, and improving adjustability.

All respondents were asked what they thought made their vehicle seat more comfortable than other vehicles they had driven. The results are shown in Table 13. As could be expected, those who were experiencing no discomfort generally considered their vehicle to be more comfortable than those who were experiencing discomfort. Of 314 total responses, 72 said they didn't know. There were 55 responses that indicated that the contoured bucket seat was a factor and 38 responses that liked the fully-adjustable power seat. There were also 17 responses that a good lumbar and back support was the key to comfort and 17 responses that a firmer cushion with good thigh support was important.

Body Region Discomfort

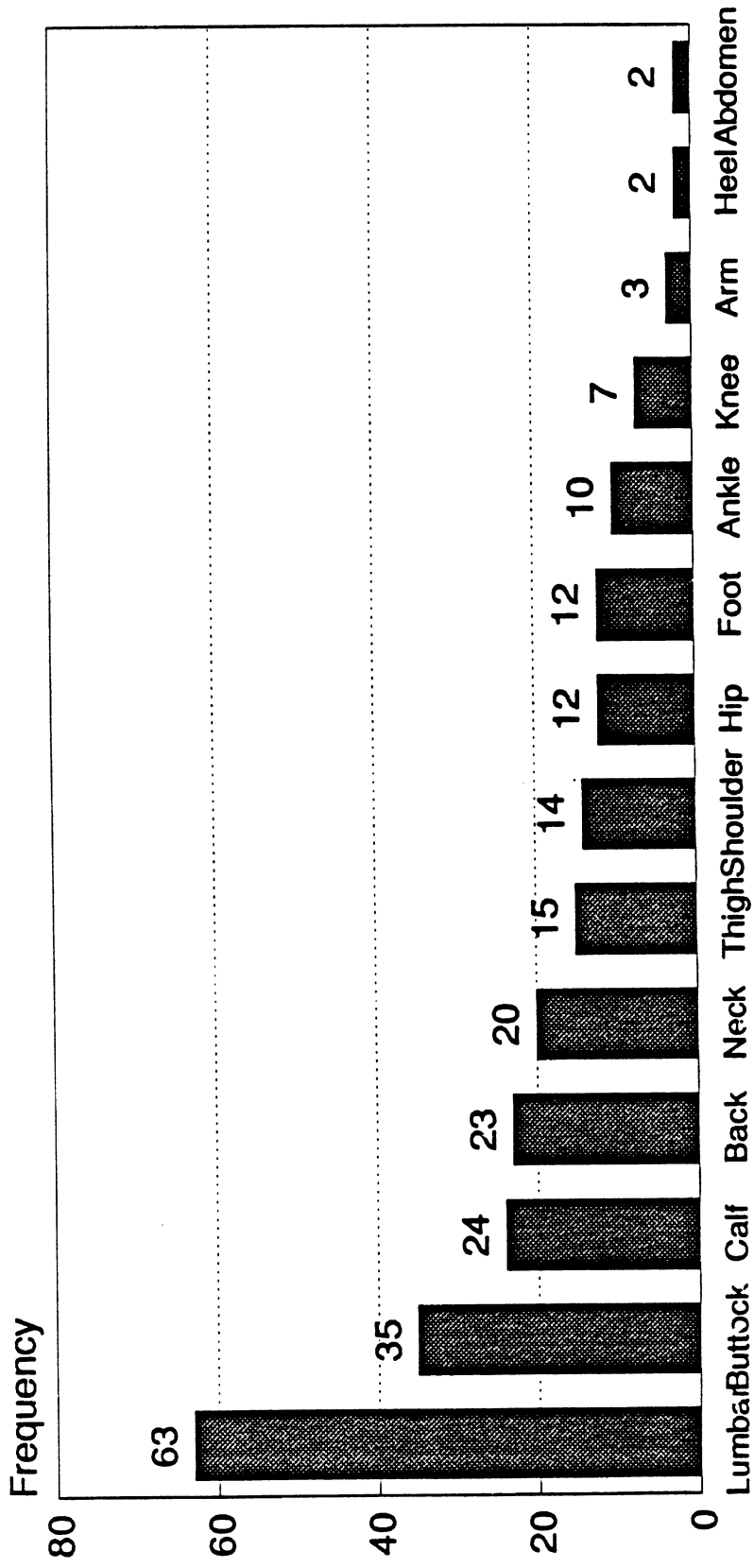


FIGURE 3. Frequency histogram of subject discomfort by body region.

BODY REGION DISCOMFORT

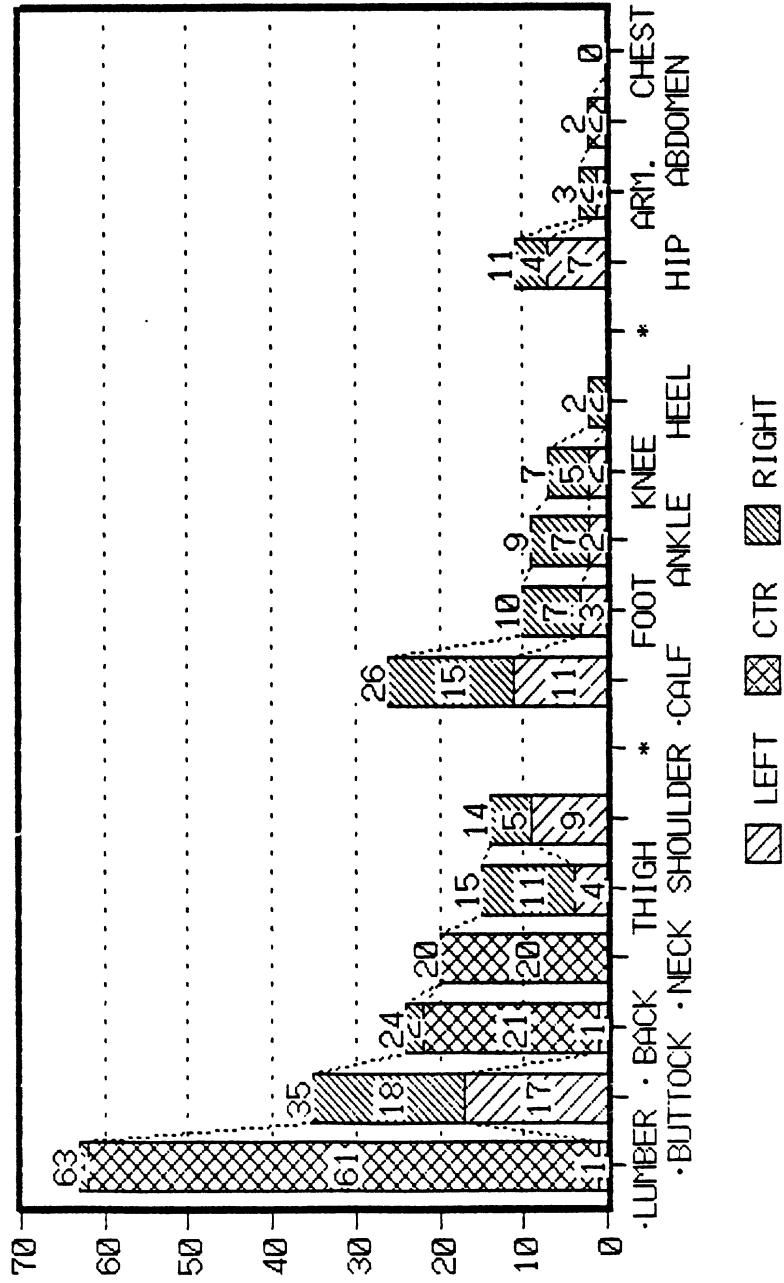


FIGURE 4. Frequency of body discomfort by body region broken down by left, right, and center regions.

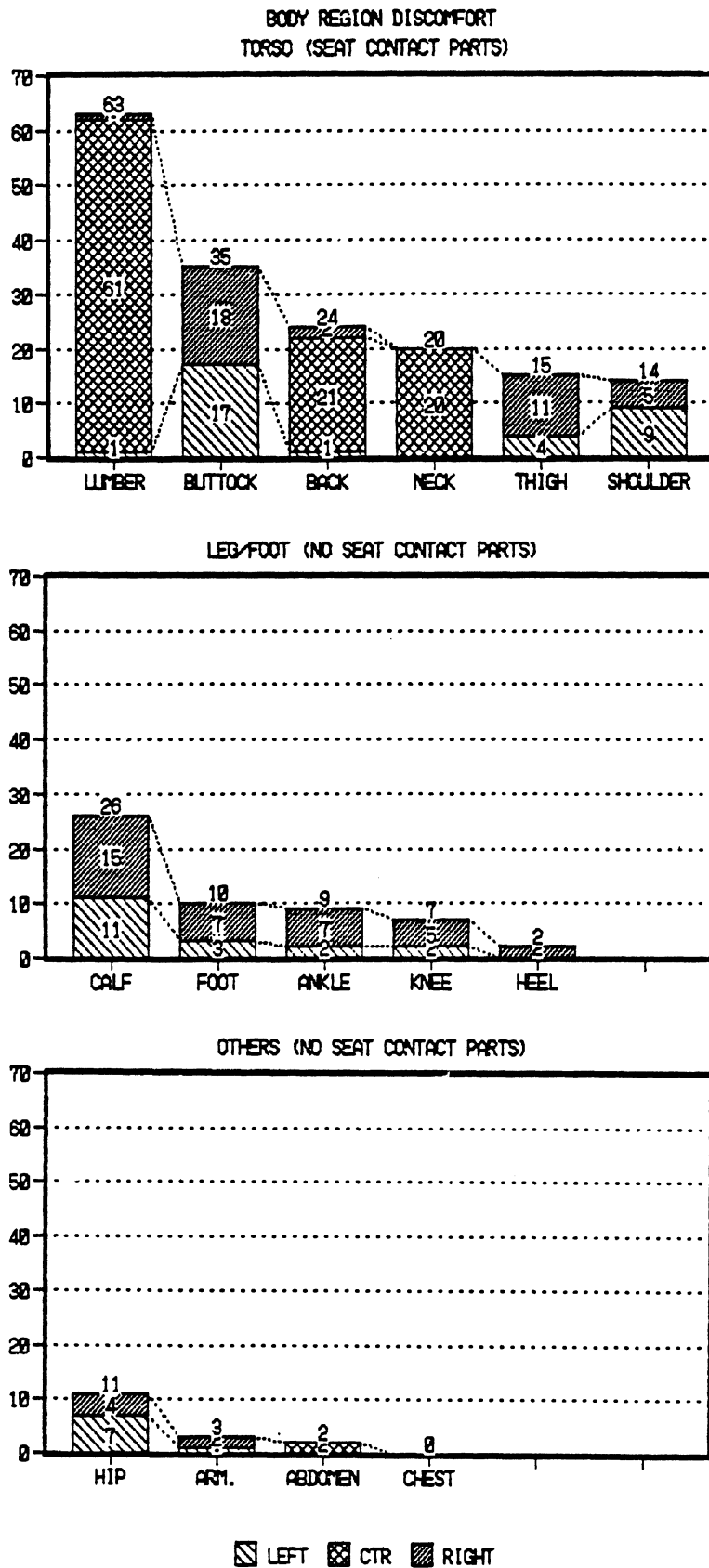


FIGURE 5. Frequency of subject discomfort by body region for body parts in contact with seat (TOP), and body regions not in contact with seat (BOTTOM AND CENTER).

TABLE 1
SUBJECT DESCRIPTIVE STATISTICS
BY COMFORT/DISCOMFORT GROUPS

Variable	NO DISCOMFORT		SOME DISCOMFORT		TOTAL	
	N	% Subjects	N	% Subjects	N	% Subjects
SEX						
Male	100	70.4	72	65.5	172	68.3
Female	42	29.6	38	34.5	80	31.7
TOTAL	142	100.0	110	100.0	252	100.0
HEIGHT						
5'0"-5'5"	39	27.5	25	22.7	64	25.4
5'6"-5'11"	66	46.5	52	47.3	118	46.8
6'0"-6'8"	36	25.4	33	30.0	69	27.4
Refused	1	0.7		0.0	1	0.4
TOTAL	142	100.0	110	100.0	252	100.0
WEIGHT (pounds)						
104-148	33	23.3	27	24.5	60	23.8
150-198	74	52.1	66	60.0	140	55.6
200-320	32	22.5	16	14.5	48	19.0
Refused	3	2.1	1	1.0	4	1.6
TOTAL	142	100.0	110	100.0	252	100.0
AGE (years)						
18-29	20	14.1	20	18.2	40	15.9
30-39	33	23.2	23	20.9	56	22.2
40-49	25	17.6	22	20.0	47	18.7
50-59	26	18.3	18	16.4	44	17.5
60+	36	25.4	27	24.5	63	25.0
Refused	2	1.4	0	0.0	2	0.8
TOTAL	142	100.0	110	100.0	252	100.0
MILES DRIVEN/YEAR						
<10,000	29	20.4	24	21.7	53	21.0
10,001-20,000	59	41.5	50	45.5	109	43.3
20,001-30,000	23	16.3	17	15.5	40	15.9
30,000+	31	21.8	19	17.3	50	19.8
TOTAL	142	100.0	110	100.0	252	100.0

TABLE 2
DESCRIPTIVE STATISTICS

Variable	NO DISCOMFORT		SOME DISCOMFORT		TOTAL	
	N	% Subjects	N	% Subjects	N	% Subjects
DAY OF WEEK						
Monday	12	8.5	20	18.2	32	12.7
Tuesday	23	16.2	15	13.6	38	15.1
Wednesday	17	12.0	13	11.8	30	11.9
Thursday	21	14.8	17	15.5	38	15.1
Friday	30	21.1	22	20.0	52	20.6
Saturday	26	18.3	18	16.4	44	17.5
Sunday	13	9.2	5	4.5	18	7.1
TOTAL	142	100.0	110	100.0	252	100.0
LOCATION						
U.S. 23	98	69.0	72	65.5	170	67.5
I-94	44	31.0	38	34.5	82	32.5
TOTAL	142	100.0	110	100.0	252	100.0
TIME OF INTERVIEW						
10-11 AM	4	2.8	1	0.9	5	2.0
11-12 AM	9	6.3	5	4.5	14	5.6
12-1 PM	20	14.1	14	12.7	34	13.5
1-2 PM	28	19.7	16	14.5	44	17.5
2-3 PM	38	26.8	25	22.7	63	25.0
3-4 PM	25	17.6	29	26.4	54	21.0
4-5 PM	12	8.4	16	14.5	28	11.1
7-8 PM	3	2.1	2	1.1	5	1.9
8-9 PM	3	2.1	2	1.8	5	2.0
TOTAL	142	100.0	110	100.0	257	100.0
MONTH						
August	19	13.4	26	23.6	45	17.9
September	123	86.6	84	76.4	207	82.1
TOTAL	142	100.0	110	100.0	252	100.0
TRIP PURPOSE						
Work Related	35	24.7	17	15.5	52	20.6
Vacation	51	35.9	41	37.3	92	36.5
Other	7	4.9	3	2.7	10	4.0
Visits	19	13.4	18	16.4	37	14.7
Short Trip	17	12.0	14	12.7	31	12.3
Errand	4	2.8	8	7.3	12	4.8
Wedding	2	1.4	0	0.0	2	0.8
School	5	3.5	4	3.6	9	3.6
Doctor/Hospital/Medical	2	1.4	5	4.5	7	2.8
TOTAL	142	100.0	110	100.0	252	100.0

TABLE 2 (Continued)

Variable	NO DISCOMFORT		SOME DISCOMFORT		TOTAL	
	N	% Subjects	N	% Subjects	N	% Subjects
HOURS/MINUTES DRIVING						
<1 Hour	2	1.4	1	0.9	3	1.2
1.0-1.5	22	15.5	9	8.2	31	12.3
1.5-2.0	14	9.9	15	13.6	29	11.5
2.0-2.5	21	14.8	14	12.7	35	13.9
2.5-3.0	7	4.9	4	3.6	11	4.4
3.0-3.5	15	10.6	15	13.6	30	11.9
3.5-4.0	3	2.1	3	2.7	6	2.4
4.0-4.5	16	11.3	11	10.0	27	10.7
4.5-5.0	4	2.8	4	3.6	8	3.2
5.0-5.5	14	9.9	11	10.0	25	9.9
5.5-6.0	4	2.8	4	3.6	8	3.2
6.0-6.5	6	4.2	7	6.4	13	5.2
6.5-7.0	4	2.8	2	1.8	6	2.4
>7 Hours	10	7.0	10	9.1	20	7.9
TOTAL	142	100.0	110	100.0	252	100.0
HRS/MIN SINCE LAST STOP						
<1 Hour	21	14.8	13	11.8	34	13.5
1.0-1.5	41	28.9	28	25.5	69	27.4
1.5-2.0	26	18.3	26	23.6	52	20.6
2.0-2.5	32	22.5	25	22.7	57	22.6
2.5-3.0	8	5.6	3	2.7	11	4.4
3.0-3.5	7	4.9	8	7.3	15	6.0
3.5-4.0	3	2.1	1	0.9	4	1.6
4.0-4.5	1	0.7	6	5.5	7	2.8
4.5-5.0	0	0.0	0	0.0	0	0.0
5.0-5.5	1	0.7	0	0.0	1	0.4
5.5-6.0	1	0.7	0	0.0	1	0.4
6.0-6.5	1	0.7	0	0.0	1	0.4
TOTAL	142	100.0	110	100.0	252	100.0

TABLE 3
VEHICLE DESCRIPTIVE STATISTICS

Variable	NO DISCOMFORT		SOME DISCOMFORT		TOTAL	
	N	% Subjects	N	% Subjects	N	% Subjects
VEHICLE YEAR						
1980	5	3.5	3	2.7	8	3.2
1981	1	0.7	0	0.0	1	0.4
1982	10	7.0	6	5.5	16	6.3
1983	10	7.0	11	10.0	21	8.3
1984	16	11.3	14	12.7	30	11.9
1985	24	16.9	20	18.2	44	17.5
1986	22	15.5	24	21.8	46	18.3
1987	35	24.6	15	13.6	50	19.8
1988	18	12.7	17	15.5	35	13.9
1989	1	0.7	0	0.0	1	0.4
TOTAL	142	100.0	110	100.0	252	100.0
RESTRAINT USE						
Restrained	107	75.4	87	79.1	194	77.0
Unrestrained	35	24.6	23	20.9	58	23.0
TOTAL	142	100.0	110	100.0	252	100.0
SEAT TYPE						
Bucket	79	55.6	74	67.3	153	60.7
Bench-Type	63	44.4	36	32.7	99	39.3
TOTAL	142	100.0	110	100.0	252	100.0
SEAT ADJUSTMENT						
Power	38	26.8	20	18.2	58	23.0
Manual	104	73.2	90	81.8	194	77.0
TOTAL	142	100.0	110	100.0	252	100.0
SEATBACK						
Recline	69	48.6	64	58.2	133	52.8
Non-Recline	73	51.4	46	41.8	119	47.2
TOTAL	142	100.0	110	100.0	252	100.0
HEADREST						
One-Piece	29	20.4	25	22.7	54	21.4
Adjustable	101	71.1	81	73.6	182	72.2
None	12	8.5	4	3.6	16	6.3
TOTAL	142	100.0	110	100.0	252	100.0
SEAT MATERIAL						
Vinyl	16	11.3	12	10.9	28	11.1
Cloth	71	50.0	69	62.7	140	55.6
Velour	47	33.1	25	22.7	72	28.6
Leather	8	5.6	4	2.8	12	4.8
TOTAL	142	100.0	110	100.0	252	100.0

TABLE 3 (Continued)

Variable	NO DISCOMFORT		SOME DISCOMFORT		TOTAL	
	N	% Subjects	N	% Subjects	N	% Subjects
SEAT COLOR						
White	3	2.1	1	0.9	4	1.6
Black	5	3.5	7	6.4	12	4.8
Grey	38	26.8	19	17.3	57	22.6
Tan	22	15.5	24	21.8	46	18.3
Red	6	4.2	5	4.5	11	4.4
Blue	37	26.1	33	30.0	70	27.8
Green	3	2.1	1	0.9	4	1.6
Burgundy	19	13.4	13	11.8	32	12.7
Brown	9	6.3	7	6.4	16	6.3
TOTAL	142	100.0	110	100.0	252	100.0
LUMBAR SUPPORT						
Yes	15	10.5	4	3.6	19	7.6
No	127	89.4	106	96.4	233	92.5
TOTAL	142	100.0	110	100.0	252	100.0
SEAT ACCESSORIES						
Soft Cover	7	4.9	5	4.5	12	4.8
Bottom Cushion	1	0.7	4	3.6	5	2.0
Back Cushion	0	0.0	1	0.9	1	0.4
Bottom/Back Cushion	1	0.7	2	1.8	3	1.2
None	133	93.7	98	89.1	231	91.7
TOTAL	142	100.0	110	100.0	252	100.0
AIR CONDITIONING						
Yes	44	31.0	35	31.8	79	31.3
No	88	62.0	70	63.6	158	62.7
Not Equipped	10	7.0	5	4.5	15	6.0
TOTAL	142	100.0	110	100.0	252	100.0

TABLE 4
DISCOMFORT RESPONSES BY BODY LOCATION

Body Location	No. of Responses	% of Responses
Neck	20	8.3
Left Shoulder	9	3.8
Right Shoulder	5	2.1
Left Arm	1	0.4
Right Arm	2	0.8
Neck/Shoulder/Arm	37	15.4
Mid and Upper Back	23	9.6
Lumbar	63	26.3
Abdomen	2	0.8
Back/Lumbar/Abdomen	88	36.7
Left Buttock	17	7.1
Right Buttock	18	7.5
Left Hip	7	2.9
Right Hip	4	1.87
Left Thigh	4	1.7
Right Thigh	11	4.6
Buttock/Hip/Thigh	61	25.4
Left Knee	2	0.8
Left Calf	9	3.8
Left Ankle	2	0.8
Left Foot	11	1.7
Left Heel	0	0.0
Left Knee/Leg/Foot	17	7.1
Right Knee	5	2.1
Right Calf	16	6.7
Right Ankle	6	2.5
Right Foot	8	3.3
Right Heel	2	0.8
Right Knee/Leg/Foot	37	15.4
Total Knee/Leg/Foot	54	22.5
TOTAL	240	100.0

TABLE 5
SEVERITY OF PAIN

Body Region	MILD		MODERATE		SEVERE		TOTAL	
	N	%Regional Response	N	%Regional Response	N	%Regional Response	N	%Regional Response
Neck/Shoulder/Arm	21	56.8	11	29.7	5	13.5	37	100.0
Back/Lumbar/Abdomen	68	77.3	13	14.8	7	7.9	88	100.0
Buttock/Hip/Thigh	42	68.9	16	26.2	3	4.9	61	100.0
Knee/Leg/Foot	43	79.6	9	16.7	2	3.7	54	100.0
TOTAL	174	72.5	49	20.4	17	7.1	240	100.0

TABLE 6
TYPE OF PAIN

Body Region	SHARP		BURNING		NUMBING		DULL ACHE		OTHER		TOTAL	
	N	%Reg. Resp.	N	%Reg. Resp.	N	%Reg. Resp.	N	%Reg. Resp.	N	%Reg. Resp.	N	%Reg. Resp.
Neck/Shoulder/Arm	13	35.1	3	8.1	3	8.1	18	48.7			37	100.0
Back/Lumbar/Abdomen	13	14.8	2	2.3	4	4.5	69	78.4			88	100.0
Buttock/Hip/Thigh	11	18.1	1	1.6	28	45.9	20	32.8	1	1.6	61	100.0
Knee/Leg/Foot	4	7.4	2	3.7	11	20.4	37	68.5			54	100.0
TOTAL	41	17.1	8	3.3	46	19.2	144	60.0	1	0.4	240	100.0

TABLE 7
CAUSES FOR DISCOMFORT

Response	N	% of Responses
Need to keep foot in same position on accelerator pedal	28	11.3
Not enough lower back support	32	13.0
Not enough head support	7	2.8
Can't adjust seat close enough	2	0.8
Can't adjust seat far back enough	8	3.2
Can't adjust seat-back angle enough	25	10.1
Can't adjust seat height	5	2.0
Seat too hard	7	2.8
Seat too soft	5	2.0
Seat too hot	3	1.2
Shape too flat	8	3.2
Shape too narrow	7	2.8
Shape too deep	5	2.0
Shape not deep enough	6	2.4
Improper location of arm support	7	2.8
Lack of arm support	7	2.8
Improper location of head support	17	6.9
Seat trim too hard	1	0.4
Springs or frame parts too hard	7	2.8
Shoulder harness pressure too high	12	4.9
Shoulder harness angle not right	9	3.6
Seat is OK. Old injury/wound	5	2.0
No head support	1	0.4
Not enough room in vehicle to stretch	6	2.4
Shape of foot weld not wide enough	1	0.4
Drive too long/many hours driving	22	8.9
Back seat too low	1	0.4
Other	3	1.2
TOTAL	247	100.0

TABLE 8
WAYS DRIVERS RELIEVE DISCOMFORT

Response	N	% Subjects
Change postures	36	32.7
Change seat position	2	1.8
Stop and relax	30	27.3
Nothing I do relieve discomfort	8	7.3
I don't do anything	3	2.7
Change postures/change seat position	2	1.8
Change postures/change seat-back angle	1	0.9
Change postures/stop and relax	13	11.8
Change postures/use cruise control	1	0.9
Change postures/other	1	0.9
Use cruise control/stop and relax	3	2.7
Stop/relax/other	1	0.9
Change postures/seat back angle/stop/relax	1	0.9
Other	8	7.3
TOTAL	110	100.0

TABLE 9
DRIVING TIME FOR DISCOMFORT

No. Hours	N	% of Responses
Trips < 1 Hour	55	22.9
1-2 Hours	83	34.6
2-5 Hours	88	36.7
5-10 Hours	14	5.8
TOTAL	240	100.0

TABLE 10

DRIVER CHRONIC HEALTH PROBLEM

Health Problem	N	% of Responses
Left Shoulder	1	2.7
Center Back	3	8.1
Lumbar	23	62.1
Abdomen	1	2.7
Hips	6	16.2
Knees	2	5.4
Calf	1	2.7
TOTAL	37	100.0

TABLE 11

WHAT MAKES OTHER VEHICLE MORE COMFORTABLE

Response	N	% of Responses
Bucket/contoured/fits better	9	13.6
Cushioned better/firmer seat	7	10.6
More adjustable	4	6.1
Better back support	4	6.1
Inflatable/adjustable lumbar-thigh	5	7.6
Seat angle better	1	1.5
Cloth seats	1	1.5
Don't know	4	6.1
Higher seat	6	9.1
Bigger seat/bigger car/luxury car	14	21.2
Presence of center armrest	2	3.0
More leg room	2	3.0
Gas pedal not so hard	1	1.5
Bench seat supports more evenly	2	3.0
Better ride/smooth ride	1	1.5
Better made seat	3	4.5
TOTAL RESPONSES	66	100.0

TABLE 12
SUGGESTED SEAT IMPROVEMENTS

Improvements	N	% of Responses
Nothing/couldn't/wouldn't improve seat	67	41.9
More cushion (area unspecified)	13	8.1
More padding around sides	7	4.4
More bottom/thigh area support	3	1.9
More back/lumbar support	14	8.8
More adjustability in seat	15	9.4
Increase seat height	1	0.6
Lower headrest	1	0.6
Higher headrest/support	1	0.6
Need headrest	1	0.6
Bring headrest closer	3	1.9
Left armrest softer/same texture as center rest	1	0.6
Leather seats	1	0.6
Cloth seats	3	1.9
Bucket seats/better contour	3	1.9
Split bench seat	2	1.3
Bench seat	1	0.6
Higher seat back	2	1.3
Wider seat	1	0.6
Better seat angle	2	1.3
Lower gas pedal	1	0.6
Tilt wheel	1	0.6
Softer seat	1	0.6
More room in vehicle	1	0.6
Better seat construction	1	0.6
Don't know how to improve seat	13	8.1
TOTAL	160	100.0

TABLE 13

WHAT MAKES THIS CAR SEAT MORE COMFORTABLE

Response	N	% of Responses
Don't know/not sure	72	22.9
Bucket/contoured/fits better	55	17.5
Fully adjustable/power	38	12.1
Sits high/good leg room	16	5.1
Sits close enough	1	0.3
Seat reclines	13	4.1
Wide/big seats	5	1.6
Center armrest	7	2.2
Better Construction	8	2.5
Good back/lumbar support	17	5.4
Sits up straighter/upright	7	2.2
One-piece seat with headrest	3	1.0
Cloth seats	12	3.8
Luxury/new/custom vehicles	13	4.1
Bench seat	1	0.3
Higher seat back	2	0.6
Ricaro/flex steel seats	2	0.6
Good headrest location	1	0.3
Firmer/good bottom/thigh support	17	5.4
Leather seats	2	0.6
Tilt wheel	3	1.0
Softer seats	9	2.9
Adjustable shoulder harness	1	0.6
Good ride/smooth ride	3	1.0
Good position from steering wheel	2	0.6
Split-bench seats	2	0.6
Big roomy car	2	0.6
TOTAL	314	100.0

APPENDIX
SURVEY FORMS

DRIVER SEATING COMFORT SURVEY: SOME DISCOMFORT

DATE: ___/___/___ RESP.: 2 ___ SITE: ___ Observed restraint use: [1] [] Restrained
 [1 - 3] [4 - 6] [7] [2] [] Unrestrained
 [8]

1. Was this discomfort on: [1] [] Current trip
 [2] [] Past trips
 [9]

[SHOW CARD]

2. What part of your body is uncomfortable? How great is your discomfort: Would you say
 [1] mild, [2] moderate, or [3] severe? What type of pain is it? Would you say
 [1] sharp, [2] burning, [3] numbing, [4] dull ache or what? [5=other].

[Code up to 5 responses]

[10-13][14-17][18-21][22-25][26-29]

SEV.	TYPE	SEV.	TYPE	SEV.	TYPE
[01]	Head	[13]	Chest	[23]	L Calf
[02]	Neck	[14]	Abdomen	[24]	R Calf
[03]	L Shoulder	[15]	L Buttock	[25]	L Ankle
[04]	R Shoulder	[16]	R Buttock	[26]	R Ankle
[05]	L Arm	[17]	L Hip	[27]	L Foot
[06]	R Arm	[18]	R Hip	[28]	R Foot
[07]	L Back	[19]	L Thigh	[29]	L Heel
[08]	C Back	[20]	R Thigh	[30]	R Heel
[09]	R Back	[21]	L Knee	[31]	Other:
[10]	L Lumbar	[22]	R Knee		
[11]	C Lumbar				
[12]	R Lumbar				

3. What can and do you do to relieve this discomfort while you are driving? [READ]
 [1] [] Change postures
 [2] [] Change seat position
 [3] [] Change seat back angle
 [4] [] Use cruise control
 [5] [] Stop and relax
 [6] [] Other: _____
 [7] [] Nothing I do relieves this discomfort
 [8] [] I don't do anything

4. Would you tell me when you begin to experience this discomfort?
 Would you say on: [READ]
 [1] [] Trips under 1 hour
 [2] [] Trips between 1 & 2 hours
 [3] [] Trips between 2 & 5 hours
 [4] [] Trips between 5 & 10 hours
 [5] [] Trips over 10 hours
 [6] [] Other: _____
 [31]

5. Do you have any chronic health problems such as low back pain, any injuries, etc?

[1] [] YES

[2] [] NO

[32]

5a. What is the problem?
 [code body location]

5b. What is it related to?
 [what disease or injury]

5c. Does it contribute to your driving discomfort

[1] yes [2] no [9] N/

[33 34]

[35 36]

[37]

[38 39]

[40 41]

[42]

[43 44]

[45 46]

[47]

6. Do you ever experience similar types of discomfort in other sitting situations?

[1] [] YES

[2] [] NO

48

[SHOW CARD]

7. What do you think are the major causes of the seating discomfort you have mentioned?
 [code most important item first]

[49-50]	[01] Need to keep foot in same position on accelerator pedal	[14] Shape too deep
[51-52]	[02] Not enough lower back support	[15] Shape not deep enough
[53-54]	[03] Not enough head support	[16] Improper location of arm support
[55-56]	[04] Can't adjust seat close enough	[17] Lack of arm support
[57-58]	[05] Can't adjust seat far back enough	[18] Improper location of head support
	[06] Can't adjust seat back angle enough	[19] Head support too hard
	[07] Can't adjust seat height	[20] Seat trim too hard
	[08] Seat too hard	[21] Springs or frame parts too hard
	[09] Seat too soft	[22] Shoulder harness pressure too high
	[10] Seat too hot	[23] Shoulder harness angle not right
	[11] Seat too cold	[24] Other: _____
	[12] Shape too flat	
	[13] Shape too narrow	

8. Have you driven other cars in which you found the seat more comfortable than in this car?

[1] [] YES

[2] [] NO

59

8a. Make/model of car?

8b. How was it more comfortable?

[60 - 63]

[64 65]

[66 - 69]

[70 71]

9. What makes this car seat more comfortable than the car seats in other cars you have driven, if anything? [up to three responses] [code 99 if no response]

[72 73]

[74 75]

[76 77]

10. How long have you been driving today? _____ Hours _____ Min.

[78-79]

[80-81]

11. How long have you been driving since your last stop? _____ Hours _____ Min.

[82]

[83-84]

12. About how many miles do you drive in a year?

[1] _____ 10,000 miles or less

[2] _____ 10,001 - 20,000 miles

[3] _____ 20,001 - 30,000 miles

[4] _____ 30,001 or greater

[85]

13. VEHICLE MAKE _____ MODEL _____ YEAR _____
[86 - 89] [90 91]

DRIVERS SEAT TYPE

14. [1] Bucket
[2] Bench
[3] Split Bench
[92]

15. [1] Power
[2] Manual
[93]

16. [1] Reclining back
[2] Nonreclining back
[94]

17. HEADREST:
[1] One-piece
[2] Adjustable
[9] None
[95]

18. SEAT MATERIAL:
[1] Vinyl
[2] Cloth
[3] Velour
[4] Leather
[5] Sheepskin
[96]

19. SEAT COLOR:
[01] White
[02] Black
[03] Grey
[04] Tan
[05] Red
[06] Blue
[07] Other: _____
[97-98]

20. Is your car equipped with adjustable/
inflatable lumbar or thigh supports?
[1] Yes
[2] No
[99]

21. Are you using any seat accessories?
[1] Soft cover [5] Other: _____
[2] Bottom cushion [6] None
[3] Back cushion
[4] Bottom and back cushion
[100]

22. When you drove up here, right now,
did you have the air conditioning
on in your car?
[1] YES
[2] NO
[9] No air in car
[101]

23. What is the purpose of this trip today?
[01] Work related
[02] Vacation
[03] Other: _____
[102-103]

I WOULD LIKE TO ASK A FEW QUESTIONS ABOUT YOU FOR STATISTICAL PURPOSES ONLY.

24. What month and year were you born? _____ / _____
[104 - 107]

25. Sex: [1] Male
[2] Female
[108]

26. About what is your height? _____
[109 - 111]

27. About what is your weight? _____
[112 - 114]

28. Does your occupation require that you
travel in a car: [READ]
[1] less than 25% of your work time
[2] between 26 & 50% of your work time
[3] between 51 & 75% of your work time
[4] more than 76% of your work time
[5] does not require travel time
[115]

29. Excluding travel, does your occupation
require that you sit: [READ]
[1] less than 25% of your work time
[2] between 26 & 50% of your work time
[3] between 51 & 75% of your work time
[4] more than 76% of your work time
[5] does not require me to sit
[116]

30. Could you tell me where you are sitting? _____

117 118

End time of interview: _____ : _____

119 - 122

DRIVER SEATING COMFORT SURVEY: NO DISCOMFORT

DATE: ___/___/___ RESP.: 1 ___ SITE: ___ Observed seat belt use: [1] Restrained
 [2] Unrestrained
 [8]

1. How would you improve this car seat to make it more comfortable, if anything?
 [up to three responses] [code 99 if no improvements]

 [9 10] _____

 [11 12] _____

 [13 14] _____

2. What makes this car seat more comfortable than the car seats in other cars you have driven, if anything? [up to three responses] [code 99 if no response]

 [15 16] _____

 [17 18] _____

 [19 20] _____

3. In hours, how long have you been driving today? _____ Hours _____ Min.
 [21-22] [23-24]

4. In hours, how long have you been driving since your last stop? _____ Hours _____ Min.
 [25] [26-27]

5. About how many miles do you drive in a year?
 [1] 10,000 miles or less
 [2] 10,001 - 20,000 miles
 [3] 20,001 - 30,000 miles
 [4] 30,001 miles or more
 [28]

6. VEHICLE MAKE _____ MODEL _____ YEAR _____
 [29-32] [33-34]

DRIVERS SEAT TYPE

7. [1] Bucket [2] Bench [3] Split Bench [35]
 8. [1] Power [2] Manual [36]
 9. [1] Reclining back [2] Nonreclining back [37]

10. HEADREST: [1] One-piece [2] Adjustable [9] None [38]
 11. SEAT MATERIAL: [1] Vinyl [2] Cloth [3] Velour [4] Leather [5] Sheepskin [39]
 12. SEAT COLOR: [01] White [02] Black [03] Grey [04] Tan [05] Red [06] Blue [07] Other: _____ [40-41]

13. Is your vehicle equipped with adjustable/inflatable lumbar or thigh supports?
 [1] Yes [2] No [42]

14. Are you using any seat accessories?
 [1] Soft Cover [2] Bottom Cushion [3] Back Cushion [4] Bottom and Back Cushion [5] Other: _____ [9] None [43]

15. When you drove up here, right now, did you have the air conditioning on in your car?
 [1] YES [2] NO [9] No air in car [44]

16. What is the purpose of this trip today?
 [01] Work related [02] Vacation [03] Other: _____ [45-46]

I WOULD LIKE TO ASK A FEW QUESTIONS ABOUT YOU FOR STATISTICAL PURPOSES ONLY.

17. What month and year were you born? ____ / ____
[47 - 50]

18. Sex: [1] Male
[2] Female
[51]

19. About what is your height? ____
[52 - 54]

20. About what is your weight? ____
[55 - 57]

21. Does your occupation require that you
travel in a car: [READ]
[1] less than 25% of your work time
[2] between 26 & 50% of your work time
[3] between 51 & 75% of your work time
[4] more than 76% of your work time
[5] does not require travel time
[58]

22. Excluding travel, does your occupation
require that you sit: [READ]
[1] less than 25% of your work time
[2] between 26 & 50% of your work time
[3] between 51 & 75% of your work time
[4] more than 76% of your work time
[5] does not require me to sit
[59]

23. Could you tell me where you are sitting? _____

[60-61]

24. End time of interview: ____ : ____
[62 - 65]