Synthesis title:

Tyres

Category: Vehicles

About the Road Safety Observatory

The Road Safety Observatory aims to provide free and easy access to independent road safety research and information for anyone working in road safety and for members of the public. It provides summaries and reviews of research on a wide range of road safety issues, along with links to original road safety research reports.

The Road Safety Observatory was created as consultations with relevant parties uncovered a strong demand for easier access to road safety research and information in a format that can be understood by both the public and professionals. This is important for identifying the casualty reduction benefits of different interventions, covering engineering programmes on infrastructure and vehicles, educational material, enforcement and the development of new policy measures.

The Road Safety Observatory was designed and developed by an Independent Programme Board consisting of key road safety organisations, including:

- Department for Transport
- The Royal Society for the Prevention of Accidents (RoSPA)
- Road Safety GB
- Parliamentary Advisory Council for Transport Safety (PACTS)
- RoadSafe
- RAC Foundation

By bringing together many of the key road safety governmental and non-governmental organisations, the Observatory hopes to provide one coherent view of key road safety evidence.

The Observatory originally existed as a standalone website, but is now an information hub on the RoSPA website which we hope makes it easy for anyone to access comprehensive reviews of road safety topics.

All of the research reviews produced for the original Road Safety Observatory were submitted to an Evidence Review Panel (which was independent of the programme Board), which reviewed and approved all the research material before it was published to ensure that the Key Facts, Summaries and Research Findings truly reflected the messages in underlying research, including where there may have been contradictions. The Panel also ensured that the papers were free from bias and independent of Government policies or the policies of the individual organisations on the Programme Board.

The Programme Board is not liable for the content of these reviews. The reviews are intended to be free from bias and independent of Government policies and the policies of the individual organisations on the Programme Board. Therefore, they may not always represent the views of all the individual organisations that comprise the Programme Board.

Please be aware that the Road Safety Observatory is not currently being updated; the research and information you will read throughout this paper has not been updated since 2017. If you have any enquiries about the Road Safety Observatory or road safety in general, please contact **help@rospa.com** or call **0121 248 2000**.

How do I use this paper?

This paper consists of an extensive evidence review of key research and information around a key road safety topic. The paper is split into sections to make it easy to find the level of detail you require. The sections are as follows:

Key Facts	A small number of bullet points providing the key facts about the topic, extracted from the findings of the full research review.
Summary	A short discussion of the key aspects of the topic to be aware of, research findings from the review, and how any pertinent issues can be tackled.
Methodology	A description of how the review was put together, including the dates during which the research was compiled, the search terms used to find relevant research papers, and the selection criteria used.
Key Statistics	A range of the most important figures surrounding the topic.
Research Findings	A large number of summaries of key research findings, split into relevant subtopics.
References	A list of all the research reports on which the review has been based. It includes the title, author(s), date, methodology, objectives and key findings of each report, plus a hyperlink to the report itself on its external website.

The programme board would like to extend its warm thanks and appreciation to the many people who contributed to the development of the project, including the individuals and organisations who participated in the initial consultations in 2010.

TYRES: KEY FACTS

- Tyres are the vehicle's only point of contact with the road. The actual area of contact between the car and the road through the tyres is small.

- Tyres must be correctly inflated to the manufacturer's specification for the purpose for which the vehicle is being used, and be free from cuts and other defects.

- Tyres on cars, light vans and light trailers must have a tread depth of at least 1.6mm across the centre three-quarters of the tyre and around its entire circumference. For motorcycles, large vehicles and passenger carrying vehicles, the minimum tread depth is 1mm. Mopeds should have visible tread.

- The condition of a vehicle's tyres is an important safety factor: tyres with insufficient tread depth may affect stopping distances and grip on the road. Incorrect tyre pressures can affect braking and steering and may cause premature tyre failure. Damaged tyres are more likely to suffer punctures or blow-outs.

- In 2016, 8 people were killed, 150 seriously injured and there were 876 road casualties in total in reported road accidents in Great Britain in which illegal, defective or under inflated tyres were recorded as a contributory factor by the police officers investigating the scene. (RRCGB, DfT, 2017)

- In 2012/13, 7.7% of cars, 3.8% of large passenger vehicles, and 7.2% of goods vehicles failed the MoT test due to a fault with their tyres, or only passed the test after a tyre defect was rectified. Also, 3.5% of motorcycles failed the MoT test due to a fault with their tyres or wheels, or only passed the test after a tyre or wheel defect was rectified.

- Lower tyre tread depths increase stopping distances in wet conditions on both asphalt and concrete surfaces.

- Regular tyre pressure checks have been associated with reducing the likelihood of being seriously injured in a crash

- In Scandinavian countries, studded tyres resulted in minor declines in automobile accident rates of 5% on snow or ice covered roads, 2% on dry and wet roads, and 4% on all road surfaces combined. They are not normally legal to use in the UK.

- Tyre pressure monitoring systems (TPMS) are an electronic system to monitor the air pressure inside tyres and alert the driver if the pressure falls below a pre-set parameter.

- Under European Union Regulation (EC) 661/2009 all new models of passenger cars must be fitted with a tyre pressure monitoring system from 1 November 2012, and all new vehicles in the European Union must be fitted with tyre pressure monitoring system from 1 November 2014.

- No research was found which compared accident rates between vehicles with and without central European winter tyres

TYRES: SUMMARY

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- Tyres must be correctly inflated to the vehicle manufacturer's specification for the purpose for which the vehicle is being used, and be free from cuts and other defects. Tyres on cars, light vans and light trailers must have a tread depth of at least 1.6mm across the centre three-quarters of the tyre and around its entire circumference.

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- The condition of a vehicle's tyres is an important safety factor: tyres with insufficient tread depth have longer stopping distances and less grip on the road, incorrect tyre pressures can affect braking and steering and may cause premature tyre failure. Damaged tyres are more likely to suffer punctures or blow-outs.

- In 2016, 8 people were killed, 150 seriously injured and there were 876 road casualties in total in reported road accidents in Great Britain in which illegal, defective or under inflated tyres were recorded as a contributory factor by the police officers investigating the scene. (RRCGB, DfT, 2017)

- Over the 5 year period from 2012 to 2016, 96 people were killed in accidents in which the police judged the condition of tyres to be a contributory factor. (RRCGB, DfT, 2017)

In 2012/13:

- 3.5% of motorcycles either failed their MoT due to a tyre or wheel fault, or passed their MoT after a fault with the tyres or wheels was corrected. This figure appears to have remained fairly consistent over time.

- 7.7% of cars and passenger vehicles with less than 12 seats failed the MoT test on their first attempt due to a fault with the tyre, or passed their MoT after a fault with the tyres or wheels was corrected. This proportion appears to have decreased since 2007/08.

- There was a lower failure rate for passenger vehicles with more than 12 seats of 3.8%, a rate which has been consistently since 2007/08.

- 7.2% of goods vehicles weighing between 3,000 and 3,500kg failed the MoT test, or passed their MoT after a fault with the tyres or wheels was corrected, due to a failure with the tyres. This rate has fallen slightly since 2007/08.

- Lower tyre tread depths increase stopping distances in wet conditions on both asphalt and concrete surfaces. On a hot rolled asphalt surface, stopping distance from 80 kph increased from 23.89 metres for a car with 6.7mm tyre tread depth to 36.56 metres for a car with 0.9mm tread depth.

- On a smooth concrete surface, the stopping distance increased from 28.81 metres for a car with 6.7mm tyre tread depth to 49.08 metres for a car with 0.9mm tread depth

- Regular tyre pressure checks have been associated with reduced odds of being seriously injured in a crash. In one study, drivers who had recently checked their tyre pressures were less 4 times less likely to be involved in a crash.

- In Scandinavian countries, studded tyres resulted in minor declines in automobile accident rates of 5% on snow or ice covered roads, 2% on dry and wet roads, and 4% on all road surfaces combined. They are not normally legal to use in the UK.

- Tyre pressure monitoring systems (**TPMS**) are an electronic system to monitor the air pressure inside tyres and alert the driver if the pressue falls below a pre-set parameter.

- Under European Union Regulation (EC) 661/2009 all new models of passenger cars must be fitted with a tyre pressure monitoring system from 1 November 2012, and all new vehicles in the European Union must be fitted with tyre pressure monitoring system from 1 November 2014.

- No research was found which compared accident rates between vehicles with and without central European winter tyres

- The literature search did not identify any published research studies about the effects of tyre aging, mixing tyre types or using run-flat tyres on crash risk.

METHODOLOGY

A description of the methodological approach to all of the research reviews on the Road Safety Observatory is available at http://www.roadsafetyobservatory.com/Introduction/Methods.

This review was compiled during December 2012 and January 2013, and updated in April 2014.

Note

This review includes statistics from Reported Road Casualties Great Britain 2012, which were the latest available data when the review was written. In December 2017, statistics from Reported Road Casualties Great Britain were updated to Reported Road Casualties Great Britain 2016.

Identification of relevant research

Searches were carried out on pre-defined research (and data) repositories. Search terms used to identify relevant papers included but were not limited to:

- "Tyre"
- "Tire"
- "Stopping distance"
- "Winter Tyres"
- "Winter Tires"

A total of 19 pieces of potentially relevant research were identified.

Initial review of research

This primarily involved sorting the research items based on key criteria, to ensure the most relevant and effective items went forward for inclusion in this review. Key criteria included:

- Relevance: whether the research makes a valuable contribution to this synthesis, for example robust findings from a hospital-based study.
- Provenance: whether the research is relevant to drivers, road safety policies or road safety professionals in the UK. If the research did not originate in the UK the author and expert reviewer have applied a sense check to ensure that findings are potentially relevant and transferable to the UK.
- Age: Priority is given to the most up to date titles in the event of over-lap or contradiction, although older research papers are included because much of the fundamental research took place as seat belts were being developed and used.
- Effectiveness: whether the research credibly proves (or disproves) the effectiveness of a particular road safety initiative or intervention.

Following the initial review, 11 pieces of research were taken forward to form the basis for this synthesis, 3 of which were published in the UK.

Detailed review of research

Key facts, figures and findings were extracted from the identified research to highlight pertinent road safety issues and interventions.

KEY STATISTICS

In 2012, 25 people were killed, 169 seriously injured and 1,044 slightly injured in road accidents in Great Britain in which illegal, defective or under inflated tyres were regarded as being a contributory factor by the police officers investigating the scene.

(DfT, 2013)

Over the 5 year period from 2008 to 2012, 127 people were killed in accidents in which the police judged the condition of the vehicle tyres to have been a contributory factor.

(DfT, 2008 – 2013)

Table 1: Reported Injury Accidents and Casualties Involving Illegal, Defective or Under Inflated Tyres, 2008 to 2012, Great Britain.

	2008	**2009**	**2010**	**2011**	**2012**
Accidents					
Fatal	34 (2%)	17 (1%)	15 (1%)	26 (2%)	22 (1%)
Serious	171 (1%)	165 (1%)	144 (1%)	140 (1%)	140 (1%)
All	928 (1%)	860 (1%)	746 (1%)	709 (1%)	765 (1%)
Casualties					
Fatal	36 (2%)	20 (1%)	18 (1%)	28 (2%)	25 (2%)
Serious	228 (1%)	196 (1%)	172 (1%)	177 (1%)	169 (1%)
Slight	1,168 (1%)	1,168 (1%)	1,020 (1%)	931 (1%)	1,044 (1%)

Around 2% of fatal road accidents and casualties over this period had tyre defects recorded as a contributory factor, as did around 1% of serious and slight injury reported accidents and casualties.

(DfT, 2008 – 2013)

The police system for recording contributory factors is based on the judgement of the officer attending the scene of the accident, and is not necessarily the result of an extensive investigation. Neither the nature of the tyre defect nor the chain of events that led to the defect are captured in this data.

Note
This review includes statistics from Reported Road Casualties Great Britain 2012, which were the latest available data when the review was written. In December 2017, statistics from Reported Road Casualties Great Britain were updated to Reported Road Casualties Great Britain 2016.

MoT Failures Due to Tyre Defects

The proportion of cars and goods vehicles between 3,000 and 3,500 kg gross weight that fail MOT tests due to tyre defects, or only pass after a tyre defect has been rectified, is about twice as high as passenger carrying vehicles and motorcycles.

In 2012/13, the proportion of vehicles that either failed their MoT due to a tyre fault, or passed their MoT after a fault with the tyres was corrected, was:

7.7% of cars
3.8% of passenger carrying vehicles
7.2% of goods vehicles (between 3,000 and 3,500 kg)
3.5% of motorcycles (tyres and wheels)

These figures do not include goods vehicles over 3,500 kg)

(TSGB, 2013)

The proportion of cars that fail an MOT due to a tyre defect, or pass only after a tyre defect has been rectified, has fallen over time, from 9.1% in 2007/08 to 7.7% in 2012/13.

The proportion of passenger carrying vehicles that fail an MOT due to a tyre defect, or pass only after a tyre defect has been rectified, has remained steady over time. It was 3.6% in 2007/08 and 3.8% in 2012/13.

The proportion of goods vehicles weighing between 3,000 and 3,500kg that fail an MOT due to a tyre defect, or pass only after a tyre defect has been rectified, has fallen slightly over time, from 8.1% in 2007/08 to 7.2% in 2012/13.

The proportion of motorcycles that fail an MOT due to a tyre or wheel defect, or pass only after a tyre or wheel defect has been rectified, has remained steady over time. It was 3.7% in 2007/08 and 3.5% in 2012/13.

(TSGB 2013)

Table 2: Percentage of vehicles failing the MoT test, or passing after an initial tyre fault was rectified by vehicle type and financial year

	2007/08	**2008/09**	**2009/10**	**2010/11**	**2011/12**	**2012/13**
Motorcycles	3.7%	3.8%	3.8 %	3.6 %	3.6 %	3.5%
Cars and other passenger vehicles (up to 12 seats)	9.1%	9.2%	9.0 %	8.0%	7.8%	7.7%
Private passenger vehicles (more than 12 seats)	3.6%	3.9%	3.9 %	3.7 %	3.7 %	3.8%
Goods vehicles between 3,000 and 3,500 kg gross weight	8.1%	8.0%	7.9 %	7.4%	7.2%	7.2%

(TSGB, 2013)

THE LAW

Section 27 of The Construction and Use Regulations 1986 sets out the main legal requirements for tyres, stating when tyres are illegal for use on the road:

- the tyre is unsuitable having regard to the use to which the motor vehicle or trailer is being put or to the types of tyres fitted to its other wheels;

- the tyre is not so inflated as to make it fit for the use to which the motor vehicle or trailer is being put;

- the tyre has a cut in excess of 25 mm or 10% of the section width of the tyre, whichever is the greater, measured in any direction on the outside of the tyre and deep enough to reach the ply or cord;

- the tyre has any lump, bulge or tear caused by separation or partial failure of its structure;

- the tyre has any of the ply or cord exposed;

- the base of any groove which showed in the original tread pattern of the tyre is not clearly visible;

- either—

    - the grooves of the tread pattern of the tyre do not have a depth of at least 1.6 mm throughout a continuous band measuring at least three-quarters of the breadth of the tread and round the entire outer circumference of the tyre; or
    - if the grooves of the original tread pattern of the tyre did not extend beyond three-quarters of the breadth of the tread, any groove which showed in the original tread pattern does not have a depth of at least 1.6 mm; or

- the tyre is not maintained in such condition as to be fit for the use to which the vehicle or trailer is being put or has a defect which might in any way cause damage to the surface of the road or damage to persons on or in the vehicle or to other persons using the road.

The minimum tread legal depth tread depth was increased to 1.6 mm by The Road Vehicles (Construction and Use) (Amendment) (No. 4) Regulations 1990.

RESEARCH FINDINGS

Tyre Tread

Tyre treads are designed to pump water from the road surface and provide maximum grip. In order to be legal, a car tyre's tread must be 1.6mm deep across the centre three-quarters of the tyre and around its entire circumference. By the time the tread is worn down to the legal limit they will be unable to perform this task efficiently and MUST be replaced.

The British Rubber Manufacturer's Association commissioned MIRA to carry out tests on tread depth and a vehicle's adhesion with the road in the wet. Two sets of experiments were performed:

- Measuring the straight line braking distance of a typical passenger car in the wet, at five different tread depths
- Measuring the cornering performance of the same car in the wet, at the same five tread depths.

The study was carried out on an off-road test track. The tread depths used were 6.7mm, 4.1mm, 2.6mm, 1.6mm (the legal minimum), and 0.9mm. The tests were carried out on both hot rolled asphalt and smooth concrete, and were repeated several times. The stopping distance from 80kmph was recorded at each of these tread depths.

On the hot rolled asphalt surface, the stopping distance increased from 23.89 metres for the car with 6.7mm tyre tread depth to 36.56 metres for the car with 0.9mm tread depth.

On the smooth concrete surface, the stopping distance increased from 28.81 metres for the car with 6.7mm tyre tread depth to 49.08 metres for the car with 0.9mm tread depth.

Table 3: The stopping distance of tyres of 5 different tread depths on hot rolled asphalt and smooth concrete surfaces

	Stopping Distance (m) on	
Tyre Tread Depth (mm)	Hot rolled asphalt	Smooth concrete
6.7	23.89	28.81
4.1	24.28	33.33
2.6	27.65	36.58
1.6	32.69	41.67
0.9	36.56	49.08

The stopping distance is different for the two road surfaces due to the differing co-efficients of friction of the two surfaces.

(BRMA 2003)

Cornering performance was tested with the steering wheel and acceleration set at fixed – 'steady state' – positions. The track used was a short continuous loop of fixed radius, so the skill level of the driver should not have influenced the results.

The mean lap time varied from 19.8s with a 6.7mm tread depth, to 22.8s with a 0.9mm tread depth. This was due to the reduced adhesion with the road of the tyres with lower tread depths. The instrumentation indicated that the 0.9mm tread depth tyre only achieved 73% of the lateral acceleration of the tyre with 6.7mm tread depth.

Research has found an association between lower tyre tread depths and an increased risk of collision. The tread depths from 898 vehicles which were involved in accidents with utility poles in Melbourne between 7 July 1976 and 7 March 1977 were compared with the tread depths of 627 vehicles in petrol stations in the same area.

The risk of being involved in a collision remained constant until vehicle tread depths dropped below 3mm. Vehicles with tread depths of 1.6mm were 3 times more likely to be involved in a collision in the dry and 3.5 times more likely to be involved in a collision in the wet. The risk increased at lower tread depths. This same relationship was seen for tyre tread depths on the front and rear of the vehicle.

However, there was no statistically significant difference between the relative risk of an accident between wet and dry conditions, whereas the expected result would be a difference in risk in wet and dry conditions. The study did not examine or control for any confounding factors, which are the potential other explanations why vehicles with lower tread depths were more at risk of an accident.

(Fox et al 1979)

Tyre Pressure

The law requires that the tyre pressures should be suitable for the vehicle or trailer on which they are being used.

Vehicle manufacturers specify the tyre pressures for their vehicles in different conditions. This typically varies if the vehicle is heavily loaded – for instance, if there are 5 adult passengers in the vehicle.

A report by TUV Automotive summarised some of the effects of over inflation and under inflation:

- Over-inflation increases overall tyre diameter, decreases the amount of tread in contact with the road, decreases sidewall flexibility, and affects road-adhesion.
- Under-inflation decreases overall tyre diameter, increases sidewall flexion, generates higher tyre operating temperatures and difficult vehicle handling characteristics. Running an under-inflated tyre may cause premature tyre failure.
- Both over and under-inflation adversely affect tyre life

Regular tyre checks have been associated with the reduced likelihood of being seriously injured in a crash. 571 drivers or occupants in a collision where at least one occupant was hospitalised were interviewed and the time of the most recent tyre pressure checks was ascertained. This was compared against the most recent tyre pressure check for 588 drivers in cars randomly selected on New Zealand's roads.

(Blows et al, 2003)

The likelihood of having had a recent tyre pressure check within the last 3 months were 4 times higher for vehicles that had not been involved in a crash. In other words, drivers who had recently checked their tyre pressures were four times less likely to be involved in a crash. This finding had been adjusted to control for alternative explanations such as for differences in driver age, sex, ethnicity, seatbelt use, licence type, self-reported speed, and hours per week of driving exposure between the two groups.

Tyre pressure monitoring systems (**TPMS**) are an electronic system to monitor the air pressure inside tyres and alert the driver if the pressue falls below a pre-set parameter.

Under European Union Regulation (EC) 661/2009 all new models of passenger cars must be fitted with a tyre pressure monitoring system from 1 November 2012, and all new vehicles in the European Union must be fitted with tyre pressure monitoring system from 1 November 2014.

(EC 661/2009)

The requirements for tyre pressure monitoring systems are defined in ECE Regulation No. 64.02, and include technical requirements for the tyre pressure monitoring system and test procedures for determining compliance.

(UNECE Regulation 64.02, 2010)

Tyre Aging

Rubber compounds used in tyres contain anti-oxidising chemicals that help to slow down the natural aging process of untreated rubber. However, tyres do deteriorate with age, which increases the risk of tyre failure, and there are many ways in which this can be spotted:

- Cracking/crazing on the side wall of the tyre, caused by its flexing
- Distortion of tyre tread
- Deformation of the carcass of the tyre

There will also be a deterioration of the ride quality caused by vibrations through the tyre. This may signify the tyre's performance has been affected by age and should be investigated as soon as possible.

All tyres that display signs of aging should be removed and not put to further use.

Tyres that have been in storage should not be placed into use if they are over 6 years old, from their date of manufacture. When a tyre has been in use, the effects of aging are lessened to a degree, but such tyres should be replaced after 10 years.

The effects of aging can be brought about prematurely in several conditions. Tyres fitted as spare wheels or used on caravans and trailers may age prematurely. If tyres on caravans or trailers are not in regular use, then they should be inspected before every journey. Tyres used predominantly in coastal areas will age at a greater rate due to the saline conditions, and several cleaning products may also harm the chemicals in the rubber.

The literature search did not identify any published research studies about the effects of tyre aging on crash risk.

Tyre Types

It is illegal to mix tyres of different types of tyres (cross-ply; bias belted or radial) on the same axle.

Cross-ply and bias-belted tyres are seldom used on production cars, and are not widely available in the UK. Cross-ply and radial tyres should never be mixed on the same axle of a vehicle. Where a mix is necessary, radial tyres MUST only ever be used on the rear axle and cross-ply tyres on the front. This mix of tyres will produce 'understeer' (in which the vehicle turns at less of an angle than it is steered) whereas the opposite will produce 'oversteer' (in which the vehicle turns more tightly into a corner than it is steered). Of the two conditions, understeer is generally accepted to be easier to control.

Motor vehicle manufacturers choose the type, make, size, profile, load carrying capacities and speed ratings to match their vehicles' ride and performance and advise which tyres are appropriate for their vehicles.

The literature search did not identify any published research studies about the effects of mixing tyre types on crash risk.

Run-flat Tyres

In conventional tyres, the pressurised air contained within the tyre supports the weight of the car. However, recently tyres have been developed which are able to support the weight of the car by themselves, for a short period of time.

In everyday operating conditions, run-flat tyres work like conventional tyres. They still contain air; to reduce the load that the run-flat system has to bear, to spread the weight of the vehicle evenly on the road surface, and to maximise the contact patch between the car and the road.

The advantage of run-flat tyres is that they can operate without air in them, for a relatively short distance and at low speeds, as their basic shape is kept by rigid components. This rigidity helps a driver to maintain control of the vehicle if the tyre loses pressure, and removes the need to change a tyre immediately.

When punctured and deflated, run-flat tyres are not designed to run for long distances or at high speeds. Tyre manufacturers stipulate the maximum speed and distance for each tyre.

As many run-flat tyres offer good ride comfort whist deflated, it can be hard for the driver to feel that a tyre is deflated. In order to detect a deflated run-flat tyre, vehicles need to be fitted with a Tyre Pressure Monitoring System (TPMS).

The literature search did not identify any published research studies about the effects of run-flat tyres on crash risk.

Winter Tyres

Modern winter tyres are available in the UK and are based on a softer silica compound than regular tyres. This allows the tyres to retain more elasticity in the cold allowing them to key into the road surface more effectively than regular tyres. This grip should allow shorter stopping distances in colder weather.

There is a distinction between ‘Central European’ and ‘Scandinavian’ winter tyres, although some manufacturers refer to the Central European make of winter tyres as ‘Cold Weather tyres’.

Both of these types of winter tyres differ in design from regular summer tyres. Although there is no industry definition or written consensus of the difference, there are design differences between regular (summer) tyres and winter tyres:

- Firstly the compound used in the tyre behaves more elastically at temperatures below 7°C, which creates greater adhesion between the tyre and road surface at colder temperatures.

- Secondly, the tyres have a different tread pattern, which is designed to be more suitable for the typical weather conditions.

The literature search did not identify any published research studies that compared accident rates between vehicles with and without central European winter tyres.

A meta-analysis of 12 studies of winter tyres conducted in Scandinavian countries between 1971 and 1997 found that studded tyres resulted in minor reductions in accident rates of 5% on snow or ice covered roads, 2% on dry and wet roads and 4% on all road surfaces combined. However, the findings were not statistically significant and so it cannot be ruled out statistically that they were due to chance.

(Elvik et al, 2009)

Another paper by the same author expanded on the detail provided in the handbook and discussed the striking variations in the results of the various evaluation studies. On snow and ice covered roads, the range of best estimates varied from a reduction of 72% to a reduction of 4%. On all surface conditions, the best estimates ranged from a 70% decline to 10% increase in accident rates.

(Elvik, 1999)

The differences between the study findings were reflective of significant differences in the way that the studies were designed and differences between the two groups being compared. Numerous factors that could have altered the effectiveness were found; poorly conducted studies tended to predict the large statistically significant decreases in accident rates amongst vehicles fitted with studded tyres.

However, studded tyres are not normally legal to use in the UK.

How Effective?

- Tyres are a crucial component of a vehicle's safety system. They are the vehicle's only point of contact with the road, and must be in a legal condition in order to perform properly.
- There is relatively little data about the number of accidents or casualties caused by tyres in poor condition, but the Police Contributory Factors database indicates that over the 5 year period from 2012 to 2016, 96 people were killed in accidents in which the police judged the condition of the vehicle tyres to have been a contributory factor (RRCGB, DfT, 2017).
- In 2012/13, 7.7% of cars, 3.8% of large passenger vehicles, and 7.2% of goods vehicles failed the MoT test due to a fault with their tyres, or only passed the test after a tyre defect was rectified. Also, 3.5% of motorcycles failed the MoT test due to a fault with their tyres or wheels, or only passed the test after a tyre or wheel defect was rectified.
- Lower tyre tread depths increase stopping distances in wet conditions on both asphalt and concrete surfaces.
- Regular tyre pressure checks have been associated with reduced odds of being seriously injured in a crash
- In Scandinavian countries, studded tyres resulted in minor declines in automobile accident rates of 5% on snow or ice covered roads, 2% on dry and wet roads, and 4% on all road surfaces combined. However, no research was found which compared accident rates between vehicles with and without central European winter tyres, and studded tyres are not normally legal to use in the UK.

TYRES: REFERENCES

Title:	**Contributory Factors to Reported Road Accidents 2012** (in Reported Road Casualties Great Britain 2012)
Author:	Department for Transport
Published:	Department for Transport, 2013
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/269601/rrcgb-2012-complete.pdf
Objectives:	To provide insight into why and how road accidents occur.
Methodology:	Analysis of contributory factors assigned to reported road accidents by police officers attending the accident scenes.

Key Findings:

In 2012:

25 people were killed, 169 seriously injured and 1,044 slightly injured in road accidents in Great Britain in which illegal, defective or under inflated tyres were regarded as being a contributory factor by the police officers investigating the scene.

34 fatal accidents, 171 serious accidents and 928 reported road accidents in total Involved Illegal, Defective or Under Inflated Tyres.

Over the 5 year period from 2008 to 2012, 127 people were killed in accidents in which the police judged the condition of the vehicle tyres to have been a contributory factor.

	2008	**2009**	**2010**	**2011**	**2012**
Accidents					
Fatal	34 (2%)	17 (1%)	15 (1%)	26 (2%)	22 (1%)
Serious	171 (1%)	165 (1%)	144 (1%)	140 (1%)	140 (1%)
All	928 (1%)	860 (1%)	746 (1%)	709 (1%)	765 (1%)
Casualties					
Fatal	36 (2%)	20 (1%)	18 (1%)	28 (2%)	25 (2%)
Serious	228 (1%)	196 (1%)	172 (1%)	177 (1%)	169 (1%)
Slight	1,168 (1%)	1,168 (1%)	1,020 (1%)	931 (1%)	1,044 (1%)

- Around 2% of fatal road accidents and casualties over this period had tyre defects recorded as a contributory factor, as did around 1% of serious and slight injury reported accidents and casualties.

- Contributory factors are largely subjective, reflecting the opinion of the reporting police officer, and are not necessarily the result of extensive investigation. Some factors are less likely to be recorded. Subsequent enquiries could lead to the reporting officer changing his/her opinion.

Format: Pdf	Cost: Free
Themes:	Tyres, tyre defects

Title:	**Reported Road Casualties Great Britain 2013**
Author:	Department for Transport
Published:	Department for Transport, 2014
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/359311/rrcgb-2013.pdf
Objectives:	To provide insight into why and how road accidents occur.
Methodology:	Analysis of contributory factors assigned to reported road accidents by police officers attending the accident scenes.

Key Findings:

In 2013:

18 people were killed, 158 seriously injured and 792 slightly injured in road accidents in Great Britain in which illegal, defective or under inflated tyres were regarded as being a contributory factor by the police officers investigating the scene.

17 fatal accidents, 122 serious accidents and 517 reported road accidents in total involved Illegal, Defective or Under Inflated Tyres.

Over the 6 year period from 2008 to 2013, 145 people were killed in accidents in which the police judged the condition of the vehicle tyres to have been a contributory factor.

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Accidents						
Fatal	34 (2%)	17 (1%)	15 (1%)	26 (2%)	22 (1%)	17 (1%)
Serious	171 (1%)	165 (1%)	144 (1%)	140 (1%)	140 (1%)	122 (1%)
All	928 (1%)	860 (1%)	746 (1%)	709 (1%)	765 (1%)	517 (1%)
Casualties						
Fatal	36 (2%)	20 (1%)	18 (1%)	28 (2%)	25 (2%)	18 (1%)
Serious	228 (1%)	196 (1%)	172 (1%)	177 (1%)	169 (1%)	158 (1%)
Slight	1,168 (1%)	1,168 (1%)	1,020 (1%)	931 (1%)	1,044 (1%)	792 (1%)

- Around 1% of fatal road accidents and casualties over this period had tyre defects recorded as a contributory factor, as did around 1% of serious and slight injury reported accidents and casualties.

- Contributory factors are largely subjective, reflecting the opinion of the reporting police officer, and are not necessarily the result of extensive investigation. Some factors are less likely to be recorded. Subsequent enquiries could lead to the reporting officer changing his/her opinion.

Format: Pdf	Cost: Free
Themes:	Tyres, tyre defects

Title:	**Reported Road Casualties Great Britain 2014**
Author:	Department for Transport
Published:	Department for Transport, 2015
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/463797/rrcgb-2014.pdf
Objectives:	To provide insight into why and how road accidents occur.
Methodology:	Analysis of contributory factors assigned to reported road accidents by police officers attending the accident scenes.

Key Findings:

In 2014:

28 people were killed, 196 seriously injured and 901 slightly injured in reported road accidents in Great Britain in which illegal, defective or under inflated tyres were recorded as a contributory factor by the police officers investigating the scene.

22 fatal accidents, 146 serious accidents and 546 reported road accidents in total involved Illegal, Defective or Under Inflated Tyres,

Over the 6 year period from 2009 to 2014, 137 people were killed in accidents in which the police judged the condition of the vehicle tyres to have been a contributory factor.

	2009	**2010**	**2011**	**2012**	**2013**	**2014**
Accidents						
Fatal	17 (1%)	15 (1%)	26 (2%)	22 (1%)	17 (1%)	22 (1%)
Serious	165 (1%)	144 (1%)	140 (1%)	140 (1%)	122 (1%)	146 (1%)
All	860 (1%)	746 (1%)	709 (1%)	765 (1%)	517 (1%)	546 (1%)
Casualties						
Fatal	20 (1%)	18 (1%)	28 (2%)	25 (2%)	18 (1%)	28 (2%)
Serious	196 (1%)	172 (1%)	177 (1%)	169 (1%)	158 (1%)	196 (1%)
All	1,168 (1%)	1,020 (1%)	931 (1%)	1,044 (1%)	792 (1%)	901 (1%)

- Around 1% of fatal road accidents and casualties over this period had tyre defects recorded as a contributory factor, as did around 1% of serious and slight injury reported accidents and casualties.

- Contributory factors are largely subjective, reflecting the opinion of the reporting police officer, and are not necessarily the result of extensive investigation. Some factors are less likely to be recorded. Subsequent enquiries could lead to the reporting officer changing his/her opinion.

Format: Pdf	Cost: Free
Themes:	Tyres, tyre defects

Title:	**Studded tyres, in The Handbook of Road Safety Measures**
Author:	Rune Elvik, Alena Høye, Truls Vaa and Michael Sørensen
Published:	The Handbook of Road Safety measures, 2009
Link:	Unavailable online
Objectives:	To identify the best estimate of the effectiveness of studded tyres in preventing injury.
Methodology:	Meta analysis of 12 studies of studded tyres
Key Findings: Studded tyres resulted in minor declines in automobile accident rates of • 5% on snow or ice covered roads, • 2% on dry and wet roads, and • 4% on all road surfaces combined.	
Format: book	**Cost:** priced
Themes:	Tyres, studded tyres, weather

Title:	**The effects on accidents of studded tires and laws banning their use: a meta-analysis of evaluation studies**
Author:	Rune Elvik
Published:	Accident Analysis and Prevention 31 (1999) 125-134
Link:	http://www.ncbi.nlm.nih.gov/pubmed/10084627
Objectives:	To identify the best estimate of the effectiveness of studded tyres in preventing injury and the limitations in the current literature
Methodology:	Literature review
Key Findings: Studded tyres resulted in minor declines in automobile accident rates of • 5% on snow or ice covered roads, • 2% on dry and wet roads, and • 4% on all road surfaces combined. The results of studies of the effects of studded tires on automobile accident rates are found to vary substantially, depending on the quality of the study design	
Format: pdf	**Cost: priced**
Themes:	Tyres, studded tyres, weather

Title:	**An investigation into the effects of tyre tread depth on wet road braking and cornering performance**
Author:	MIRA
Published:	The British Rubber Manufacturer's Association, 2003
Link:	Unavailable Online
Objectives:	Establish the influence of tyre tread on a vehicle's adherence in cornering and braking tests
Methodology:	Track testing
Key Findings: • Lower tyre tread depths increased stopping distances in wet conditions on both asphalt and concrete surfaces. • At lower tread depths a vehicle's cornering performance was reduced in wet conditions due to the reduced adhesion	
Format: pdf	**Cost:** Priced
Themes:	Tyres, tread depth, wet weather, stopping distances

Title:	**Does periodic vehicle inspection reduce car crash injury? Evidence from the Auckland Car Crash Injury Study**
Author:	Blows, Ivers, Connor, Ameratunga, Norton
Published:	Aust N Z J Public Health. 2003;27(3):323-7.
Link:	http://www.ncbi.nlm.nih.gov/pubmed/14712793
Objectives:	Study the association between periodic motor vehicle inspection and frequent tire pressure checks, and the risk of car crash injury.
Methodology:	Case control study comparing the service history of vehicles involved in a crash, with vehicles that had not.
Key Findings: • Inspection records and the date of the most recent tyre pressure check were collected from 571 vehicles involved in a crash and 588 randomly selected vehicles which had not. • The odds of a vehicles that had not had its tyre pressure checked being involved in a crash were 4.10 times greater (95% confidence interval 1.71 to 9.84).	
Format: pdf	**Cost: priced**
Themes:	Tyres, vehicle checks, tyre pressure

Title:	**Survey on Motor Vehicle Tyres and Related Aspect**
Author:	TŰV Automotive GmbH
Published:	EC ENTR/02/045, 2004
Link:	http://ec.europa.eu/enterprise/sectors/automotive/files/projects/report_motor_vehicle_tyres_en.pdf
Objectives:	Review the European evidence on tyre safety
Methodology:	Literature review

Key Findings:

Broad evidence on tyre safety. Specifically relating to tyre pressure, the report identified:

- Over-inflation increases overall tyre diameter, decreases the amount of tread in contact with the road, decreases sidewall flexibility and affects road-adhesion.
- Under-inflation decreases overall tyre diameter, increases sidewall flexion, generates higher tyre operating temperatures and difficult vehicle handling characteristics. Running an under-inflated tyre may cause premature tyre failure.
- Both over and under-inflation adversely affect tyre life

Format: pdf	**Cost: free**
Themes:	Tyres

Title:	**Road vehicle testing scheme (MOT): percentage of tests with one or more Fail or PRS1 type RfRs2 in defect group: 2007/08 to 2012/13**
Author:	DfT
Published:	Transport Statistics Great Britain. Table TSGB0909, 2012
Link:	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/259772/tsgb0909.xls
Objectives:	Establish why vehicles failed their MoT test
Methodology:	Collate reports from individual MoT test centres

Key Findings:

The proportion of cars and goods vehicles between 3,000 and 3,500 kg gross weight that fail MOT tests due to tyre defects, or only pass after a tyre defect has been rectified, is about twice as high as passenger carrying vehicles and motorcycles.

In 2012/13, the proportion of vehicles that either failed their MoT due to a tyre fault, or passed their MoT after a fault with the tyres was corrected, were:

7.7% of cars
3.8% of passenger carrying vehicles
7.2% of goods vehicles (between 3,000 and 3,500 kg)
3.5% of motorcycles (tyres and wheels)

These figures do not include goods vehicles over 3,500 kg)

The proportion of cars that fail an MOT due to a tyre defect, or pass only after a tyre defect has been rectified, has fallen over time, from 9.1% in 2007/08 to 7.7% in 2012/13.

The proportion of passenger carrying vehicles that fail an MOT due to a tyre defect, or pass only after a tyre defect has been rectified, has remained steady over time. It was 3.6% in 2007/08 and 3.8% in 2012/13.

The proportion of goods vehicles weighing between 3,000 and 3,500kg that fail an MOT due to a tyre defect, or pass only after a tyre defect has been rectified, has fallen slightly over time, from 8.1% in 2007/08 to 7.2% in 2012/13.

The proportion of motorcycles that fail an MOT due to a tyre or wheel defect, or pass only after a tyre or wheel defect has been rectified, has remained steady over time. It was 3.7% in 2007/08 and 3.5% in 2012/13.

Format: Excel	**Cost:** free
Themes:	MoT failure, MoT, tyres, statistics

Title:	**Collisions with utility poles**
Author:	J C Fox, M C Good And P N Joubert
Published:	ISBN: 0 642 51010 5
Link:	http://www.infrastructure.gov.au/roads/safety/publications/1979/Coll_Ut_Poles_1.aspx
Objectives:	To examine vehicle collisions with utility poles and identify countermeasures
Methodology:	For comparison of tyre tread depths; compare the tread depths of vehicles involved in collisions with a random sample of vehicles in petrol stations.
Key findings: • The tread depth from 898 vehicles which were involved in accidents were compared with the tread depth of 627 vehicles that had not been. • The risk of being involved in a collision in wet and dry weather condition increased with tread depths below 3mm. • There was no statistically significant difference between the relative risk of an accident between wet and dry conditions, • The study did not examine or control for any confounding factors.	
Format: pdf	**Cost:** free
Themes:	Tyres, tread depth

Title:	**EC Regulation (EC) 661/2009**
Author:	European Commission
Published:	European Commission, 2009
Link:	http://ec.europa.eu/enterprise/sectors/automotive/files/safety/gsr-clarifications_en.pdf
Objectives:	To set regulations for the type approval requirements for the general safety of motor vehicles, their trailers and systems and components.
Methodology:	Regulations
Key Findings: N/A – Regulations setting general safety requirements for vehicles	
Format: pdf	**Cost:** Free
Themes:	Tyres, Regulations, safety

Title:	**UNECE Regulation 64.02**
Author:	**UNECE**
Published:	**UNECE, 2010**
Link:	http://www.unece.org/trans/main/wp29/wp29regs61-80.html
Objectives:	To set requirements for Temporary use spare unit, run flat tyres, run flat-systems and tyre pressure monitoring systems
Methodology:	Regulations
Key Findings: N/A – Regulations setting technical requirements for temporary spare tyres, run flat tyres, run flat-systems and tyre pressure monitoring systems	
Format: pdf	**Cost:** Free
Themes:	Tyres, Regulations, safety

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