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Abstract

Through the Australian Design Rule program, action has been taken to make seat belts more convenient, more comfortable to use and more effective in accidents. Inertia reel lap-sash belts for front outboard positions and improved upper anchorage locations for all outboard seating positions became compulsory for all passenger cars and derivatives manufactured on or after 1 January 1975. These represent the most recent major efforts to improve restraint systems in these vehicles.

In March 1978 the Office of Road Safety conducted a roadside survey of seat belt fitting and wearing in four Australian cities. In one city, Melbourne, registration plate numbers were obtained to enable calculation of fitting and wearing rates by year of vehicle manufacture. Hence, wearing rates of belts in vehicles complying with different Design Rules, could be estimated.

Survey results show that improved inertia reel installations are worn more often. An additional benefit is the higher percentage of these belts which are worn correctly adjusted compared with static belts.

Note

This report is disseminated in the interest of information exchange. The views expressed are those of the author and do not necessarily represent those of the Commonwealth Government.

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Contents

Introduction

The effects and benefits of legislation requiring fitting and wearing of seat belts in all motor vehicles (except buses) in Australia have been well documented by Vulcan, Ungers and Milne (1975) and Milne (1979). The Australian Design Rule (ADR) program specifies vehicles safety standards including those for occupant restraint and has resulted in seat belts now being available in the front seats of the vast majority of passenger cars*. Retro-fitting legislation in some States has also contributed to this level of seat belt availability. At least 90 per cent of front seat car occupants aged eight years or more have a seat belt available for their use.

Roadside surveys of seat belt fitting and wearing have been conducted by the Commonwealth Department of Transport since 1973. Survey results have been used to monitor the effects of seat belt wearing legislation, and to evaluate the effects of publicity campaigns encouraging correct seat belt wearing (Johnston and Cameron, 1979), retro-fitting legislation (Boughton and Cameron, in preparation), and the impact of child restraint legislation (Boughton, Lancashire and Johnston, 1977).

The most recent surveys, in March and July 1978, were undertaken to provide data to evaluate the effects of a publicity campaign aimed at increasing child restraint usage (Boughton and Johnston, 1979). The March 1978 survey provided an opportunity to investigate the feasibility of determining the distribution of vehicles complying with the different seat belt ADRs. Compliance with ADRs is specified by date of manufacture and can be estimated by year of first registration (Cameron and Wessels, 1975). In the Melbourne survey, year of first registration was estimated by matching the first three letters on the vehicle registration place with blocks of registration numbers derived from registration records. Data from the survey, combined with results from the previous Department of Transport surveys, have been used in this paper to evaluate the impact of the seat belt ADRs on observed wearing rates and manner of wearing. Discussion includes consideration of the effects of occupant age and sex, vehicle age and improved seat belt systems.

Survey design

The population of vehicles on which sample observations were made in March 1978 consisted of passenger cars, including commercial passenger cars, in Melbourne, Adelaide, Perth and Canberra, which are the capital cities of the respective States and Territory. Five or six sites were selected in each city using the following criteria:

each site being a signalised intersection on an urban arterial road with a central median;

each site having heavy traffic flow to ensure maximum observations per unit time;

each site having adequate street lighting and other features to ensure safety of the observers; and

all sites giving a reasonable geographic spread across the city.

Two observers were stationed on the central median at each site. Survey vehicles were defined as the leading vehicle in the lane closest to the central median at each red-light phase. If there were two or more eligible vehicles stationary in this lane during the red-light phase then the observers were permitted to select whichever of the first three vehicles contained children.

Observations were made between 0600 and 2400 hours on 16 to 19 March 1978. The allocation of sites to interviewer shifts was made according to a truncated latin square design.

*In this paper, passenger cars includes station wagons, panel vans and utilities.

Data collected

The following data was obtained:

occupancy by seating position;

type of restraint fitted by seating position, whether occupied or not;

for each occupied seating position with restraint available, whether or not the restraint was in use;

sex and estimated age (0–7, 8–13, 14–29, 30–49, 50 plus years) of all occupants;

the tightness of sash, flatness of sash and position of the buckle for seat belts in use in either of the front outboard seating positions; and

first three characters on the vehicle registration plate.

The registration plate data have been used to give a breakdown of vehicles observed by year of registration and by inference year of manufacture for the majority of vehicles. This procedure is described in detail on page 8.

Overall survey results

General

The number of vehicles observed in each city in the survey was as follows:

Melbourne	2985
Adelaide	2775
Perth	2544
Canberra	2595

Totals appearing in the following tables will vary from these overall totals due to missing and inapplicable data values, e.g. no rear seats in utilities. Percentages have been used where possible to simplify presentation.

Table 1 shows the number of occupants observed by each seating position in the vehicle. Approximately 90 per cent of all occupants were in outboard seating positions with some 80 per cent of all occupants in front outboard seating positions.

The percentages for types of restraint fitted in outboard seating positions are shown in Table 2. There is slightly greater availability of restraints in front seat outboard positions in vehicles in Melbourne compared with vehicles in Adelaide, Perth and Canberra. Availability of seat belts in rear outboard seating positions is greatest in Canberra compared with the other cities.

Boughton and Cameron (in preparation) estimated that Victoria's retro-fitting legislation resulted in an additional 6–13 per cent of front outboard seating positions having seat belts fitted at December 1975. They also calculated the Australian Capital Territory's vehicles population to be younger than that of Victoria or New South Wales, which is likely to be a major reason for the greater availability of seat belts in rear outboard seating positions in Canberra vehicles in March 1978.

Percentages for types of restraint fitted in outboard seating positions occupied by a person aged at least eight years are presented in Table 3. More than 90 per cent of front seat occupants, and about 70 per cent of rear seat occupants have a seat belt available for their use.

Wearing rates*

Under ADR 4, lap-sash belts have been mandatory for front outboard seating positions from 1 January 1969 and for rear outboard seating positions from 1 January 1971. Improvements to the convenience and performance of seat belt systems implemented since then have been for increased convenience and restricted buckle location

*Wearing rate means percentage wearing available belt.

Table 1: Occupants observed by seating position in vehicle, Melbourne, Adelaide, Perth, Canberra, March 1978

	Melbourne		*Adelaide*		*Perth*		*Canberra*	
Seating position	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Front: driver	2 985	54.4	2 775	54.5	2 544	52.4	2 595	56.8
centre	66	1.2	78	1.5	113	2.3	65	1.4
left	1 368	24.9	1 273	25.0	1 197	24.6	1 096	24.0
other	18	0.3	56	1.1	59	1.2	49	1.1
All front	4 437	80.9	4 182	82.1	3 913	80.5	3 805	83.3
Rear: right	325	5.9	317	6.2	314	6.5	245	5.4
centre	234	4.3	179	3.5	206	4.2	164	3.6
left	437	8.0	367	7.2	336	6.9	283	6.2
tailgate	16	0.3	22	0.4	63	1.3	21	0.5
other	37	0.7	28	0.5	26	0.5	48	1.1
All rear	1 049	19.1	913	17.9	945	19.5	761	16.7
All occupants	5 486	100.0	5 095	100.0	4 858	100.0	4 566	100.0

Table 2: Percentage of each type of restraint fitted in outboard seating positions (regardless of whether seat occupied) Melbourne, Adelaide, Perth, Canberra, March 1978.

Seating position and city	Seat belt				Child			All restraints	None	Bassinet	Total	
			Lap-sash									
	Lap	Sash	Static	Inertia	Harness	Harness	Seat				%	No.
Melbourne												
Driver	1.5	0.5	58.7	37.6	0.6	—	—	99.0	1.0	—	100	2 985
Front left	1.6	0.5	58.6	37.6	0.5	*	*	98.9	1.1	—	100	2 985
Rear right	2.6	0.2	63.1	2.0	*	0.7	2.0	70.8	29.0	0.1	100	2 751
Rear left	2.6	0.3	62.5	2.1	—	1.0	2.8	71.4	28.5	0.1	100	2 751
Adelaide												
Driver	0.5	0.2	57.2	33.7	0.2	—	—	91.8	8.2	—	100	2 775
Front left	0.5	0.3	57.0	33.6	0.1	*	*	91.7	8.3	—	100	2 775
Rear right	0.7	2.7	56.5	1.7	—	0.6	1.1	63.3	36.5	0.2	100	2 571
Rear left	0.7	2.7	55.8	1.6	—	1.2	1.8	63.8	36.1	*	100	2 571
Perth												
Driver	1.4	0.2	51.6	39.3	0.2	—	—	92.6	7.4	—	100	2 544
Front left	1.4	0.1	51.1	39.1	0.1	—	*	91.9	8.1	—	100	2 544
Rear right	0.9	0.5	61.8	3.6	*	0.4	1.6	68.9	31.0	0.1	100	2 248
Rear left	0.9	0.6	61.0	3.6	*	0.7	1.9	68.8	31.0	0.2	100	2 248
Canberra												
Driver	0.3	0.3	56.2	40.7	0.3	—	—	97.8	2.1	—	100	2 595
Front left	0.3	0.3	56.4	40.4	0.3	—	0.2	97.8	2.2	—	100	2 595
Rear right	0.8	0.3	69.8	0.9	*	0.9	2.0	74.7	25.2	*	100	2 236
Rear left	0.7	0.3	68.4	0.9	*	0.8	3.5	74.6	25.4	*	100	2 236

Note: *denotes less than 0.1 per cent.

Table 3: Percentage of each type of seat belt fitted in outboard seating positions occupied by persons at least 8 years of age, Melbourne, Adelaide, Perth, Canberra, March 1978

Seating position and city	Seat belt		Lap-sash			All type	No seat belt	Total	
	Lap	Sash	Static	Inertia	Harness			%	No.
Melbourne									
Driver	1.5	0.5	58.7	37.6	0.6	99.0	1.0	100	2 985
Front left	1.6	0.5	60.3	35.9	0.7	99.0	1.0	100	1 346
Rear right	3.7	0.5	68.4	1.4	—	74.0	26.0	100	217
Rear left	2.2	—	67.6	2.2	—	72.0	28.0	100	322
Adelaide									
Driver	0.5	0.2	57.2	33.7	0.2	91.8	8.2	100	2 775
Front left	0.4	0.2	58.3	33.7	0.1	92.7	7.3	100	1 216
Rear right	0.5	0.5	61.5	2.3	—	64.7	35.3	100	221
Rear left	0.8	2.7	64.6	1.5	—	69.6	30.4	100	264
Perth									
Driver	1.4	0.2	51.6	39.3	0.2	92.6	7.4	100	2 544
Front left	1.4	0.1	52.2	38.3	0.2	92.1	7.9	100	1 169
Rear right	0.9	1.9	62.8	0.9	—	66.5	33.5	100	215
Rear left	1.2	2.8	63.0	0.8	—	67.9	32.1	100	247
Canberra									
Driver	0.3	0.3	56.2	40.7	0.3	97.8	2.2	100	2 595
Front left	0.3	0.1	54.9	42.5	0.3	98.0	2.0	100	1 073
Rear right	1.9	—	72.1	1.9	—	76.0	24.0	100	161
Rear left	1.1	—	71.8	1.7	—	74.7	25.3	100	185

in all seating positions via ADR 4A from 1 January 1974; re-design of upper anchorage location in all outboard seating positions via ADR 5B from 1 January 1975; inertia reel belts for front outboard seating positions via ADR 4B from 1 January 1975; and dual sensing retractors for inertia reels via ADR 4C from 1 January 1976. The inertia reel belt systems satisfying these requirements enable one-handed fastening, ensure the buckle is correctly located, ensure adequate tightness and reduce the likelihood of twist in the webbing. Dual sensing retractors have two independent sensing devices to lock the reel. One is actuated by velocity change of the vehicle and the other by rate of strap reel-out, the latter allowing users to check that the strap sensitive device is operating.

The Design Rules concerned with seat belt fitting and wearing have been described in detail by McKenzie and Milne (1976) and Bell (1977).

Laws requiring occupants to wear available seat belts were introduced in the States and Territories at different times, but have been in force throughout Australia since 1 January 1972. Differences between the States and Territories are minor and relate mainly to exemptions. The minimum age from which occupants must wear available seat belts in all jurisdictions was in practice eight years, except in the Australian Capital Territory where the age specified was fourteen years. Recent legislation relating to children has effectively reduced the minimum age in some jurisdictions to less than eight years. However, for maximum comparability the following analysis has only considered occupants at least eight years of age.

Wearing rates by occupants at least eight years of age in outboard seating positions are presented in Table 4. In all cities, inertia reel lap-sash belts were worn more frequently than static lap-sash belts by front outboard occupants aged at least eight years. This is also generally true for rear outboard occupants, although the conclusion is limited by the small number of inertia reel lap-sash belts available in rear outboard positions.

For all cities combined, 79 per cent (6967 out of 8822) of front outboard seating position occupants aged at least eight years were observed wearing an available static lap-sash belt while 88 per cent (5204 out of 5908) of such occupants wore an available inertia reel lap-sash belt. The difference between these percentages is highly significant ($p<0.001$ for one degree of freedom). Comparative rates for rear outboard seating positions were 34 per cent (406 out of 1194) for static belts and 48 per cent (14 out of 29) for inertia reel belts. No test of significance was made as it is considered that no conclusion from a sample of this size could be justified.

Manner of wearing

Early reports of poor seat belt adjustment were made by Andreassend (1972) and Ryan and Baldwin (1972). Andreassend estimated from roadside observations that of drivers wearing seat belts, only 14 per cent had the belt correctly adjusted; characterised by being adequately tight, not twisted and with the buckle beside the hip. Ryan and Baldwin estimated from roadside observations that about half of the drivers wearing seat belts had the belt correctly adjusted in terms of sash tightness and buckle location. They applied these criteria to a sample of sixteen seat belt wearers injured in road accidents and considered that in all cases the belt was too loose and in fifteen cases the buckle was improperly positioned.

The above roadside survey estimates should not be considered comparable due to differences in the criteria and survey methods used. However, they do suggest that a significant proportion of seat belts were worn unsatisfactorily adjusted.

Table 4: Percentage wearing available seat belt for occupants at least eight years of age by seating position and type of seat belt, Melbourne, Adelaide, Perth, Canberra, March 1978

Seating position and city	*Seat belt*					
	Lap	*Sash*	*Lap-sash*			
			Static	*Inertia*	*Harness*	*All types*
Melbourne						
Driver	57	67	81	89	79	84
Front left	48	71*	77	86	89*	80
Rear right	25	0*	31	33*	—	30
Rear left	43	—*	32	14*	—	33
Adelaide						
Driver	50	80*	81	89	67*	83
Front left	60*	100*	75	82	100*	77
Rear right	9*	100*	39	40*	—	39
Rear left	0*	43*	34	50*	—	34
Perth						
Driver	63	75*	85	91	100*	87
Front left	44	100*	74	85	100*	78
Rear right	50*	50*	36	50*	—	36
Rear left	33*	57*	40	0*	—	40
Canberra						
Driver	71*	43*	79	89	89*	83
Front left	33*	100*	70	84	100*	76
Rear right	67*	—	32	67*	—	34
Rear left	100*	—	29	67*	—	31

Note: *denotes less than ten occupants.

This problem has been approached from two directions — educating users and improving seat belt systems through ADRs. The effects of the latter approach are discussed on page 12.

A publicity campaign conducted by the Department of Transport in 1974 was aimed at informing users of static lap-sash belts of means of adjusting their seat belts correctly. Data collected by roadside surveys indicated that television publicity is a viable medium to increase correct seat belt adjustment in the short term (Johnston and Cameron, 1979).

Table 5 provides information on the manner of static lap-sash belt wearing by front outboard occupants aged at least eight years in all cities in March 1978. It is obvious that there are still large numbers of static belts in use which are not correctly adjusted.

Table 5: Manner of wearing static lap-sash seat belts by front outboard seating position occupants at least eight years of age, Melbourne, Adelaide, Perth, Canberra, March 1978

City	*Manner of wearing (per cent)*			
	Loose	*Twisted*	*Buckle on abdomen*	*Correctly adjusted*
Melbourne	43	21	11	17
Adelaide	56	24	8	9
Perth	37	24	12	13
Canberra	65	28	7	6

Note: (1) Correctly adjusted means sash tight, sash not twisted and buckle beside the hip.
(2) Row percentages do not total to 100 per cent due to use of three levels in the operational definition of tightness and buckle location. 'Loose' and 'buckle on abdomen' represent the worst of the three conditions specified.

Effect of Australian Design Rules 4B and 5B, and 4C.

Investigation of the relative influence of each of the seat belt ADRs, particularly 4B and 5B, and 4C, requires a breakdown of fitting and wearing rates of lap-sash belt types by vehicle age. Vehicles may then be grouped according to their compliance with the relevant ADRs and wearing rates for the available systems calculated.

The separate effects of ADRs 4B and 5B in front seat positions cannot be investigated since both Rules came into force on 1 January 1975. The effect of ADR 5B, redesign of upper anchorage location, could be examined by calculating wearing rates by vehicle age in rear seat positions where inertia reel belts are not mandatory. However, there were insufficient relevant rear seat occupants observed in the survey to enable tests of significance to be conducted.

Estimation of vehicle age

As indicated on page 2, the first three characters on the registration plate of the survey vehicles were recorded in the March 1978 survey. Year of registration was derived from records of blocks of registration numbers for individual calendar years and used as an estimator of year of manufacture. It is recognised that a variety of errors may be incurred for individual vehicles. Observers were advised to note on the coding form any apparent discrepancies of registration number and vehicle age but were not permitted to verify vehicle age by questioning the driver. Vehicle age derived by this method has been tabulated only for the Melbourne, March 1978 survey because year of first registration of vehicles in the other three cities could not be readily identified from blocks of registration numbers. Age was not estimated for 232 out of the 2985 vehicles observed; mostly due to personalised and non-Victorian registration plates.

The accuracy of using registration numbers for estimating year of manufacture has been investigated by Cameron and Wessels (1975). A sample of vehicles involved in accidents in Victoria was drawn and year of manufacture deduced from blocks of registration numbers. A comparison with year of first registration on the matched Certificate of Registration found that the registration number erroneously estimated year of manufacture by an average of 1.06 years. Registration number gave an underestimate of year of manufacture in 25 per cent of the sample, perhaps due to re-registrations, and an overestimate of year of manufacture in 4 per cent of cases.

The age distribution of vehicles on the road in March 1978 can be compared with the distributions estimated from vehicle census and vehicle usage survey data. The method for estimating the age distribution of vehicles on the road follows that developed by Cameron (Boughton and Cameron, in preparation) and is described in the Appendix.

Table A2 of the Appendix presents the age distribution of the vehicles observed in Melbourne in March 1978, along with a comparison of the distribution estimated from Cameron's method to be extant in Victoria at 30 September 1971 and 30 September 1976. The March 1978 distribution suggests a younger vehicle sample for Melbourne than may be on the road in Victoria. However, this result can be neither proven nor quantified. The data have therefore been used without any correction for possible bias.

Deriving year of registration from the registration number has been assumed to provide estimates of year of vehicle manufacture for the purposes of the following analysis.

Availability of inertia reel belts

Table 6 sets out the numbers of static and inertia reel lap-sash belts available to front outboard occupants of vehicles, grouped according to estimated vehicle age. The vehicle age groups used were selected on the basis of the following.

1951 to September 1964:	retrofit on resale in Victoria	
October 1964 to 1968:	compulsory retrofit in Victoria	
1969 to 1973:	ADR 4	static belts required
1974:	ADR 4A	
1975:	ADR 4B	inertia reel belts required
1976 to 1978:	ADR 4C	

Table 6: Lap-sash restraint type available to front outboard seating position occupants aged at least eight years by estimated vehicle age, Melbourne, March 1978

Estimated vehicle age group	*Type of lap-sash belt*	
	Static	*Inertia*
Up to 1964	166	6
1965 to 1968	432	18
1969 to 1973	1 207	72
1974	267	119
1975 to 1978	327	1 229
Total	2 399	1 444

Note: Total of 3843 observations where both lap-sash belt type known and estimate of vehicle age available.

Thirty-eight per cent of lap-sash restraints available for use by front occupants aged at least eight years were inertia reel belts. Fifteen per cent of inertia reel belts were fitted in vehicles estimated to have been manufactured prior to the implementation of ADR 4B. This could be due to:

pre-ADR 4B fitting of inertia reel belts by some manufacturers;
owners fitting inertia reel belts under Victorian retro-fitting legislation;
incorrect identification of belt type or vehicle registration number by observers; and
bias in the estimation of age procedure.

Fourteen per cent of static lap-sash belts were fitted in vehicles estimated to have been manufactured on or after the date of implementation of ADR 4B. This percentage can probably only be regarded as error, possibly introduced through the last two factors listed above.

Wearing rates of static and inertia reel belts

Seat belt wearing rates by vehicle age and occupant age and sex are set out in Table 7. Survey data referred to in Table 7 include observations of front outboard occupants aged at least eight years who had:

a static lap-sash belt available if in a passenger car estimated to have been manufactured before 1 January 1975; or
an inertia reel belt available if in a passenger car estimated to have been manufactured on or after 1 January 1975.

The column 'total by belt type' indicates that the wearing rate of inertia reel belts is 10 per cent more than the wearing rate of static belts (chi-square = 54.99, significant at $p<0.001$ for one degree of freedom). Although the comparison is of static and inertia reel belts, the difference between wearing rates may be partly due to an influence of improved upper anchorage location in the inertia reel systems, since ADR 5B came into force on the same date as ADR 4B.

The column 'total by vehicle age' indicates a steady increase in wearing rates for vehicles of decreasing age corresponding to improvements in seat belt systems (chi-square = 59.23, significant at $p<0.001$ for four degrees of freedom). A major increase in wearing rate is noted for the 1975 to 1978 vehicles subject to ADRs 4B, 5B and 4C.

Table 7: Percentage and wearing rates by front outboard seating position occupants aged at least eight years by lap-sash belt type and estimated vehicle age, occupant age and sex, Melbourne, March 1978

Estimated vehicle age group	*Lap-sash belt type*	*Total by Belt type*	*Vehicle age*	*Males (years)*				*Females (years)*			
				8–13	*14–29*	*30–49*	*50+*	*8–13*	*14–29*	*30–49*	*50+*
Up to 1964	static	80.8	77.1	0.0*	81.6	64.3	84.6	100.0*	84.6	70.0	68.8
1965 to 1968	static		80.3	80.0*	78.6	78.9	89.7	—	74.6	78.2	94.4
1969 to 1973	static		80.7	42.9	83.4	76.8	80.2	100.0*	83.6	80.2	83.3
1974	static		84.3	100.0*	84.9	82.5	87.0	100.0*	88.0	84.4	76.0
1975 to 1978	inertia	90.5	90.5	83.3	87.9	90.5	94.9	100.0*	90.1	91.6	93.3
Total	all	84.4		71.4	84.2	82.4	92.0	100.0	85.4	83.9	86.9

*denotes less than ten observations.

Note: (1) Total of 3301 observations where lap-sash belt type known and estimate of vehicle age available, of which thirteen were occupant age and/or sex unknown.
(2) Does not include observations of inertia reel belts in pre-1975 vehicles, or of static belts in the 1975 to 1978 vehicles.

In all age–sex groups for which at least ten observations were recorded, the largest wearing rates are in general for 1975–78 vehicles, fitted with inertia reel belts. However, lower wearing rates may be associated with increasing vehicle age *per se*. Hence, the apparent difference between wearing rates of static and inertia reel belt installations may be due to characteristics of occupants (apart from age and sex) in vehicles of different ages, or in the vehicles themselves.

The numbers of occupants at least eight years of age in front outboard seating positions, by estimated vehicle age group and lap-sash seat belt type are shown in Table 8. Vehicles have been divided into two groups according to whether or not they were estimated to have been manufactured before or after the implementation of ADRs 4B and 5B on 1 January 1975.

These data indicate the relative occupancy associated with the wearing rates presented in Table 9, complementing the availability data in Table 6.

Table 8: Numbers of occupants aged at least eight years in front outboard seating positions, by lap-sash belt type, estimated vehicle age and occupant age and sex, Melbourne, March 1978

Estimated vehicle age group	*Lap-sash belt type*	*Males (years)*					*Females (years)*			
		Total	*8–13*	*14–29*	*30–49*	*50+*	*8–13*	*14–29*	*30–49*	*50+*
Up to 1974	static	2 072	15	542	522	186	9	337	294	161
	inertia	215	2	46	70	35	1	19	27	15
1975 to 1978	static	327	2	95	68	33	2	61	44	21
	inertia	1 229	6	256	336	175	2	191	166	90

Note: Total of 3843 where lap-sash belt type known and estimate of vehicle age available, fourteen of which had occupant age and/or sex unknown.

Table 9: Percentage wearing rates for front outboard seating position occupants aged at least eight years by lap-sash belt type and vehicle age, and occupant age and sex, Melbourne, March 1978

Estimated vehicle age group	*Lap-sash belt type*	*Males (years)*					*Females (years)*			
		Total	*8–13*	*14–29*	*30–49*	*50+*	*8–13*	*14–29*	*30–49*	*50+*
Up to 1974	static	81	67	82	77	83	100*	83	80	83
	inertia	83	100*	76	89	80	100*	89	70	100
1975 to 1978	static	77	0*	76	79	73	0*	77	86	76
	inertia	91	83*	88	90	95	100*	90	92	93

* denotes less than ten observations.

Note: Total of 3843 observations where lap-sash belt type known and estimate of vehicle age available, of which fourteen had occupant age and/or sex unknown.

The wearing rates of static and inertia reel belts in pre-1975 vehicles are similar (chi-square = 0.77, not significant for one degree of freedom). This indicates that either the occupants of older vehicles have different characteristics to occupants of newer vehicles or that older inertia reel installations are inferior and therefore less used, than the newer designs specified by ADRs 4B and 5B, and 4C. The apparent low wearing rate of static belts in new vehicles is probably due to incorrect estimation of vehicle age.

Trends in wearing rates over time

There is no information available on the stability over time of any effect of vehicle age *per se* on wearing rates. In addition there are no data available on the effects of attitudes and enforcement over time so a direct comparison with the wearing rates by vehicle age in the March 1978 survey cannot be made. However, one comparison that can be made is of wearing rates for all vehicles, accounting for wearer age and sex.

Information on wearing rates in Melbourne prior to January 1975 (date of implementation of ADRs 4B and 5B) is available from the May 1973 Department of Transport survey. Table 10 compares wearing rates for all vehicles, by occupant age and sex groups, of front outboard seating positions occupied by a person aged at least eight years in the May 1973 and March 1978 Melbourne surveys.

Table 10: Wearing rates of lap-sash belts by front outboard seating position occupants aged at least eight years by occupant age and sex, Melbourne, May 1973 and March 1978

	Males (years)	*Females (years)*					
Year	*Total*	*8–29*	*30–49*	*50+*	*8–29*	*30–49*	*50+*
1973	81	81	79	83	81	86	85
1978	83	82	81	86	84	83	88

Note: Includes 4872 observations in 1973 (43 age and/or sex unknown) and 4169 observations in 1978 (14 age and/or sex unknown) for which belt type known.

The wearing rate of lap-sash belts in Melbourne in May 1973 was 81 per cent and in March 1978 was 83 per cent, an increase of 2 per cent (chi-square = 5.44, significant at $p = 0.025$ for one degree of freedom). The increase in wearing rates occurred in all age/sex groups except that of females aged 30 to 49 years. It should be noted that the overall wearing rate of lap-sash belts by front outboard seating position occupants aged at least eight years in Melbourne in December 1975 and December 1976 was also 83 per cent.

The increase in wearing rates following the availability of improved inertia reel installations may have been affected by differences in attitudes and enforcement, but no data on these aspects are available.

Manner of wearing

A key aim of ADR 4A is to ensure correct buckle location by restricting the buckle strap length so that the buckle cannot be located on the abdomen. Table 11 shows the percentage of static belt wearers observed in all Melbourne and Canberra surveys who had the buckle located on their abdomen.

Table 11: Percentage front outboard occupants aged at least eight years wearing static lap-sash belts with buckle located on abdomen, Melbourne, May 1973, Melbourne and Canberra, December 1975, December 1976, March 1978

Year	*Melbourne*	*Canberra*
May 1973	25	—
December 1975	12	17
December 1976	13	12
March 1978	11	8

The percentage of static belt wearers who have the buckle incorrectly located is decreasing with time. A chi-square test to compare buckle location (on the abdomen versus off the hip plus those in between) showed the decreases to be highly significant

for both Melbourne and Canberra ($p<0.001$). The contribution to these differences of using different observers in each survey is not known.

This improvement is probably due to effects of ADR 4A and the increasing proportion of vehicles with static belts subject to this ADR. There may also have been some improvement resulting from publicity in Melbourne in May to July 1973, aimed at improving manner of wearing (Johnston and Cameron, 1979). However, effectiveness of such publicity was considered to be dependent on program intensity and duration with little long-term effect.

Inertia reel installations ensure that buckle location and sash tightness are automatically adjusted. Therefore, only webbing twist can be compared between these and static belts. For all lap-sash belts in use by front outboard occupants of all vehicles in Melbourne in March 1978 for which adjustment data were collected, 21 per cent (303 out of 1420) of static belts and 4 per cent (35 out of 999) of inertia reel belts observed had the sash twisted.

Of all static belts 43 per cent had the belt loose and 11 per cent had the buckle located on the user's abdomen.

Thus, 96 per cent of inertia reel belt wearers had their seat belt correctly adjusted, compared with 17 per cent of static belt wearers as indicated in Table 5. ADRs 4B and 4C have led to a massive improvement in the correctness of adjustment of seat belts.

Conclusions

Approximately 90 per cent of passenger car occupants occupy outboard seating positions.

For occupants aged at least eight years in outboard seating positions, at least 90 per cent in front seats and about 70 per cent in rear seats have a seat belt available for their use.

More front outboard seating position occupants aged at least eight years in Melbourne have a seat belt available, compared with Adelaide, Perth and Canberra. This is likely to be a result of Victoria's retro-fitting legislation.

At least 95 per cent of seat belts in front outboard positions are lap-sash belts. The overall wearing rate of lap-sash belts by front outboard occupants aged at least eight years is 83 per cent. The corresponding wearing rate in rear seat positions is 34 per cent. A low percentage (6 to 17 per cent) of static lap-sash belts are worn correctly adjusted (sash tight, sash not twisted and buckle beside the hip).

Seat belt availability and wearing rates in cars of different ages, hence complying with different Design Rules, were calculated for front outboard seating position occupants aged at least eight years observed in cars in Melbourne in March 1978. Thirty-eight per cent of lap-sash restraints available for use by these occupants were inertia reel belts. Eighty-five per cent of inertia reel belts were fitted in vehicles estimated to have been manufactured on or after 1 January 1975, that is, fitted in compliance with ADRs 4B, 5B and 4C.

The highest wearing rate in vehicles for which an estimate of age was available, was 91 per cent for inertia reel installations in the 1975 to 1978 vehicles. In vehicles estimated to have been manufactured prior to 1 January 1975 there was less difference between wearing rates for static and inertia reel belts, being 81 per cent and 83 per cent respectively.

Department of Transport surveys indicate that seat belt wearing rates of outboard seating position occupants aged at least eight years have been stable in Melbourne in the period from 1973 to 1978. This suggests that seat belts in newer vehicles, especially inertia reel installations, have higher wearing rates which are counterbalanced by lower wearing rates in older vehicles.

Wearing rates in other States have fluctuated more widely, due to factors such as level of enforcement and impact of publicity campaigns (Milne, 1979).

Overall, the net effect on wearing rates of ADRs 4A; 4B and 5B; and 4C cannot be isolated and it is not possible to estimate the future effect of increased availability of inertia reel installations on wearing rates.

Unfortunately, rear outboard seating position wearing rates are considerably lower, about 34 per cent. There are too few inertia reel belts available to rear seat occupants at present to enable any definite conclusions to be made on the wearing rates of different seat belt systems in rear seats. However, it is possible that wearing rates would increase if inertia reel belts became compulsory equipment in such seating positions.

An obvious advantage of inertia reel belts is that some 96 per cent of users of these belts have their belt correctly adjusted, compared with 17 per cent of static belt wearers. The total number of correctly adjusted seat belts will therefore increase over time as the proportion of vehicles on the road fitted with inertia reel belts increases.

Care needs to be exercised in the interpretation of the above conclusions since the procedure for estimating year of vehicle manufacture from blocks of registration numbers has been shown not to be completely satisfactory. While errors in this method could be reduced by matching registration numbers with Certificates of Registration, this was not possible in the current study.

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APPENDIX

Age distribution of cars and station wagons on the road

The sources used to obtain information on the age distribution of cars and station wagons on the road are the Motor Vehicle Censuses and Surveys of Motor Vehicle Usage conducted by the Australian Bureau of Statistics (ABS) in 1971 and 1976 (ABS 1973 a,b; 1978 a,b). Earlier Census and Survey results have not been considered in the following analysis due to the age of the results and doubts as to their reliability.

Data cover all States and Territories, in particular Victoria for the purpose of this study of improved seat belt systems.

Vehicle census

The vehicle censuses conducted for 30 September 1971 and 30 September 1976 (ABS 1973 a, 1978 a) give numbers of motor vehicles by type and year of model. The 1971 census explanatory notes state for year of model that 'particulars of age of vehicle are recorded in registration records in some States by year of model of vehicle, and in others, by year of manufacture'. Year of model is not defined, except to say that is is 'the term more commonly used in the motor vehicle industry'. No such comments are provided in the explanatory notes of the 1976 census. In the absence of other information, year of model as published has been equated to age of vehicle.

The census figures have been used to draw cumulative distributions of the ages of cars and station wagons in Victoria in 1971 and 1976. Because the 1976 census relates to a point part way through the year (30 September), 1976 vehicles have been taken as those up to 9 months (0.75 years) old, 1975 vehicles as 0.75 to 1.75 years old, etc. Similarly for the 1971 census, the 1971 vehicles have been taken as those up to 0.75 years old, etc. Table A1 (p. 18) shows large apparent discrepancies between new registrations in the first nine months of 1971 and 1976, and 1971 and 1976 model cars and station wagons in the census for Victoria (ABS; 1971 and 1976). The discrepancies could be due to re-registration, but recent work shows that they are unlikely to be due to scrappage, i.e. de-registration (Thoresen and Stella, 1977). As a result of Table A1 consideration was given to the use of new registrations in the first nine months of 1976 instead of the census 1976 vehicles but negligible changes in the cumulative distributions result.

The cumulative age distributions of cars and station wagons in single years of age (these would have been available directly had the census been conducted at year end) have been read off the cumulative distributions. The estimated single-year age distributions at 30 September 1971 and 30 September 1976 are shown in column (a) of Table A2 (p. 19). These are the age distributions of vehicles on the register in Victoria in 1971 and 1976.

Vehicle usage

A sample survey of vehicle usage (ABS, 1973b and 1978b) was conducted at the same time as each vehicle census. Owners of registered vehicles were asked to estimate the distance covered by their vehicle in the year ending 30 September or, if they did not own the vehicle for the whole of that year, in that part of the year for which they were the registered owner. The latter type of estimates were scaled up to annual estimates (365 days) by using the number of days in the part-year owned.

The 1971 survey showed a lower average annual distance travelled by the older cars and station wagons in Australia (Table 8 of ABS, 1973b). Unpublished data (held at the Victorian office of ABS) of a similar nature are available for Victoria for each survey, by selected vehicle age intervals. These data were used to plot the annual

average distance travelled by cars and station wagons, by vehicle age for Victoria. Data points were obtained after standardising by the annual average distance travelled by cars and station wagons in Victoria; to obtain an annual average distance travelled rate.

Each survey was taken at 30 September, thus not all vehicles will have been on the road for 12 months when surveyed. Considering the 1976 survey, the 1976 vehicles have been taken as being an average 4.5 months old, so that the estimate of distance travelled (per annum) is an estimate of the instantaneous performance rate of a 2.25 months old vehicle. Similarly, those 1976 vehicles first registered in the period 30 September to 31 December 1975 have been taken as having average age 0.875 years, so estimating the instantaneous performance of a 0.4375 years old vehicle. The remaining 1975 vehicles have been taken as 1.375 years average age, between the ages of 1 and 1.75 years, so estimating the instantaneous performance of a 0.875 years old vehicle. Hence, assuming uniform sales through 1975, the average annual mileage for 1975 vehicles has been taken as the instantaneous mileage rate of a vehicle aged 0.766 years (= 25% x 0.4375 + 75% x 0.875).

Plotting the data for earlier years of manufacture is simpler, since all such vehicles were registered at least 12 months before the time of the survey. For example 1970 to 1974 vehicles, have an average age of 4.25 years at 30 September 1976. The reported annual distance travelled of these vehicles is calculated on the basis of all vehicles performing the same average distance in the survey period 1.10.75 to 30.9.76 and the average age in this period is taken at 31.3.76. At 31.3.76, 1970 to 1974 vehicles are aged 1.25 to 6.25 years — the average being 3.75 years. So the average annual distance travelled for 1970 to 1974 vehicles at 30.9.76 is estimated by vehicles aged 3.75 years.

Average distance travelled by single year of age may be interpolated from the age-distance rates calculated by the preceding argument. For example, vehicles aged less than one year have an average annual distance travelled rate which is estimated by the mid-point of the age interval, that is, at six months. Note that this reasoning disregards the existence of any explicit survey period. The results of this interpolation are shown in column (b) of Table A2.

Vehicle age distribution

The product of columns (a) and (b) in Table A2 is an estimate of the age distribution of cars and station wagons performing on the road in September 1971 or 1976. This calculation (after re-scaling to sum to 100 per cent) is shown in column (c) of Table A2, for each of the two years. Column (d) is the cumulative age distribution of vehicles on the road for each year.

The 1978 results in columns (c) and (d) of Table A2 were derived from plotting the distribution of vehicle age as estimated from the registration numbers of cars observed in the Department of Transport restraint fitting and wearing survey conducted in that year. As the survey was conducted in March 1978 the 1978 vehicles are considered as being up to 0.2 years old, 1977 vehicles 0.2–1.2 years old and so on when observed. The cumulative age distribution in single years of age were interpolated and are shown in column (d) of Table A2.

Discussion

An average relative difference of 8 per cent is observed in the vehicle distribution by single year of age, of Victorian vehicles up to six years old, between 1971 and 1976 (See Table A2). With only two data points it is not possible to predict a distribution for vehicles on the road in 1978, although the data presented suggest an older vehicle population in 1976.

As shown in Table A2, the March 1978 restraint survey data suggest a younger

vehicle sample than that of 1971 or 1976. It should be noted that the 1971 and 1976 data are for cars and station wagons in Victoria, and the 1978 data are for passenger cars as defined on page 1 of the paper. An average relative difference of 20 per cent is observed in the vehicle distribution by single year of age, of victorian vehicles up to six years old, between 1976 and 1978. This may be due to sampling only Melbourne vehicles in the 1978 survey, bias from the use of registration numbers to estimate vehicle age, sampling from the right hand of the traffic stream, or attempting to select vehicles containing children. In addition, there is no means of confirming the validity of the ABS results, apart from the discrepancy observed in Table A1.

In the absence of any strictly reliable set of comparative data, no conclusions can be made regarding the representativeness of the vehicles observed in Melbourne in March 1978. It is likely, however, that the method used in the survey to estimate vehicle age is inaccurate. This conclusion is supported by the distribution of seat belt types by vehicle age data presented on page 9 of the report, in particular the observance of static belts in vehicles whose estimated age would indicate that inertia reel belts should have been provided and vice versa.

Table A1: Numbers of 1971 and 1976 cars and station wagons newly registered and in vehicle census: Victoria

New registrations:	1971	81 246
1 January to 30 September	1976	90 835
Vehicle census at	1971	76 450
30 September for model year	1976	84 065
Apparent discrepancy in	1971	–5.9%
census	1976	–7.5%

Source: Australian Bureau of Statistics (1971, 1973a, 1976, 1978a).

Table A2: Age distribution of vehicles on the road, Victoria, 1971 and 1976, Melbourne, 1978

Vehicle age (years)	*Age distribution of registered vehicles, Victoria (%) (a)*		*Mileage performance rate, Victoria (b)*		*Age distribution of vehicles on the road (c) = (a) x (b)*			*Cumulative age distribution on the road (d)*		
	1971	*1976*	*1971*	*1976*	*1971*	*1976*	*1978*	*1971*	*1976*	*1978*
less than 1	9.3	7.9	1.36	1.30	12.6	10.2	12.9	12.6	10.2	12.9
1	9.8	8.6	1.25	1.32	12.3	11.2	13.7	24.9	21.4	26.6
2	9.3	8.5	1.17	1.21	10.9	10.1	10.8	35.9	31.5	37.4
3	8.6	8.1	1.08	1.09	9.3	8.7	9.8	45.1	40.2	47.2
4	7.9	7.3	1.04	1.03	8.2	7.5	8.5	53.3	47.7	55.7
5	7.4	7.4	1.01	0.99	7.5	7.3	7.5	60.8	55.0	63.2
6	7.8	7.5	0.98	0.95	7.7	7.1	6.0	68.5	62.1	69.3
7	7.5	6.8	0.95	0.91	7.1	6.1	6.0	75.6	68.2	75.3
8	6.5	6.2	0.91	0.86	5.9	5.3	5.1	81.5	73.5	80.4
9	5.2	5.5	0.86	0.87	4.5	4.7	4.5	86.0	78.2	85.0
10	4.0	4.9	0.80	0.88	3.2	4.3	3.3	89.2	82.5	88.2
11	4.6	5.2	0.74	0.92	3.4	4.6	3.2	92.5	87.1	91.4
12	3.1	4.1	0.68	0.94	2.1	3.7	2.5	94.6	90.8	93.8
13	2.3	2.7	0.62	0.89	1.4	2.5	2.1	96.1	93.3	96.0
14	1.8	2.6	0.60	0.81	1.1	2.3	1.5	97.1	95.6	97.5
15	1.4	1.9	0.59	0.73	0.8	1.5	1.0	98.0	97.1	98.5
16	0.8	1.6	0.58	0.65	0.5	1.2	0.5	98.4	98.3	99.0
17 *plus*	2.8	3.2	0.56	0.58	1.6	1.7	1.0	100.0	100.0	100.0
All ages	100	100			100	100	100			