



STAY AHEAD
OF THE CURVE
WITH CR AUTO
RATINGS, NEWS
& ADVICE™

ROAD REPORT

DASHBOARD DECODER

What Does
This Icon
Mean?



- YOU'RE TRAVELING FASTER THAN A SPEEDING BULLET
- THE AUTOMATIC HIGH-BEAM FEATURE IS ACTIVATED
- GIANT SQUID DETECTED AHEAD
- HORN AMPLIFIER IS ON

This is the symbol for the automatic high-beam function, which automatically turns the high-beam headlights on and off. We like this feature: The added visibility of high beams gives drivers more time to react. But fewer than 1 in 5 drivers (18 percent) use them when they should.

ASK OUR EXPERTS

What's the best way to keep my car clean in the winter?



Wash your car every two to four weeks to help prevent the corrosive effects of road salt.

Use a "touchless" or "brushless" car wash.

Brushes can cause salt, sand, and other winter grime to scour the paint surface.

Pay extra for undercarriage cleaning, but skip the wax and tire treatments, which won't last long.

Keep sensors free of snow, ice, and grime between washes so that safety systems work properly.

Top off your windshield washer fluid with a winter blend, which won't freeze and may help to clear salt mist, ice, and snow from the windshield.

THE VITAL STATISTIC

9

Average number of additional feet it takes a hybrid sedan to stop on dry pavement vs. a non-hybrid version of the same model. Hybrid SUVs take an average of 4 additional feet.

Source: CR testing data.

RECALL



GM SUVs and Pickups

General Motors is recalling 652,967 Chevrolet and GMC pickup trucks and SUVs because a faulty sensor may cause a wheel to brake unexpectedly, which could lead to a crash. The recall is for 2014-2018 Chevrolet Silverado and GMC Sierra pickups, and 2015-2020 Chevrolet Suburban, Chevrolet Tahoe, and GMC Yukon SUVs. Only models with a 5.3-liter engine, four-wheel drive, and a 3.08-ratio rear axle are affected.

What to do: Dealers will reprogram software free of charge. GM's number for this recall is N192261050.

AHEAD OF THE CURVE

Affordable Cars With Advanced Safety Systems

Automatic emergency braking, pedestrian detection, and forward collision warning systems save lives and shouldn't—CR believes—cost extra. Advanced safety features come standard on these CR recommended 2020 models, which have a base price of less than \$25,000*.

**Kia
Forte**
\$20,165

66
OVERALL
SCORE

**Hyundai
Elantra**
\$20,630

67
OVERALL
SCORE

**Toyota
Corolla**
\$23,530

75
OVERALL
SCORE

Mazda3
\$24,115

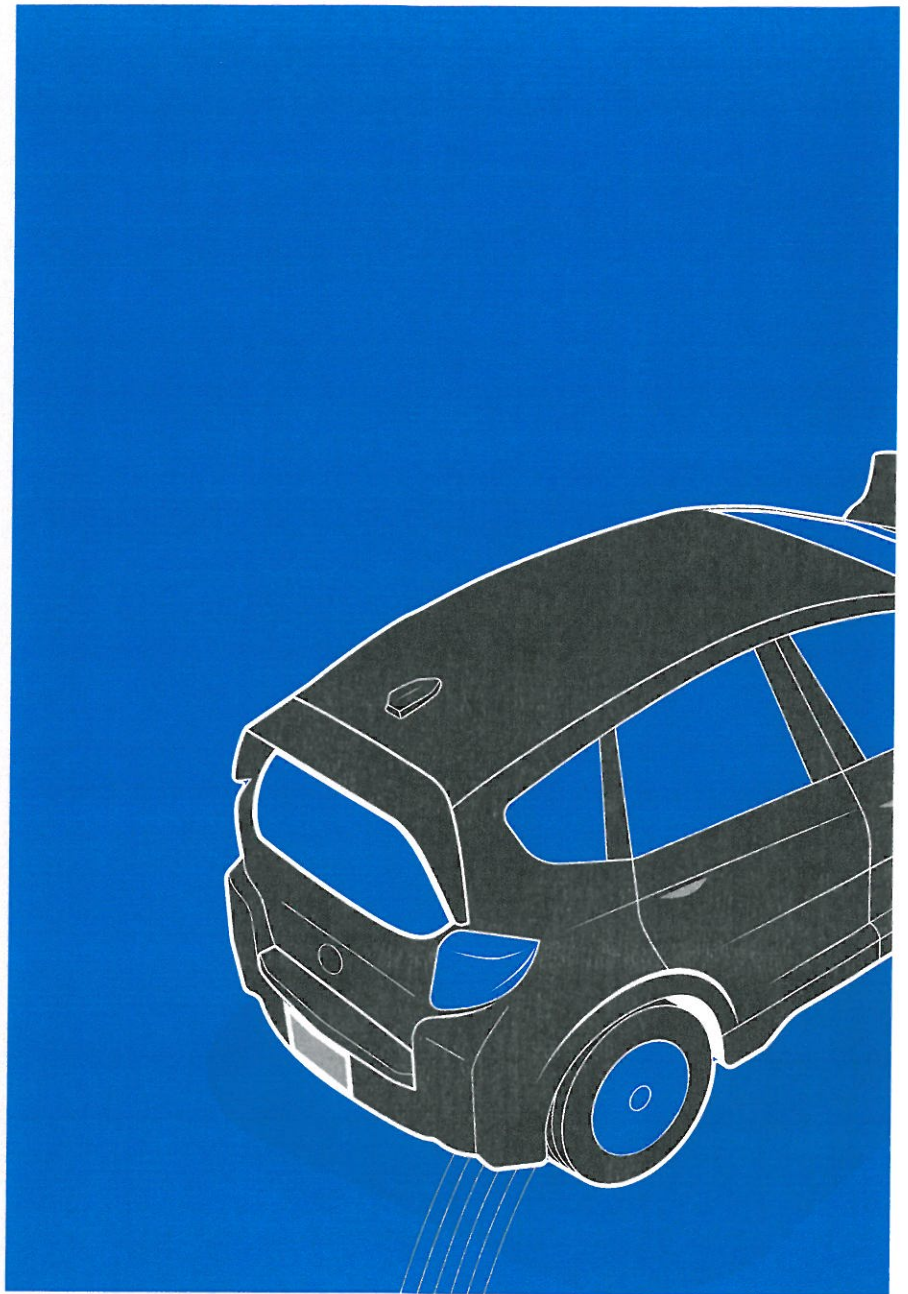
68
OVERALL
SCORE

*Prices listed are for the versions CR tested

Making Cars Safer for Women

Women are at higher risk of injury or death in a car crash, and yet auto safety testing is still geared almost exclusively toward men. Why have safety regulators and automakers continued to ignore women—and what must be done to provide better protection?

by Keith Barry



THE FACE OF a crash test dummy looks eerily vacant. With indents instead of eyes, a pointy nose, and permanently pursed lips, it appears remarkably expressionless—especially considering it's about to hurtle toward a stationary barrier at speeds as high as 40 mph.

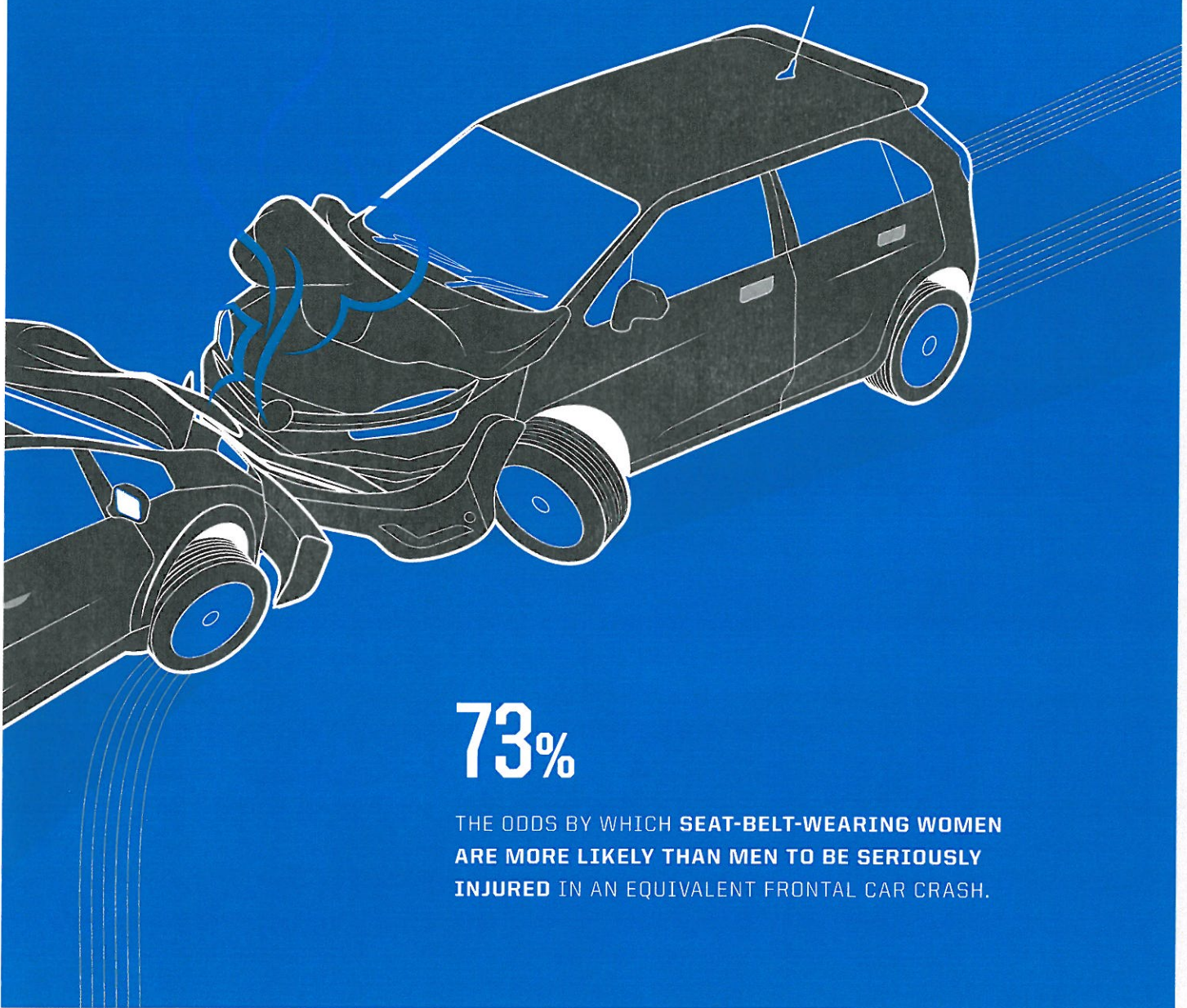
You might assume from its lack of distinguishing features that a crash test dummy is an avatar for all humanity. But despite the blank faces, most of the dummies used in automotive crash tests by the government and the insurance industry—the tests that determine whether a car gets a coveted five-star

safety rating or is named a top safety pick—represent a very specific man.

Even though female and male bodies react differently in crashes, an average adult female crash test dummy simply does not exist, despite the fact that women obviously drive to work, take road trips, and ride in cars with friends. That absence has set the course for four decades' worth of car safety design, with deadly consequences.

Although the majority of Americans killed or injured in car crashes are male, the raw data masks the fact that females are actually at greater risk of

death or injury when a crash occurs. Data from the National Highway Traffic Safety Administration (NHTSA) and the Federal Highway Administration (FHWA) show that males drive more miles than females and are more likely to engage in risky behavior, such as speeding, driving under the influence of alcohol, and not wearing a seat belt. But a study from NHTSA shows that a female driver or front passenger who is wearing her seat belt is 17 percent more likely than a male to be killed when a crash takes place. And a 2019 study from the University of Virginia (UVA)



73%

THE ODDS BY WHICH **SEAT-BELT-WEARING WOMEN ARE MORE LIKELY THAN MEN TO BE SERIOUSLY INJURED** IN AN EQUIVALENT FRONTAL CAR CRASH.

shows that for a female occupant, the odds of being injured in a frontal crash are 73 percent greater than the odds for a male occupant. That's controlling for occupant age, height, and body mass index, in addition to collision severity and vehicle model year.

These alarming numbers suggest an urgent safety issue, but the problem is neither new nor unfamiliar to regulators and automakers. "These same trends have been observed in many, many studies in the past," says Jason Forman, Ph.D., who is a principal scientist with the Center for Applied

Biomechanics at UVA and led that 2019 survey of injury disparities.

In fact, researchers have understood since at least the early 1980s that male and female bodies perform differently in crashes, but the vast majority of automotive safety policy and research is still designed to address the body of the so-called 50th percentile male—currently represented in crash tests by a 171-pound, 5-foot-9-inch dummy that was first standardized in the 1970s. (Today, the average American man is about 26 pounds heavier.)

Regulators asked for a female dummy

in 1980, and a group of automakers petitioned for one in 1996, but it took until 2003 for NHTSA to put one in the car. Even then, it's just a scaled-down version of a male dummy that represents only the smallest 5 percent of women by the standards of the mid-1970s—so small that it can work double-duty as a 12- or 13-year-old child. Furthermore, no dummy takes into account the biological differences between male and female bodies.

In frontal crash tests performed by both NHTSA and the Insurance Institute for Highway Safety (IIHS),

this 5th percentile female dummy either rides as a passenger or doesn't participate in the test at all. (The female dummy sits in the driver's seat for some side-impact tests.) This, despite the fact that women now represent almost 50 percent of drivers in the U.S., according to the FHWA.

Because automotive design is directly influenced by the results of safety testing, any bias in the way cars are crash-tested translates into the way cars are manufactured. So if safety tests don't prioritize female occupants, carmakers won't necessarily make changes to better protect them.

"The reality of progress in automotive safety is that it heavily relies on regulation," says Emily Thomas, Ph.D., automotive safety engineer at Consumer Reports' Auto Test Center. "Unless the federal motor vehicle safety standards require dynamic crash testing with average-sized female crash dummies in multiple seating positions, driver side included, the dummy industry and automakers won't make that leap themselves."

The Three Stages of a Crash

Automotive safety experts look at car crashes in three distinct stages. The first stage is the vehicle crash—the impact of a car or truck into a foreign object. Stage two is the human crash, when the bodies of the vehicle's occupants come into contact with seat belts and airbags—or worse, the dashboard, windows, or some other

object. The third stage is the internal crash, which refers to the collisions of organs, bones, and soft tissue that happen within the human body.

According to Consumer Reports' Thomas, the crash energy that isn't absorbed by the vehicle in that first stage is then transferred to the occupants. "Vehicle restraint systems, like seat belts and airbags, are intended to limit motion and that transfer of energy," she says. "But to do that effectively across a range of body types, carmakers and crash testers need to consider not just the size of different occupants but also the material properties of their bodies."

That means crash-testing cars with dummies that represent a variety of body types, Thomas says, and ones that can account for the physiological differences between males and females.

"Females are not just smaller versions of males," says Kristy Arbogast, Ph.D., the co-scientific director of the Center for Injury Research and Prevention at the Children's Hospital of Philadelphia, who also sits on the board of the Association for the Advancement of Automotive Medicine. "They're put together differently. Their material properties—their structure—is different."

According to the Centers for Disease Control and Prevention, today's average woman is 5.4 inches shorter and 27 pounds lighter than the average man. As a result, women may sit closer to the steering wheel or wear their seat belts differently from men. But

differences aren't just about shape, size, and position. For example, the geometry of the female pelvis is different from the male pelvis, and the male neck can better withstand forces that bend it.

Even the internal makeup of female bones can be different from that of male bones. Because crash injuries and fatalities are often related to bone fractures, this may explain some of the disparities between the sexes.

Biomechanical engineers and anthropologists are still struggling to understand other biological variations between male and female bodies that determine how they will react in a car crash. Crashes are chaotic events, and even two occupants of the same height, weight, and sex may experience a crash differently. Research shows that in addition to women, elderly vehicle occupants are also more vulnerable in a crash, as are larger drivers and occupants. But there are specific differences in how male and female bodies react to crashes—and in some cases the cause is unclear.

Consider whiplash. Women are up to three times more likely to suffer whiplash injuries than men, but real-world crash data show that many vehicle seats specifically designed to prevent whiplash injuries are actually less likely to help female occupants.

In the late 1990s, automakers developed two kinds of safety systems designed to protect against whiplash. One, used primarily by Volvo, is designed to absorb crash energy in the seatback and head restraint. It reduced life-altering whiplash injuries for both male and female occupants but proved to be slightly more effective for females. (Toyota uses a similar design.) The other design, used by many other manufacturers, uses only a moving head restraint to diminish the movement of the head and neck in rear impacts. Though it reduces life-altering whiplash crash injuries up to 70 percent for male occupants, it has no benefit for females.

17%

THE PERCENTAGE BY WHICH FEMALE DRIVERS AND FRONT PASSENGERS ARE MORE LIKELY TO BE KILLED IN A CAR CRASH THAN MALE OCCUPANTS OF THE SAME AGE.

Blind Spots in Crash Testing

It's an open secret in the automotive industry that automakers engineer their cars specifically to pass crash tests. That's why it's critical for tests to represent how cars are used in the real world.

"When regulators or testing organizations set a new bar for crash safety, most automakers quickly change their designs so that their cars ace the new test," says David Friedman, vice president of advocacy at Consumer Reports and a former NHTSA administrator.

That's what happened in 2012, when the IIHS, an independent crash testing agency funded by insurance companies, added a new evaluation, the small-overlap test. The test simulates a crash where the front driver-side corner of a vehicle collides with another vehicle or a tree or utility pole. As soon as the test was announced, some automakers began redesigning the next generation of vehicles to score well by improving vehicle structures and airbags. But those changes were made only to the driver's side of the vehicle, where that test was targeted. That prompted the IIHS to introduce a passenger-side version of the test in late 2017. For the current model year, every one of those cars tested in 2012 now gets a Good or Acceptable score, thanks to design changes.

When asked why it doesn't use an average adult female dummy in its testing, a NHTSA spokesperson provided a written statement to CR saying that the agency already addresses inequality in crash outcomes by requiring the use of a 5th percentile female dummy.

The agency's use of 5th percentile female and 50th percentile male dummies represents "a broad spectrum of occupant crash protection rather than merely focusing on median body types," its statement said. "Currently, NHTSA is focusing its research in new advancements in both sizes of crash test dummies, including the use of advanced instrumentation and criteria designed to



'NHTSA IS FAILING IN ITS MISSION IF WOMEN ARE ALMOST 75 PERCENT MORE LIKELY THAN MEN TO DIE OR RECEIVE A SERIOUS INJURY WHEN THEY ARE INVOLVED IN AN AUTOMOBILE CRASH.'

REPRESENTATIVES KATHY CASTOR (D-FLA., ABOVE) AND JAN SCHAKOWSKY (D-ILL.) IN A LETTER TO NHTSA LAST NOVEMBER

better mitigate respective injury risks."

The Auto Alliance, a trade group that represents many large automakers in the U.S., told CR that the group does not believe that a 50th percentile female dummy would "significantly change any real-world restraint system designs," Wade Newton, a spokesman for the group, wrote in an email.

Decades of Delays

NHTSA and the IIHS are both evaluating a new set of dummies, called THOR, or Test device for Human Occupant Restraint (see the May 2019 issue of CR for more on the THOR program). They have been in development since the 1980s and may be used in European crash tests as soon as this year. They'll be able to collect more data than the current dummies, known as the Hybrid III series, and the 5th percentile female version of the THOR dummy has been designed to better mimic an actual human female body.

However, there are currently no plans for an average female THOR. Even if regulators demanded one today, researchers would first need to collect real-world injury data from female occupants to identify patterns: Which injuries happen most often? Which are most severe? Then they would have to recreate those specific patterns and mechanisms in the laboratory with animals or human cadavers, a process experts say could take at least 20 years.

"Building the dummy doesn't necessarily take that long," says Becky Mueller, a senior research engineer at the IIHS. "But to be able to relate what the dummy is measuring back to real-world injuries takes years and years of real-world data collection."

Astrid Linder, Ph.D., a professor at Chalmers University in Sweden and the research director of traffic safety at the Swedish National Road and Transport Institute, agrees that the length of time it could take to build a new female dummy is frustrating, but she says that is not an excuse for delaying the work further.

"This was the answer I got 20 years ago when I did a review as a Ph.D. student," she says. "There is no data that isn't possible to collect. Go ahead and do it. We know how to do it."

Linder has been leading efforts in Europe to address differences in crash outcomes between male and female

Road Report

vehicle occupants. She says that we need to start work on an average female dummy to determine what information we don't know. "If you wait for all data to be available, then we will wait forever," she says.

One way that automakers and safety advocates are addressing inequality in the short term is by developing computer models that can simulate how human bodies of different shapes, sizes, or sexes react in a crash. This approach is already in use by some automakers, including Toyota and Volvo. Volvo developed a computer model of an average pregnant female in the early 2000s and worked with Chalmers University to create a computer model of an average-sized female to develop its whiplash protection system—the very same one that prevents injury equally for both men and women.

"If you want to run a crash test, you have to build a car first, then you have to spend the time to instrument it, and of course you put the dummy in and run the test," says Jason Hallman, Ph.D., a principal engineer in Toyota's research and development department. "If you want to, say, shift the posture or put in a different-sized dummy, you have to do the process over again." By comparison, Hallman says that running a test with a computer model of a human body can take about a week, although the underlying research behind that model often represents years of work.

Linder says she expects computer models to become more prevalent, but she emphasizes that a virtual human is no substitute for an actual dummy. "As long as we humans are the ones using the cars, then we need to confirm in physical testing that this is actually representing the physical world," she says. Therefore, those physical tests must also include female dummies. "If you exclude half of [occupants], you can only confirm for half of

WAYS WOMEN ARE AT HIGHER RISK

Real-world crash data show that women are more likely to be injured in a car crash than men, but safety researchers are just beginning to understand why. And unless crash tests better prioritize women, some of the disparities will continue to be a mystery.



LEGS

79.7%

HIGHER RISK FOR INJURY THAN MEN (16.3%)*

Female drivers are more likely than males to have leg injuries in a crash when the floor of the car deforms, or due to crash forces transmitted through the gas or brake pedals. In the rear seat, female passengers are especially vulnerable to injuries when their legs collide with the backs of the front seats.

ARMS

58.2%

HIGHER RISK FOR INJURY THAN MEN (20.6%)*

Female drivers are highly vulnerable to arm injuries in a crash due to contact with the steering wheel and/or airbag, and women in the rear seat are more likely than men to experience shoulder fractures. These injuries may not be life threatening, but they can seriously impair quality of life.

NECK

44.7%

HIGHER RISK FOR INJURY THAN MEN (34%)*

The structure of the female spinal column is generally not as strong as a male's but still has to support a head that weighs almost as much. In addition, many anti-whiplash head restraints are more effective for men than for women.



ABDOMEN

38.5%

HIGHER RISK FOR INJURY THAN MEN (-28.4%)

Data suggest that rear seat belts may be better at protecting men than women from abdominal injury. Still, wearing a seat belt is a life saver for all vehicle occupants—including women.

CHEST

26.4%

HIGHER RISK FOR INJURY THAN MEN (-13.6%)

Especially in the rear seat, women are more vulnerable to chest injuries and rib fractures. Although researchers know that ribs differ due to factors such as age and sex, they are unsure how those differences translate to how ribs react to crash forces.

BONES

The internal structure of female bones differs from male bones. Because crash injuries and fatalities are often related to bone fractures, this can explain some of the disparities between the sexes. Bones change over time, as well. "People assume that bone is this dead, static structure in your body, but it's definitely not," says Mandy Agnew, Ph.D., a biological anthropologist and director of the Skeletal Biology Research Lab at the Ohio State University Injury Biomechanics Research Center. "It's sensing loads constantly and altering its size and shape to meet those needs, so it's quite dynamic."

PELVIS

The female pelvis has a different geometry than the male pelvis. That's one of the many reasons dummy designers can't simply change the external proportions of a male crash test dummy to turn it into an average female. It's important for crash test dummies to be biofidelic—designed so that they mimic the human body in every way. In order to do so, safety researchers need to conduct tests using human cadavers.

PREGNANCY

Car crashes are the leading cause of traumatic fetal death in the U.S. Researchers have created computer models of crash test dummies to represent pregnant vehicle occupants, but these dummies are not yet included in consumer-facing crash tests.

them what you have done in the computer world what corresponds in the physical world,” she says.

The Lesson in Deadly Airbags

Collecting the data and re-engineering America’s crash tests to better represent female occupants could take decades, but with the right motivation, there’s a chance that change could be accelerated. That’s what happened in the late 1990s, when safety regulators and researchers took just two years to fix an airbag issue that was killing children and smaller women.

Between 1996 and 2000, 179 people—including 118 children—were killed by airbags in low-speed crashes that shouldn’t have been fatal. Physicians, automakers, and safety advocates realized they had a problem, and they suspected it had to do with airbags designed to be powerful enough to keep a 50th percentile male in his seat in a crash even if he wasn’t wearing a seat belt, per federal safety regulations.

“I think that really highlighted how far behind we were and how inadequate the testing had been for them to just assume that a 50th percentile male would be sitting there,” Jackie Gillan says. Today, she’s the president emeritus of Advocates for Highway and Auto Safety, a group that lobbies for safer roads and better safety regulations. But in 1996, Gillan was the vice president of the organization, and she worked with automakers, legislators, regulators, and the families of those killed in crashes to help create safer airbags.

In November 1996, NHTSA announced that it would make changes to airbag rules in response to the deaths. Four months later, the agency relaxed testing requirements to allow automakers to rapidly redesign their airbags using a crash sled—which simulates a car crash—instead of costly, time-consuming crash tests of actual vehicles.

Almost half of automakers reduced the power of their airbags between



‘MAKING CARS EQUALLY SAFE FOR MEN AND WOMEN IS NOT AN INSURMOUNTABLE TASK. BUT IF WE DON’T TAKE ACTION NOW, WOMEN WILL CONTINUE TO BE AT A DISADVANTAGE.’

EMILY THOMAS, PH.D.,
AUTOMOTIVE SAFETY ENGINEER
AT CONSUMER REPORTS’ AUTO
TEST CENTER

the 1997 and 1998 model years. By September of 1998, NHTSA required automakers to install advanced airbags, which would deploy with a force proportional to the weight of the vehicle occupant. The strategy worked: Starting in 1998, fatalities due to airbags began decreasing appreciably.

According to Gillan, part of the reason for the swift action on airbags was a clear, perceptible harm. “You have all the elements coming together where you had a problem of children being injured, public opinion, congressional interest, and a legal

system that was not going to let this continue,” she says. By comparison, the issue of higher injury and fatality risks for women may feel more abstract and difficult to publicize.

Although fixing an airbag is no easy task, it’s not nearly as complex and nuanced as addressing the multiple factors that make women less safe in crashes. According to Ohio State’s Mandy Agnew, Ph.D., many of the mechanisms behind different injury outcomes between men and women remain unexplored, as are injury risks for other vulnerable groups, such as the elderly and larger drivers and passengers.

“We have to do the basic science; we have to go back to the fundamentals,” she says. “At the same time, we can’t wait for all of the answers to do anything. I think we need to do both in parallel.”

To start the process, regulators such as NHTSA need to act, says Chalmers University’s Linder. If that happens, she estimates that an average female crash test dummy could be included in official crash tests by 2030. “And the industry will take action, and society will take action,” she says. “But the starting point is those decisions made by regulatory bodies.”

Recent studies may have gotten the political process moving. In November of last year, four months after Forman released his UVA study, Congresswomen Kathy Castor of Florida and Jan Schakowsky of Illinois wrote to the acting administrator of NHTSA demanding action.

“NHTSA is failing in its mission if women are almost 75 percent more likely than men to die or receive a serious injury when they are involved in an automobile crash,” Castor and Schakowsky wrote. “This disparity is simply unacceptable and we must act to stop the disproportionate harm to women in automobile crashes.” For additional coverage on this topic, go to CR.org/carsafety.