

Booster Seats

Booster Seats

What is a Booster Seat?

A booster seat positions the vehicle's safety belt properly on a child. The booster makes sure that the lap belt rests on the child's lap, over the strong hip bones – and nowhere near the soft belly. The booster also makes sure that the shoulder belt rests between the child's shoulder and neck – so the child is comfortable and won't put the belt behind her back or under her arm. When a child rides on a booster, he must use the vehicle's shoulder AND lap belt across them. Boosters will not work with lap-only belts.

Why should kids ride in a booster?

Because the vehicle seat is too big and a child's bone structure is too small and underdeveloped to keep the safety belt in the proper place during a crash. A 4-8 year old child riding in a booster is 59% less likely to be injured in a crash than a 4-8 year old wearing a safety belt alone.

Are there different types of boosters?

Yes, there are two different types of boosters--backless boosters, and high-backed boosters. Which one to choose depends on your vehicle, the age, height and weight of your child, and you and your child's own preferences. Backless boosters are smaller and lighter and this makes them great for travel. High-backed boosters are better for sleeping and according to one study, are more beneficial in side impacts compared to seat belts or backless boosters.

Please note that combination seats are also sometimes called boosters or hybrid boosters. These seats start off as a 5-point harness car seat and can turn into a high-backed and/or backless booster once the child is big and/or mature enough.

Who Should Ride in a Booster?

Kids, especially younger ones, are safer in a 5-point harness. Don't rush to "graduate" your child to a booster seat. If your child still fits in his 5-point harness car seat, leave him there! Kids who are AT LEAST 40 pounds AND AT LEAST 3-4 years old can start using boosters.

If you can answer "Yes" to ALL the statements below, your child is okay to use a booster:

- There is a shoulder AND lap belt where the child sits
- The child is at least 40 pounds (kids are safer in a 5-point harness, especially those under 40lbs)
- The child is at least 3-4 years old
- The child can sit still the entire trip without leaning forward or sitting on their knees

Boy using a backless booster

When Can My Child Stop Using a Booster?

Do not stop using a booster seat unless you can answer "yes" to ALL of the questions listed here. Unless you can answer "yes" to all the questions, your child still needs a booster in order for the seat belt to fit correctly, no matter how tall, how heavy, or how old he is!

The 5-Step Test

- Does the child sit all the way back against the auto seat?
- Do the child's knees bend comfortably at the edge of the auto seat?
- Does the belt cross the shoulder between the neck and arm?
- Is the lap belt as low as possible, touching the thighs?
- Can the child stay seated like this for the whole trip?

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{mospagebreak title=Why Kids Need a Booster}

Why should kids use boosters? Can't they just use the seat belt?

Kids need to use boosters because the seat belt does not fit them correctly without the booster. If the seat belt doesn't fit the child, he is at risk for injury; in fact a child between ages 4 and 8 riding in a booster is 59% less likely to be injured in a crash than a 4 to 8 year old wearing a safety belt alone. Read on to learn what seat belts do and why they don't automatically work for kids.

What the seat belt does

The safety belt has two very important jobs:

- To prevent you from being ejected from the vehicle
- To distribute the extreme crash forces over the strongest parts of your body

In order to work properly, the safety belt needs to rest on the strong bones of the body – the collar bone (clavicle), chest bone (sternum), and hip bones (pelvis). Softer parts of the body – such as the belly (abdomen) - are not strong enough to withstand the extreme forces in a crash. It's very important that the safety belt does not rest on these soft parts, since injuries may result. In order for the seat belt to work--to prevent you from being ejected and to distribute the crash forces--it needs to fit you like it fits the man in this picture. Unfortunately, seat belts do not fit kids under ages 10 to 12 this way.

The Problem with Safety Belts on Children

There are three main problems with vehicle safety belts and children. These three factors combine together in a crash to create an extremely unsafe situation which can only be corrected by the use of a booster.

Problem 1: The shoulder belt is anchored too high

The shoulder belt is usually anchored so high up in the vehicle (even with adjustable shoulder belt anchors in many newer vehicles) that instead of crossing the center of a child's chest and resting between the neck and the shoulder, it crosses only a small part of the chest and rests against the neck. This causes the child to be uncomfortable and most kids respond by putting the shoulder belt behind their backs or under their arms. If the shoulder belt is not going across the child's chest and shoulder, it cannot hold the child's upper body back in a crash--allowing the possibility of severe head, neck or spinal injury.

Problem 2: The vehicle seat is too big and too deep

The vehicle seat is too deep for most kids to be able to sit comfortably without slouching – since their thigh bones (femurs) are too short. Slouching worsens the already poor belt fit by placing the lap belt further up on the abdomen and moving the shoulder belt even further off the chest and onto the neck. By creating a big gap between the child's back and the back of the vehicle seat, slouching introduces a large amount of slack in the safety belt, which can allow a child's head and body to move dangerously far forward in a crash.

Problem 3: The child's body is too small and underdeveloped

A child's pelvis (hip bones) is relatively small and cartilaginous and lacks the prominent anterior superior iliac spines of an adult's. Try to feel your hip bone. What you're touching is the anterior superior iliac spine--the part that sticks out the farthest. If you try to feel a child's hip bones, it's much more difficult (even though many kids are very skinny) because the iliac spine is not fully formed until about age 8-10.

An adult's iliac spine keeps the seat belt on his hips and prevents the lap belt from going into the abdomen. Unfortunately, a child's small pelvis, lacking the fully developed iliac spine, is often unable to prevent the lap belt from riding up into the abdomen. The lap belt may start out in the proper position but moves up into the abdomen during the crash, leading to a pattern of injuries to the abdominal organs and lower spinal cord known as "seat belt syndrome. These injuries are severe and life-changing.

What does the difference in seat belt fit look like?

This diagram, created by the Children's Hospital of Philadelphia, shows how a safety belt should fit (green belt) and how it typically fits on a 4-8 year old child (orange belt).

The correctly placed green belt rests on the hips, over a bony area of the body.

The incorrectly placed orange belt has moved up around the child's abdomen. It's easy to see how the spinal

cord is in danger as the orange belt tightens against the soft abdomen and pushes on the spinal cord. You can also see how the soft organs inside the abdominal area would be at great risk for injury.

{mospagebreak title=Why a Booster Works} Why Boosters Work

Boosters improve how the vehicle safety belt fits the child and how the child fits the vehicle seat.

The booster raises the child up, making the shoulder belt fit correctly.

The shoulder belt crosses the center of the chest and rests between the shoulder and neck. The child is comfortable – and therefore not tempted to place the shoulder belt behind the back or under the arm (both of which are dangerous)

The booster seat is shallow, eliminating the need to slouch.

The booster's shallower seat allows the child's knees to bend comfortably over the edge without having to slouch. The child's back rests against the back of the vehicle seat (in a backless booster) or booster seat (in a high-backed booster), allowing the safety belt to tighten appropriately against the child's upper body. The child is again more comfortable and of course safer.

The booster includes seat belt guides to prevent the seat belt from approaching the child's abdomen.

The booster has either small handles, arm rests, guides or slots that help position the lap portion of the belt low and flat across a child's upper thighs and prevent the lap belt from riding up onto the abdomen. This eliminates the risk of "seat belt syndrome."

Boosters in Action: Booster vs. No Booster

Booster seats work in conjunction with lap and shoulder belts to restrict head movement during a crash. The farther forward the head moves, the more likely it is to be injured. These diagrams, which are courtesy of the Children's Hospital of Philadelphia, show the difference in head movement in three different scenarios.

Lap and Shoulder Belt worn incorrectly, No Booster

In the first diagram, a child who should be using a booster seat is instead using just a lap-and-shoulder belt. However, he has put the shoulder portion of his seat belt behind his back, which means his upper body is not restrained. Look how far his head moves in a crash!

Lap and Shoulder belt worn correctly, No Booster

In the second diagram, a child who should be using a booster is instead using just a lap-and-shoulder belt, albeit correctly. His head still moves quite far forward during a crash.

Lap and Shoulder Belt worn correctly WITH Booster

In the third diagram, the child uses a booster correctly. His head barely moves forward and he will sustain much less serious injuries than the other two children in the above diagrams.

{mospagebreak title=Who Should Use a Booster}

Who Should Use a Booster

When is my child ready to use a booster?

Kids, especially younger ones, are safer in a 5-point harness. Don't rush to "graduate" your child to a booster seat. If your child still fits in his 5-point harness car seat, leave him there!

If you can answer "Yes" to ALL the statements below, your child is okay to use a booster:

- There is a shoulder AND lap belt where the child will sit

- The child is at least 40 lbs
- The child is at least 3 or 4 years old
- The child can sit for the entire car trip without leaning forward or sitting on his knees

If you are worried that your child might not be ready for a booster, take a look at some combination seats, which start off as 5-point harness car seats and then turn into boosters when the child is older, bigger, and more mature. See Types of Boosters for more information on choosing the right booster for your child.

When can my child stop using a booster?

There is no magic age, height or weight determining whether your child will be safe without a booster. Because a booster corrects poor vehicle seat belt fit, a child should use a booster until the vehicle seat belt fits him properly. This can be anywhere from age 8 to age 13. 50% of all ten year olds still need to use boosters for proper seat belt fit. Unless you can answer "yes" to all the questions below, your child STILL needs a booster in order for the seat belt to fit correctly--regardless of his height, his age, or his weight.

Also, please note that because boosters work in conjunction with the vehicle seat belt and vehicle seat cushion, an older child may need to use a booster in one vehicle but not in others. Make sure to perform the 5-Step Test the first time your older child rides in a new vehicle.

The 5-Step Test

Put your child in the car and have her sit like an adult, without a booster. Buckle the seat belt over her. Now answer these questions:

- Does the child sit all the way back against the auto seat?
- Do the child's knees bend comfortably at the edge of the auto seat?
- Does the belt cross the shoulder between the neck and arm?
- Is the lap belt as low as possible, touching the thighs?
- Can the child stay seated like this for the whole trip?

If you can answer "yes" to every question, your child is okay to ride without a booster. If you answer "no" to any of these questions, your child still needs a booster in order to be safe.

{mospagebreak title=Types of Booster Seats} Types of Booster Seats

Are there different types of boosters? Which type of booster is right for my child? Which type is right for my vehicle?

There are three different types of booster seats: Backless boosters, High-Backed boosters, and Combination seats. Read on for a description of each. Also note the Booster Warnings section at the bottom of this page for general information. Of course you should always read both your booster seat instruction manual and your vehicle owner's manual before installing or using a booster.

Backless Boosters

These are specialized cushions children sit on. The booster raises the child up off the vehicle seat, leading to a better seat belt fit. Backless boosters all have seat belt guides which keep the seat belt over the correct place on the child's body. Sometimes armrests serve as the seat belt guides, other seats use metal tubes or rings. In this photo, you can see the seat belt runs through two red rings on either side of the booster.

- Lightweight, compact, and usually inexpensive...so perfect for playdates and travel.
- Often preferred by older children as they appear less "babyish"
- Optional shoulder belt adjuster guide. However, if the shoulder belt is not scratching the child's neck, it's not necessary to use the belt guide.

Note: The vehicle seat MUST come up to your child's ears in order to use a backless booster. This is because the top of the ears is the same height as the bottom of the skull, which needs protection in a crash. If the seat back does not come up to the top of the ears/bottom of the skull, the child is more likely to suffer whiplash injuries in a crash. If your child's ears come up past the vehicle seat, he should use a high-back booster, where the high back of the booster itself will prevent whiplash.

High Back Boosters (BPB/Combo)

There are two types of High Back boosters: Belt Positioning Boosters (BPB) and Combination Seats.

Belt Positioning Boosters (BPB): Like a backless booster but also has a back and head support which goes up past the child's ears. Normally used as a high-back booster, many of these models also allow you to remove the back, turning the seat into a backless booster – this option is very helpful for travel and for storage.

Combination: Functions either as a car seat with a 5-point harness for children up to 40 pounds (a few models go to 50 or 65lbs) OR a belt positioning booster for kids over 40 pounds (you simply remove the harness and use the vehicle's safety belt to secure the child). The back is usually not removable on these models.

A high-back booster with an adjustable headrest will usually give the best positioning of the shoulder belt.

Provides necessary head support in vehicles with low seat backs (backless boosters cannot do this, as mentioned in the Note above).

Better than a backless booster at keeping a sleeping child placed properly in the safety belt.

According to one study, high-back boosters were more beneficial in side impacts when compared with either backless boosters or safety belts alone – providing 59% better protection. When selecting a high-back booster, look for one with deep side wings that also stick out as close to perpendicular as possible from the back of the booster. This will likely improve protection in a side-impact crash by better containing the child's head and torso.

Booster Warnings

Do not use a booster seat where the seat belt does not touch your child's shoulders and chest.

Do not use a booster seat where the lap belt is not touching the tops of the child's thighs

When selecting a high-back booster, make sure to choose one with shoulder belt guides that allow the shoulder belt to slide freely. Some shoulder belt guides restrict the retraction of the shoulder belt - when the child leans forward, the shoulder belt pulls forward, but when the child leans back the shoulder belt does not go back in and therefore stays

very loose. This is dangerous.

Be sure that the shoulder belt guide, if present, does not pull the belt off the shoulder and onto the arm. If this happens on your child's booster, try using the booster without placing the shoulder belt in the guide. If the shoulder belt is not scratching the neck, it is not necessary to use the belt guide. If you must use the guide, lock the safety belt by slowly pulling the shoulder belt out all the way before placing the belt in the guide. This locking mode – found in most vehicles made after 1995 - will prevent the child from leaning forward and placing any slack in the belt. {mospagebreak title=Carpool Solutions}

Carpool Solutions

Are you driving carpool this year and wondering how you are going to fit 3 boosters across the back of your minivan? Trying to fit multiple car seats & boosters can be a challenge - even in a big vehicle like a minivan.

Before you rush to buy a booster for carpool...

Kids, especially younger ones, are safer in a 5-point harness. Don't rush to "graduate" your child to a booster seat. Kids who are AT LEAST 40 pounds AND AT LEAST 3-4 years old can start using boosters. Remember also that kids should ride on a booster UNTIL they can pass the 5-step-test (usually age 8-10).

Which booster is the narrowest?

The Bubble Bum is the narrowest on the market at just 13 inches wide. The Bubble Bum is an inflatable booster and weighs only 1 lb, so it's perfect for all sorts of travel and carpool situations. It has no armrests, so it fits more easily in tight spaces than most traditional boosters. The missing armrests also allow kids to more easily see where to buckle the seat belt, which means they're more likely to be able to buckle themselves in--definitely a plus in carpool situations! The Bubble Bum inflates in seconds for use in your car and then deflates quickly for storage in your garage or for transport in your child's backpack.

BubbleBum in action: We were able to fit two BubbleBum boosters and one rear-facing Combi Coccoro convertible car seat in the third row of a 2011 Chrysler Town & Country minivan. This combination just fit!

The Nania High Ride (backless booster) is the next narrowest booster seat currently available - at just 14.5 inches wide. You can order an individual High Ride online from the University of Iowa Children's Safety Store or you can purchase an industrial pack of 6-8 boosters (total cost comes to less than \$20 per booster) from AllegroMedical or Child Source.

****Note:** These are all BACKLESS boosters. In order to use a backless booster, the vehicle seat back MUST come up to at least the top of the child's ears in order to provide adequate head support. If the vehicle seat back does not come up to at least the top of your child's ears, then your child must use a high back booster.

Do you need something EVEN NARROWER?

The Ride Safer Travel Vest (pictured below) is a great option as it is only as wide as the child's body. This is a vest that functions like a booster by positioning the vehicle's seat belt properly on the child's body. The Ride Safer Travel Vest can be used with just a lap belt so long as there is a tether anchor available. For vehicles 2000 and newer, there are tether anchors in at least 3 seating locations in the vehicle - most older vehicles (as old as 1989) can have tether anchors retrofitted for free or at minimal cost. The vest was redesigned in 2009; please make sure to get the newer version. You can distinguish the new from the old as the old one was only available in silver and had 2 buckles in front whereas the new one is available in a rainbow variety of colors (but not silver) and has only one buckle in front.

Want measurements on other boosters or car seats?

Carseat Measurement and Data spreadsheet

Does a child need to ride in a position with just a lap belt?

One option would be to use a 5-point harness car seat with a high-weight-harness (a harness that accommodates kids who weigh more than 40 pounds). A list of such car seats can be found here thanks to our fantastic friends at Safety Belt Safe USA. The Ride Safer Travel Vest (discussed above) also works with a lap-only belt provided there is a tether anchor available.

Ride Safer Travel Vest using tether + lap belt

{mospagebreak title=Our Best Picks for Boosters}

Our Best Picks for Boosters

The Insurance Institute for Highway Safety has released new booster seat recommendations in their Best Bet list for 2011. The IIHS tested 62 booster seats, evaluating how well the booster and seat belt fit a crash test dummy representing an average sized 6 year old child.

We've created a short presentation helping to explain the IIHS's recommendations. We also provide The Car Seat Lady's Best Picks for Boosters for travel, carpool, tall kids, long legs, wide torsos, harness-to-booster and under \$50. See the rest of our Booster section for even more info.

{mospagebreak title=Using Boosters with Lap-Only Belts}

Lap Belt Only Solutions

Many vehicles do not have shoulder belts in one or more rear seating position. Instead there is a lap-only belt. Unfortunately you CANNOT use a booster seat with a lap-only belt, since it does not protect a child well.

Retrofitting the Vehicle Seat Belts

If your child needs to ride in a seating position equipped with just a lap-only belt, you may be able to purchase a shoulder belt retrofit kit. A retrofit kit is the ideal solution when older kids/adults--who are too big for booster seats--must also ride in the rear seat, since shoulder belts provide much more protection for all passengers. Please note that shoulder belts CANNOT be added in the center of the back seat of any vehicle – these retrofit kits are only for the outboard (side) positions in the rear seat.

List of vehicles for which retrofit kits are available, along with the part number and approximate cost of the retrofit kit

Replacing a Booster with a Bigger Car Seat

If you don't or can't retrofit your vehicle's back seat, here's a list of child restraints appropriate for lap-only belts and bigger children.

Convertible Seats (Rear and Forward Facing)

Britax Marathon Classic and Marathon 70, Boulevard 70, Advocate 70, Roundabout 50 and Roundabout 55
 Diono Radian (all models)
 Maxi Cosi Pria 70
 Safety 1st Complete Air
 Recaro Proride

Combination Seats (Car Seats and Booster Seats--please note that if you have lap only belts in your vehicle, you CANNOT use these seats in their booster seat mode)

Graco Nautilus
 Graco Argos 70
 Britax Frontier 85
 Safety 1st Go Hybrid

Other Options (Vests/Harnesses/Shields)

- Ride Safer Travel Vest
- Kid Y Harness with Ride RYTE Booster

PLEASE NOTE: Ride RYTE MUST be used with Kid Y harness if vehicle seat has lap-only belt. Additionally, Ride RYTE can be used as a backless booster only if vehicle seat comes up to top of child's ears. Depending on the maximum weight capacity of the tether anchor in your vehicle, you may need to install a heavy-duty tether anchor.

{mospagebreak title=Talking to Kids}

A Parent's Guide To Talking to Kids About Boosters

As parents, we must pick our battles. Allowing a child to skip her vegetables one night or to go outside without a coat will not cause lasting harm. Riding without a booster seat could kill or seriously injure a child. Safety must be non-negotiable at all times.

Remember that you are the parent and you are in charge. Your attitude affects how your child views booster seats, and if you are positive and enthusiastic about boosters, your child is more likely to feel that way also. Likewise, if you communicate (verbally or non-verbally) that boosters are for babies or are optional, your child will pick up on these views as well. Riding in a booster seat should not be seen as a punishment. Instead, it should be seen as a normal part of everyday life. Involve your child in buckling up and explain to her how the booster seat works to keep her safe. Kids are much more likely to want to ride in a booster if they understand how it works, rather than "because Mommy and Daddy say I have to."

How to Talk to your Kids about Boosters

The goal of this exercise is to show your child how they fit differently in the vehicle and in the safety belt when they sit on a booster compared to when they are not on a booster. (You can also watch the video in the Just For Kids section with your child.) Make sure you understand how boosters work first, before doing this activity with your child.

Have the child point to his shoulder bone (clavicle), chest bone (sternum) and hip bones (pelvis), which are the strong bones where the safety belt needs to rest. Ask the child what the bone feels like – he will typically say it feels hard/

like a rock/ strong/ etc.

Now have your child point to his belly (abdomen) and ask him what this feels like – he will typically say that it is squishy/ feels like a banana/ feels like jello/ etc. Especially for older children, you can explain what is in the abdomen – kidneys, liver, spleen, intestines, stomach, bladder, and the lower spinal cord. If you have an aspiring doctor or nurse, you could get an anatomy diagram and show them.

Ask your child to imagine that you are driving down the road and a puppy runs out into the street. Ask the child what the driver should do – most kids will volunteer “the driver will slam on the brakes.” Ask the child to recall how the safety belt suddenly feels very tight when the driver slams on the brakes (if the child can not recall this, you can buckle the child in and hold the shoulder belt tight to simulate this.)

Ask your child where he thinks is the best place for the safety belt to get tight – on his hard, strong bones or on his squishy belly? Most children will understand that it's better for the belt to be tight on the bones. The child should now have a basic understanding that the safety belt gets tight to keep them safe and needs to stay on their bones, not their squishy tummy.

Now, take the child out to the vehicle and do the 5-Step-Test with them.

Does the child sit all the way back against the vehicle seat?

Do the child's knees bend comfortably at the edge of the vehicle seat? If your child has not slouched forward already, ask him to slouch until his knees bend over the edge. Show him that when he slouches the lap belt is on his squishy tummy.

Does the belt cross the shoulder between the neck and the arm? Have the child point to his shoulder bone and chest bone – make sure the belt is touching there. If the belt is rubbing the child's neck, the child will be tempted to put it under his arm or behind his back. Show the child that when it is under his arm it is not on his chest or shoulder bone. When it is behind his back he can lean forward so that his chest touches his legs and his head can hit his knees or the seat in front of him.

Is the lap belt as low as possible, touching the thighs? Have the child touch the tops of his legs – make sure the belt is resting there. Have the child touch his belly button – the lap belt should be far away from the belly button.

Can the child stay seated like this for the entire trip? Some kids like to squirm and slouch no matter what – and will need to ride in a booster seat to help keep them sitting straight.

If you answered "no" to any of these questions, your child needs a booster seat to make both the shoulder belt and the lap belt fit right to keep him the safest. If your child needs a booster, repeat the 5-step-test with him sitting on the booster and show him how he sits differently on the vehicle seat and how the safety belt fits him properly now.

When talking to your child, remember to emphasize that by sitting on a booster she will have more fun because:

She can see better out of the window

She is more comfortable

Her knees bend over the edge of the booster – she doesn't have to slouch

The shoulder belt is properly positioned so it isn't irritating her neck

She have a place to store small toys/crayons/drinks – many boosters have cup holders built in

When all else fails:

- Pick your battles. Safety is a non-negotiable battle that you must win every time. Tell your child that the car will not start unless he is sitting on his booster – and stick to this (don't turn the motor on until he is properly buckled.) If he unbuckles himself (or places the shoulder belt behind his back or under his arm or does anything else that's dangerous) during the trip, pull over at the first safe place you can find, and firmly (without yelling and or showing any emotion) tell him to sit in the booster and that the car will not move until he is rebuckled. Repeat as often as necessary.

Positive reinforcement: Buy a pack of stickers that your child would like – and everytime she sits in the booster reward her at the end of the trip with a sticker. Let her place the sticker on the booster, on herself, in a small notebook that stays in the car, a “booster chart” or any other place that will visually reward her. There are other types of

positive reinforcement you can use – if your child has a favorite song she likes to sing, promise to sing it with her/play it for her after each car ride when she sits in the booster. (Do not use food as a reward).{mospagebreak title=Misuse Patterns}

Misuse Patterns: Booster Seats and Safety Belts

Children under 40 pounds receive better protection from a child restraint with a 5-point-harness than a booster seat.^{1,2} Unfortunately, 29% of 3 year olds (who weigh less than 40 pounds) are inappropriately graduated to a booster seat.

The misuse rate for boosters is at least 20-28%^{3,4} with improper routing of the vehicle belt being the most common problem.

Common Mistakes

- shoulder belt incorrectly positioned
- child inappropriate height/weight for booster
- lap-only belt used for booster
- vehicle seat belt routed incorrectly

The other biggest source of misuse is simply non-use – i.e. kids who should be in a booster using just a safety belt, or worse yet riding completely unrestrained.

73% of kids who NEED a booster seat to ride safely are NOT in boosters

While 78% of 4 year olds use booster seats, the number drops to 65% of 5's, 43% of 6's, 21% of 7's, and a measly 11% of 8-year-olds.

The motor vehicle occupant death rate for 5 to 9 year olds has changed little in the past decade, while deaths among other child age groups have greatly decline. 63% of kids who died were unrestrained. The remaining 31% were largely inappropriately restrained using safety belts instead of boosters.⁵ {mospagebreak title=Injury Patterns}

Injury Patterns for Booster Aged Kids NOT USING Boosters

Booster aged children wearing a safety belt alone (no booster) suffer their most serious injuries to:

- the head (44%)
- lower extremities (18%)
- thorax (17%)
- pelvis/abdomen (12%)

The Head: The most common complaint from 4-8 year olds who are not riding in boosters is that the shoulder belt is rubbing their neck. In an attempt to make themselves comfortable, many children remove the shoulder belt – either by placing it under their arm or behind their back, or simply moving to a position with only a lap belt. It is in these scenarios – where the child has nothing holding their upper body – that head injuries are most common.

Without restraint, the upper body rotates around the lap belt in a “jackknife” motion, allowing the head to travel very far forward with a good chance of contacting hard structures in the vehicle, such as the back of the front seat or even the child’s knees. Typical injuries include concussions, cerebral contusions, subdural hematomas, intracerebral hemorrhage, as well as myriad facial injuries. When compared with children appropriately restrained in boosters, those inappropriately restrained were 1.6 times more likely to suffer facial fractures. 2-5 year olds restrained in safety belts were more than 4 times more likely to sustain a significant head injury when compared with their peers riding in child restraints (car seats and boosters.)

The Abdomen: The area approximately from the bottom of the ribs to the hip bones is likely to be injured when the lap belt rides up over the bony pelvis (hip bones), concentrating the crash forces over the soft abdomen. The risk for these injuries increases when a child slouches or misuses the shoulder belt. Slouching places the lap belt on the abdomen even before a crash. Without a shoulder belt across your chest and shoulder bones (when you ride with a lap-only belt, or place the shoulder belt behind the back or under the arm) your body will double over itself in a crash, but since you bend at your waist (near your belly button) instead of at your hip bones, the lap portion of the belt rides up over the hip bones and into the abdomen.

A large study on thousands of crashes found no cases of abdominal injuries among 4-to-8-year olds riding in boosters. Those 4-8 year olds who were suboptimally restrained - using a safety belt when they should have been using a booster - were more than 3 times more likely to suffer an abdominal organ injury than those optimally

restrained (in a booster seat). The presence of bruises on the abdomen or flanks is strongly associated with underlying intra-abdominal injuries – specifically those to the spine, bowel, and bladder.

Four mechanisms for the lap belt riding up into the abdomen have been described in the literature, each with a different root cause and pattern of injuries. It should be noted that the 6 year old crash test dummy (Hybrid III) does not accurately represent the human pelvis-belt interaction as no submarining occurs, so much of this data comes from real-world crashes.

1. Presubmarining: This occurs when the child's lap belt is positioned incorrectly, over the abdomen before a crash. Usually this occurs because a child is slouching. Injuries depend on exact positioning of the lap belt; presubmarining causes hollow viscus injuries in the lower abdomen if the belt started off low, and lacerations of the solid organs if the belt started off higher on the abdomen.

2. Dynamic Submarining: This can occur even if a child attempts to wear the lap portion of the safety belt correctly, because the child's pelvis is relatively small, cartilaginous, and lacks the prominent anterior superior iliac spines of an adult's which keep the lap portion in place during a crash. The child is simply too underdeveloped to allow the belt and pelvis to interact properly during a crash, so the lap portion rides up into the abdomen, causing bruising low along the pelvic and organ injuries to the abdomen.3. Jack-Knife Kinematic: When a child uses a lap-only belt, or places a shoulder belt behind their back or under their arm, the unrestrained upper torso jackknives over the lap belt. This leads to lumbar spine injuries and abdominal injuries.

4. No Shoulder Belt Used: The shoulder portion of the belt exerts a vertical force on the inboard side (the side where the buckle is) of the lap belt which helps to prevent submarining.

Booster Seats help prevent submarining and jack-knifing by maintaining proper lap belt positioning.

The booster raises up the child, giving him a shallower seating area so that he can sit comfortably without slouching (which would lead to improper belt placement).

The booster is also contoured on the sides, so that the lap belt is encouraged to remain on the tops of the legs, not the abdomen.

Finally, the booster increases the lap belt angle during the crash, keeping the restraining force directed inferiorly away from the abdomen (since the belt is parallel to the road by virtue of resting on the tops of the legs, rather than perpendicular to the road, as it would be if it rested incorrectly on the abdomen.)

The Spine/Neck: Spinal cord injuries can occur when both the shoulder and lap belt are used, but are more common when the lap belt is the only form of restraint. When the lap belt rides up over the pelvis, applying all of the forces to the spine and abdomen, the thoracolumbar (chest and back) spine is at risk for injury. Not using a shoulder belt (or placing it behind the back or under the arm) increases the loads (forces) in the lumbar spine by as much as 5 times.

Many parents worry that the shoulder belt rubbing the child's neck might be dangerous – thinking it could lead to spinal cord injury or even decapitation in a crash. These fears are completely unfounded; there is little, if any, evidence in the literature of cervical spine (neck) injuries resulting from poor positioning of the shoulder belt near the child's neck (in situation's where the child's head does not strike anything in the vehicle). A shoulder belt that touches the side of the neck is not likely to cause injury unless the belt is very loose. Cervical spine injuries may occur when no shoulder belt is used – as the child's head and upper body will travel forward, making the head likely to strike the front vehicle seat or even the child's knees.{mospagebreak title=Selected References}

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Click on the PubMed ID (PMID) number after any citation to go to the abstract and (where available) a link to the full text.

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