Evaluating an Intervention to Improve Belt Fit for Drivers

Monica L.H. Jones
Sheila M. Ebert
Lisa Buckley
Jangwoon Park
Matthew P. Reed

University of Michigan Transportation Research Institute

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16. Abstract

Previous studies have demonstrated that many drivers position their belts suboptimally. The lap portion of the belt is often higher and farther forward relative to the pelvis than would be ideal, and the shoulder portion of the belt is often placed more outboard than the position that would provide the best restraint. This project evaluated the performance of a video-based intervention and a subsequent scripted in-person interaction for improving the belt routing obtained by drivers. The belt fit video intervention can be found here: doi:10.7302/Z23B5X3K. Twenty-nine adult drivers participated in this study. Belt fit was measured before and after the intervention in participants' vehicles and in a laboratory mockup. Standard anthropometric measures were obtained and the participants completed several questionnaires to document participant health beliefs and to assess how the participants perceived the video intervention. The results provide preliminary evidence that an intervention could improve driver belt fit. Data from both the in-vehicle and in-laboratory belt measures found that 93% of participants sampled improved some aspect of lap belt fit in response to the intervention. Participants who lowered the lap belt location (Z) after the intervention, showed an improvement of 40 mm on average. This delta value is slightly less than the width of the belt used in this study (45 mm). Among those participants who shifted the horizontal lap belt location (X) rearward, closer to the pelvis, an average improvement of 50 mm delta was observed. Indices of behavioral modifications also aligned with the belt fit score improvements. More research will be needed to establish whether this intervention would be effective outside of the laboratory setting.

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CONTENTS

1. ABSTRACT

Previous studies have demonstrated that many drivers position their belts suboptimally. The lap portion of the belt is often higher and farther forward relative to the pelvis than would be ideal, and the shoulder portion of the belt is often placed more outboard than the position that would provide the best restraint. This project evaluated the performance of a video-based intervention and a subsequent scripted in-person interaction for improving the belt routing obtained by drivers. Twenty-nine adult drivers participated in this study. Belt fit was measured before and after the intervention in participants' vehicles and in a laboratory mockup. Standard anthropometric measures were obtained and the participants completed several questionnaires to document participant health beliefs and to assess how the participants perceived the video intervention. The results provide preliminary evidence that an intervention could improve driver belt fit. Data from both the in-vehicle and in-laboratory belt measures found that 93% of participants sampled improved some aspect of lap belt fit in response to the intervention. Participants who lowered the lap belt location (Z) after the intervention, showed an improvement of 40 mm on average. This delta value is slightly less than the width of the belt used in this study (45 mm). Among those participants who shifted the horizontal lap belt location (X) rearward, closer to the pelvis, an average improvement of 50 mm delta was observed. Indices of behavioral modifications also aligned with the belt fit score improvements. More research will be needed to establish whether this intervention would be effective outside of the laboratory setting.

2. INTRODUCTION

UMTRI research has shown that many drivers position the lap portion of the belt higher on the abdomen than would be ideal. Figure 1 shows examples of poorly positioned belts observed in a laboratory study (Reed et al. 2013). Placing the lap belt high or forward introduces slack in the seat belt restraint system by routing the belt further away from the underlying skeletal structures (Reed et al., 2012; Reed et al., 2013) and may increase the risk of submarining and abdominal injury, particularly in frontal crashes. Data from repeated trials in the previous study demonstrated that some drivers may be able to place the belt lower, in a more advantageous position. These findings raise the possibility that drivers could be trained to improve their belt donning behavior.

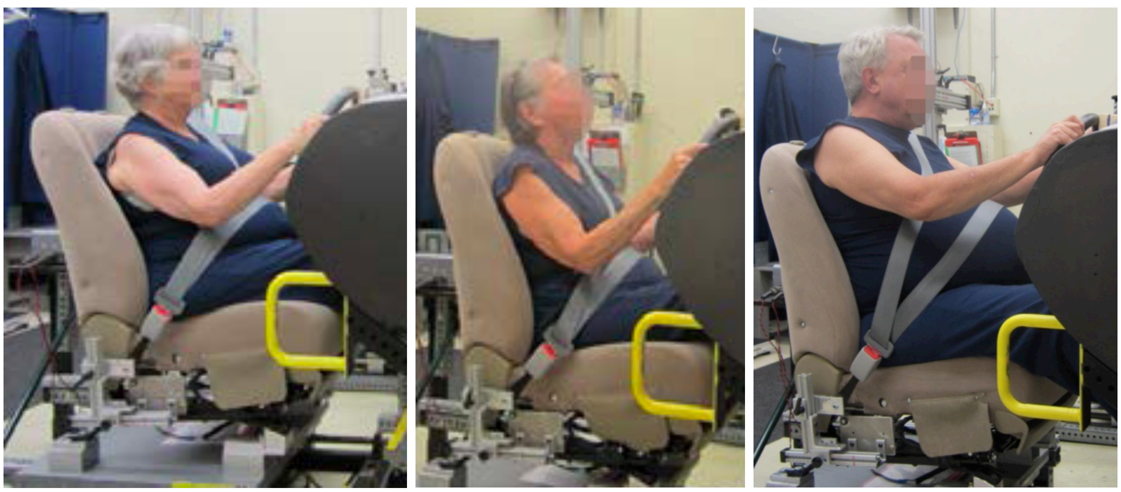


Figure 1. Examples of poor bet fit on participants in Reed et al 2013.

Many transportation safety intervention studies have focused on the promotion of seat belt use. To our knowledge prior research has not addressed improvement in belt donning with respect to seat belt fit. This report presents a pilot study that evaluated the efficacy of a short, video-based intervention and a scripted in-person interaction to supplement the video presentation both intended to show drivers how best to put on their belt, with a focus on lap belt fit. This study examined belt fit for a small cohort of adult drivers.

For the purpose of this study, a video-based tutorial was developed to present the most important aspects of good belt fit. The objective of the video-based intervention was to increase knowledge the appropriate way to wear a belt. Messaging targeted how a safety belt should be routed with respect to an individual's anatomy to ensure a proper fit. Additional context about the benefits of good belt fit was also presented.

2.1. Belt Fit Intervention

The intervention was designed using a theory-based approach to health behavior messaging. A well-designed communication message is typically based on a behavior change theory, often taken from fields of psychology or communication (Hutchinson & Wundersitz, 2011). Behavior change theory provides structure, logic, and coherence to identifying and describing factors of influence (Glanz et al., 2015). Good theories are parsimonious, supported by research, and clearly predict the target behaviors within the desired context (Buckley & Sheehan, 2004).

The Health Belief Model (HBM) is one of the most widely used conceptual frameworks for understanding and predicting health-related behaviors (Sugg Skinner, Tiro, Champion, 2008). HBM suggests that there are three components to creating behavior change: (1) recognition of harm (e.g., perceived susceptibility to, and perceived seriousness of, an injury due to incorrect seat belt use); (2) real implications for the individual (e.g., they will be injured from incorrect seat belt use); and (3) changing their behavior reduces or ameliorates their exposure to the harm and that reduction outweighs costs associated with behavior change (e.g., inconvenience). The theory suggests that individual perceptions (*susceptibility, severity*) and modifying factors (*perceived threat, environmental factors* that exacerbate threat, and *cues to action* that prompt behavior) combine to effect *likelihood of action*. More recently, *self-efficacy*, or a belief in one's ability to perform the new behavior, is considered a modifying factor. The *likelihood* of *action* is also affected by the individual's perceptions of *benefits* and *barriers* to behavior (correct seat belt use).

Perceived susceptibility is an interpretation of personal risk and s*everity or perceived seriousness* considers the individual's belief about the seriousness of the health condition or harm and is often based on knowledge. A perception of threat is thus likely when the potential for harm is serious and poses a real risk to the individual. Modifying environment factors to action might include variables such as culture, education, and past experience with *cues to action* considering the people, events, or other prompts that move people to the behavior. With regard to *benefits*, an individual may consider the value or usefulness of the new behavior in ameliorating harm and in considering *barriers*, the new behavior must be considered easy to adopt with the benefits of the new behavior outweighing costs. The relevant potential harmful consequence of the behavior may be different for individuals. For some it may be injury outcomes while for others it may be a citation or family pressure.

Although the HBM has not previously been applied to promoting the correct use of a seat belt, it has been applied to other transportation safety behaviors, including the use of a seat belt (compared with no use or limited use). Research has shown barriers to seat belt use (e.g., being "user-friendly") and benefits (e.g., they decrease injury in the event of crashes) are associated with use (Simsekoglu & Lajunen, 2008;

Fernandes, Hatfield, & Job, 2010). The salience of risk of injury from failure to wear seat belts has also been associated with increased use (Weinstein et al., 1986).

2.1.1. *Video Intervention*

To develop the video intervention, an inter-disciplinary team of experts was assembled that included automotive safety experts, injury biomechanics researchers, behavior psychologists, and communication and video production specialists. Multiple revisions of the script for the video-based intervention were undertaken and reviewed by the experts. A pilot evaluation was conducted to assess terminology for the anatomical reference of the belt position, and to evaluate the video tutorial script and proposed graphics. Twenty-four participants provided feedback that was incorporated into the video script and informed future research direction.

The objective of the video was to increase knowledge about the benefits of safety belts and how to wear them correctly. Messaging was targeted to how a safety belt should be routed with respect to an individual's anatomy to ensure a proper fit. Figure 2 shows stills of the video that illustrate these concepts. Appendix A contains a full transcript of the video. The three key belt fit concepts conveyed in the video are as follows:

1) Lap belt low on hips, touching the thighs
2) Shoulder belt crossing middle of collarbone
3) Belt snug, as close to bones as possible

Figure 2. Still images from video intervention demonstrating moving the lap belt low across the hips, centered on collarbone and snug against the body

The belt fit video intervention can be found here: doi:10.7302/Z23B5X3K.

2.1.2. *In-Person Instruction*

An in-person intervention was developed to provide scripted guidance on improving belt fit, following the guidance in the video but intervening to show the participant how to optimize the belt position. The script of this intervention is in Appendix B.

3. METHODS

3.1. Study Design and Protocol

The pre- and post-intervention design evaluated belt fit measures before and after the video-based and scripted intervention on participants in their own vehicles and in a laboratory mockup. Figure 3 illustrates the study design and outlines the sequential components of the protocol.

Initial baseline evaluation of belt fit was measured in a participant's vehicle upon arrival to the study. Participants were then escorted to the vehicle mockup to complete the in-laboratory component of the study. Anthropometric measures and joint landmarks were taken (Appendix E). Participants were trained on the adjustable features in the vehicle mockup and provided time to familiarize and adjust to obtain a comfortable driving posture. Three replicates of baseline measures were then recorded. Participants responded to the demographic questionnaire (Appendix F) and were asked to view the belt fit intervention video (Appendix A). Immediately following the video, participants donned the seat belt in the vehicle mockup for the post-video intervention measurement. A questionnaire evaluating the video was conducted (Appendix G). The final series of in-laboratory belt measures were the post-in-person intervention in which the investigators provided feedback on the specifics of belt fit (Appendix B). Lastly, participants returned to their own vehicles to complete a post-intervention in-vehicle belt fit measurement. Upon conclusion of the belt fit measurements, participants responded to the Health Belief Model questionnaire (Appendix H) and a questionnaire designed to evaluate their knowledge of where the lap and shoulder seat belt should be located to ensure maximum safety protection (Appendix I). Two-weeks following participation in the study, participants were asked to response the Health Belief Model questionnaire again.

Some deception of the participants was necessary to quantify the effectiveness of the belt fit intervention (Appendix J). To avoid drawing attention to the seat belt before the baseline measurement, the participants were told only than they were volunteering for a study evaluating vehicle component but did not know the study was focused on belt fit. Participants were told that "vehicle components" referred to safety devices in the vehicle (i.e. air bags, side air curtains (curtain shield airbag (CSA)), belt fit relative to load pre-tensioners). It was explained that the objective was to measure posture in the vehicle relative to the location of these safety features as a measure of effectiveness.

The study was conducted in a vehicle high bay and laboratory space at the University of Michigan Transportation Research Institute (UMTRI). The study protocol was approved by the University of Michigan Institutional Review Board (IRB) for Health Behavior and Health Sciences (IRB#: HUM00104350).

Licensed, adult drivers who owned a vehicle and or borrowed a vehicle that they had driven three or more times previously were recruited through online advertisements and word of mouth. Written informed consent was obtained using a form approved by the IRB (Appendix C). The instructions to the participants were scripted (Appendix D).

The detailed methods of this study in the following sections are described in the sequential order in which participants completed the study.

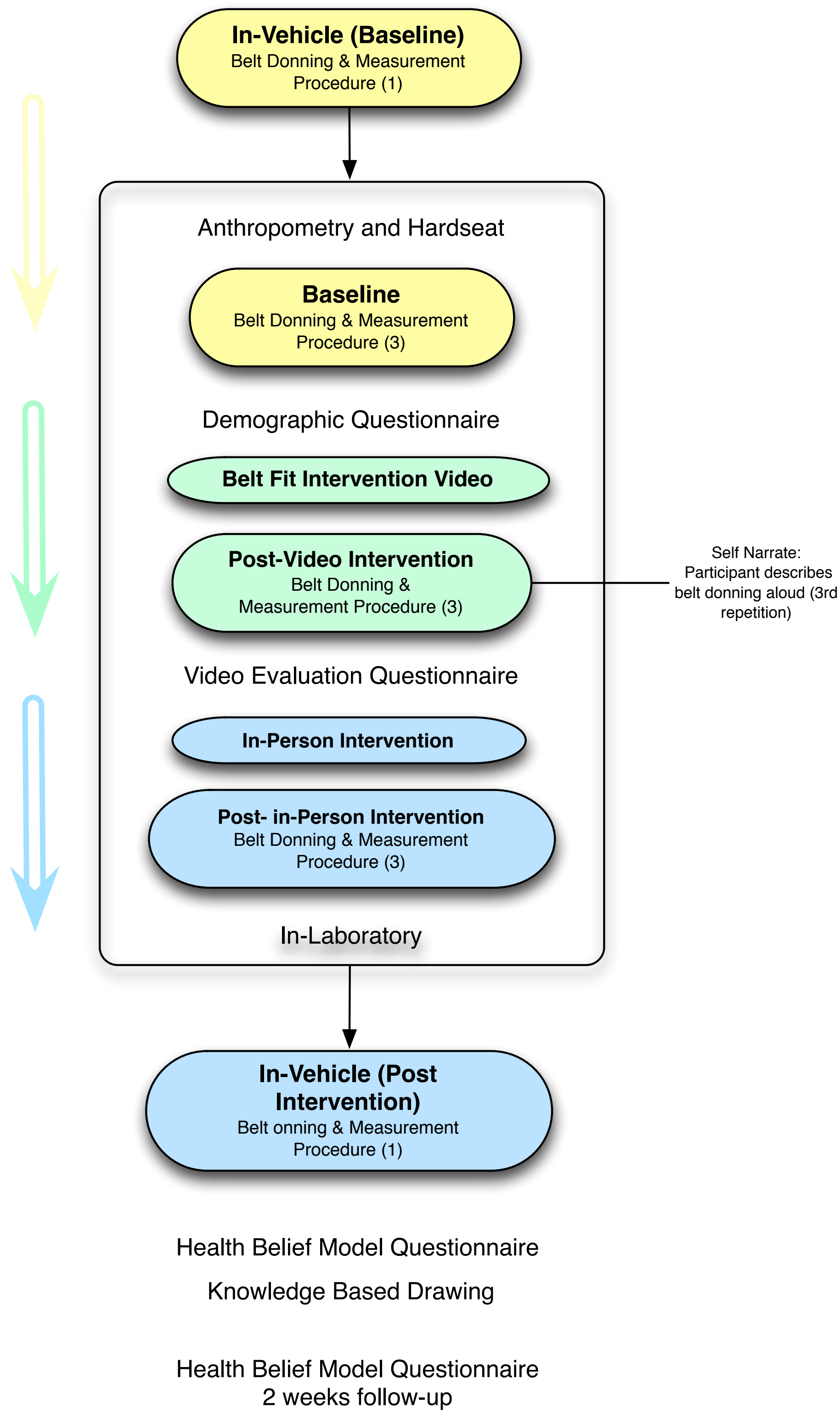


Figure 3. Study design illustration. Arrows indicate the flow of participant testing from baseline (pre intervention) through video and in-person interventions

3.2. Participants

3.2.1. Anthropometry

Twenty-nine adults (15 women and 14 men) half of whom were obese (BMI>=30 kg/m2) or 65 years or older participated. Standard anthropometric measures were taken on each participant to characterize overall body shape and size using manual measurements described in Appendix E. All participants were obtained with the participants in their own clothing. Table 1 summarizes the standard anthropometric data.

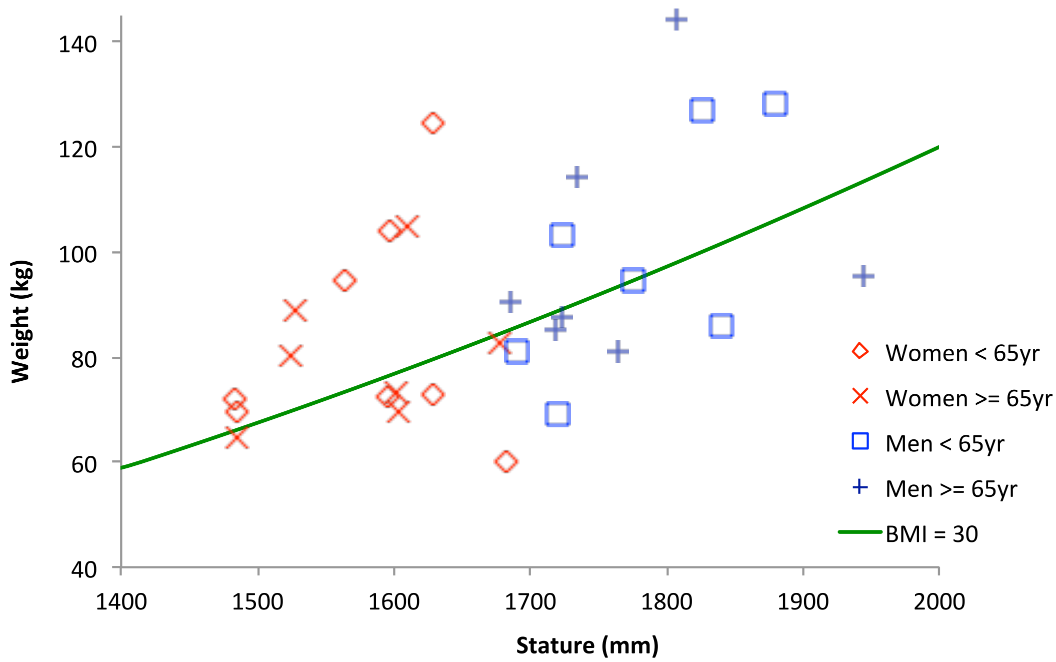


Figure 4. Weight versus stature by age and gender of participants.

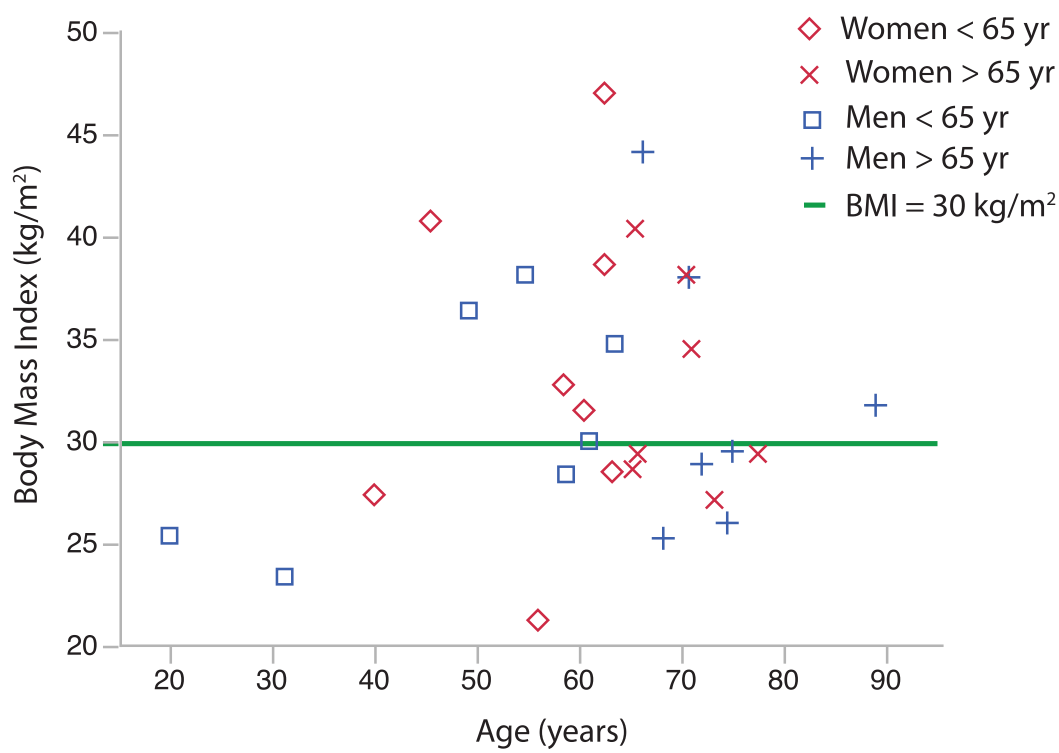


Figure 5 Body mass index (kg/m²) versus age (years) for women (◇ < 65 yrs., × > 65 yrs) and men (□ < 65 yrs, + > 65yrs). Horizontal line shows obesity threshold (BMI ≥ 30kg/m²).

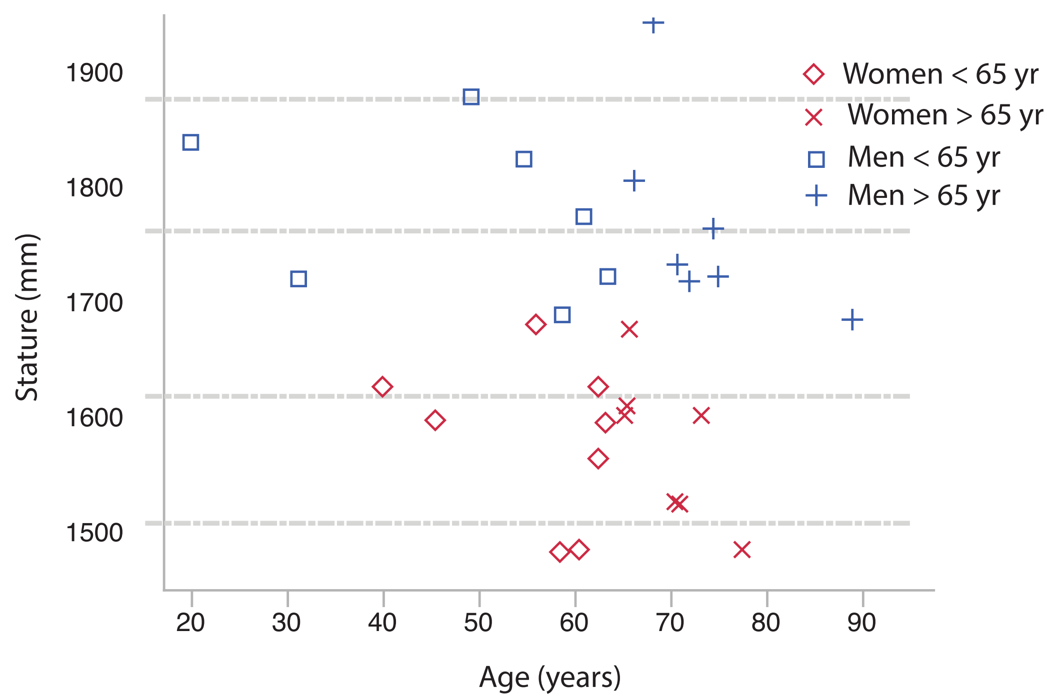


Figure 6 Stature (mm) versus age for women (◇ <65 yrs. × > 65 yrs) and men (□ <65 yrs, + > 65yrs). Horizontal line shows 5th-percentile female, 50th –percentile male, and 95th –percentile statures for the U.S. population (Fryar et al. 2012).

Table 1. Summary of Standard Body Measurements

Measurement (mm unless noted)	Mean	Min	Max	Percentiles 5th	25th	50th	75th	95th
Age (years)	62	20	89	35	58	63	71	76
Stature (with shoes)	1673	1483	1944	1485	1597	1682	1734	1864
Stature (without shoes)	1656	756	1970	1468	1585	1674	1754	1887
Weight (kg)	90.4	60.3	144.1	66.5	72.7	86.0	103.3	127.9
BMI (m/kg^2)	32	21	47	24	28	30	38	43
Erect Sitting Height	877	759	1000	785	838	878	906	979
Eye Height (Sitting)	764	665	877	681	734	758	794	864
Acromial Height (Sitting)	590	502	675	515	559	587	626	662
Knee Height	532	457	630	466	502	529	558	605
Tragion to Top of Head	121	107	136	107	115	124	125	131
Head Length	193	150	215	175	187	195	199	212
Head Breadth	154	138	184	139	147	154	158	170
Shoulder-Elbow Length	345	313	417	207	342	364	380	402
Elbow-Hand Length	459	400	531	405	430	468	479	515
Maximum Hip Breadth	421	362	532	370	396	416	435	491
Buttock-Knee Length	617	361	713	563	598	623	645	682
Buttock-Popliteal Length	517	446	582	473	505	514	540	562
Bi-Acromial Breadth	378	328	433	337	353	383	396	427
Shoulder Breadth	471	401	588	407	443	464	488	575
Chest Depth (Scapula)	296	225	402	232	273	299	318	363
Chest Depth (Spine)	240	193	309	206	217	233	257	295
Bi-ASIS Breadth	225	190	261	193	212	225	235	258
Chest Circumference (Axilla)	1091	879	1325	966	1009	1090	1145	1274
Waist Circumference (Omphalion)	1090	814	1711	829	970	1066	1181	1400
Hip Circumference (Buttocks)	1161	1006	1483	1032	1080	1135	1225	1424
Upper Thigh Circumference	659	554	842	564	602	643	700	782

3.2.2. Demographics

Demographics were recorded through a written questionnaire (Appendix F). Ninety percent of the participants were white and all had completed high school or a GED with 97% having at least some college education (Figure 7). According to the U.S. Census Bureau, 58% of U.S. citizens have some college education. Fifty-one percent of the participants reported a total household income that was at or above $60,000 (Figure 8). The median U.S. household income estimate for 2014 was $53,657 according to the 2015 Census Report.

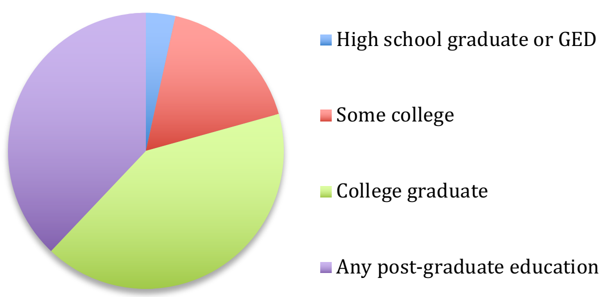


Figure 7. Education level reported by participants

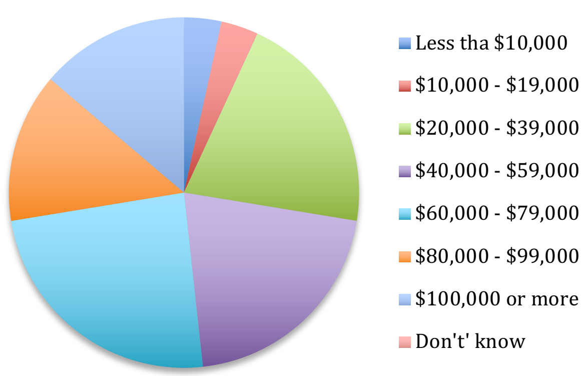


Figure 8. Household income reported by participants

3.3. In-Vehicle Baseline Belt Fit

When participants arrived for testing, they were directed to drive into the UMTRI high bay area in their own vehicles, shift the vehicle to park, turn off the engine, and remain seated with their belts on (Figure 9). While the participants sat in their vehicles, the investigator read a scripted introduction (Appendix D) and the participant read and signed a consent form (Appendix C). Table 2 lists the vehicles in which the participants were tested. The vehicles included fourteen cars, twelve SUV/crossovers, three light trucks, two minivans and one conversion van spanning the 1992 to 2015 model years, with a median and mean 2007 model year. The National Transportation Statistics Report updated January 2016 lists the 2014 average age of automobiles and trucks to be 11.4 years and the average age of household vehicles in 2009 to be 9.5, 8.7, 7.1 and 11.2 years for cars, vans, SUVs and pickup trucks respectively. The market share of vehicles sold in the U.S. in the years 2000 and 2013 were 66.6% and 50.5% for cars, 2.9% and 5.1% for car SUV, 6.3 % and 20.6% for Truck SUV, 10.0% and 9.3% for vans, and 15.4% and 14.5% for pickups (National Transportation Statistics 2016).

Figure 9. A participant sitting in her vehicle in her driving position

Table 2. List of the participant vehicles

Cars			Sport Utility and Crossover Vehicles		
Chevy	Impala	2004	Chevy	Equinox	2010
Chrysler	PT Cruiser	2007	Ford	Escape	2015
Ford	Cmax Energi	2012	Ford	Explorer	2007
Ford	Fusion	2014	Jeep	Grand Cherokee	2012
Honda	Accord	2003	Lexus	RX350	2014
Honda	Insight	2011	Nissan	Rogue	2013
Hyundai	Azera	2007	Pontiac	Aztek	2001
Mercury	Mystique	1999	Toyota	4Runner	1998
Nissan	Maxima	2001	Chevy	Equinox	2010
Toyota	Camry Hybrid	2006	Ford	Escape	2015
Toyota	Camry	1998	Ford	Explorer	2007
Toyota	Corolla	2010	Jeep	Grand Cherokee	2012
Toyota	Matrix	2003			
Volvo	S60	2002			
Trucks			**Minivans and Vans**		
Chevy	Silverado	2009	Chevy	Uplander	2005
GMC	Sierra	2014	Chrysler	Town & Country	2011
Nissan	Frontier	2004	Chevrolet	Van 20	1992

An investigator instructed the participant to maintain his or her driving position with hands on the steering wheel, right foot on the accelerator, and left foot on the vehicle floor. The investigator used a FARO Arm coordinate measurement machine to record body landmark locations and points on the belt to define where the belt crossed the clavicle, sternum, and the pelvis at the lateral position of the right and left anterior-superior iliac spine (ASIS) (Figure 10). Tables 3 and 4 list the individual points and streams of continuous points recorded.

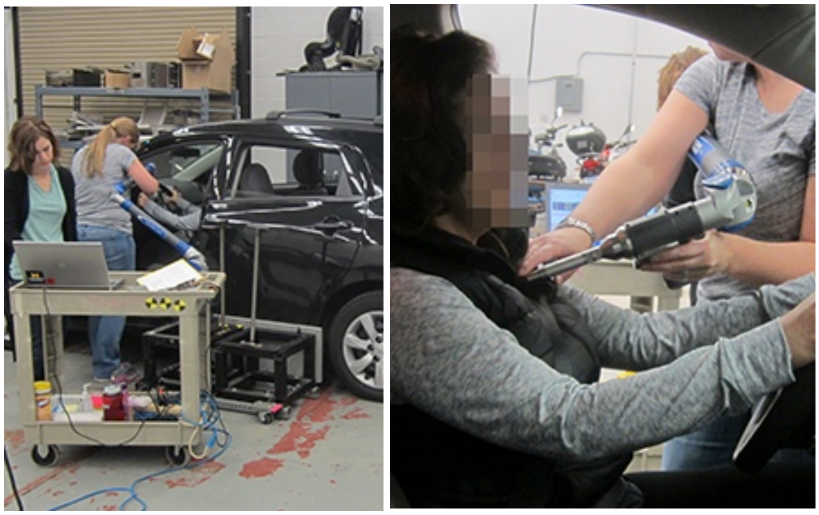


Figure 10. Investigators digitizing belt fit on study participant

Table 3. Points Data Recorded on Participant and Vehicle

Participant	Shoulder Belt	Vehicle Points
C7 (Cervicale)	Inboard and Outboard Edge on Clavicle	Floor at Participant's Heel
Back Of Head (Max Rearward)	Top and Bottom Edge at participant's midline	Steering Wheel (Top and bottom)
Top Of Head (Max Height)	Inboard Edge at participant's suprasternale height	Rocker Panel (3)
Tragion Lt		Seat track adjustment range
Ectoorbitale Lt	Lap Belt	Accelerator Pedal (8 pts)
Infraorbitale at Pupil Center Lt	Top Edge and Bottom edge at ASIS lateral position (Lt & Rt) and at Participant's Midline	Instrument Panel Center
Glabella		
Suprasternale	Restraint System	Seat
Substernale	Lower Anchorage Bolts	Seat Cushion References (2)
Medial Clavicle Lt	Lower Anchorage Webbing contact points	Seat Back References (2)
Lateral Clavicle Lt	Lower Anchorage interaction with seat surface	Top of Head Restraint
Anterior of Acromion L	Buckle Rotation range	
Lateral Humeral Epicondyle Lt	Upper Anchorage pivot point	Outside of the Vehicle
Ulnar Styloid Process, Lateral Lt	Upper Anchorage at D-ring	Ground (3)
ASIS Lt and Rt	Upper Anchorage adjustment range	CMM Cart Coordinate System (3)
Suprapatella Lt and Rt		
Infrapatellata Lt		
Lateral Femoral Epicondyle Lt		
Medal Femoral Epicondyle Rt		
Toe (Bottom edge of sole, longest shoe point) Lt		
Ball of Foot Lateral Lt		
Ball of Foot Medial Rt		
Heel (Bottom edge of sole at midline) Lt & Rt		
Lateral Malleolus Lt		
Medial Malleolus Rt		
Clothing surface (max) at lap belt		
Clothing surface (min) compressed or moved at lap belt		

Table 4. Streams of Continuous Point Data Recorded on Participant and Vehicle

Participant	Shoulder Belt	Seat without participant
Sagittal line running anteriorly from shoulder to ankle located laterally at mid shoulder	Top / inboard edge of the belt from latch plate to D-ring	Contours of seat back and seat cushion
	Lap Belt	Outside of the Vehicle
	Top edge of the belt from latch plate to as close to the lower outboard anchor as possible	Driver door opening

3.4. Laboratory Anthropometry and Hardseat

After exiting the vehicle, the participant was brought to the laboratory where standard anthropometry (described above) was completed.

Standard anthropometric measures in Table 5 and described in Appendix E were taken on each participant to characterize overall body size and shape using manual measurements. All measurements were obtained with the participants in their street clothes with any bulky items and their belt removed, except that stature was measured with and without footwear to characterize heel height. Table 1 summarizes the standard anthropometric data.

Table 5. Standard Anthropometric Dimensions

1	Weight	12	Maximum Hip Breadth
2	Stature (with shoes)	13	Buttock Knee Length
2.5	Stature (without shoes)	14	Buttock-Popliteal Length
3	Erect Sitting Height	15	Biacromial Breadth
4	Eye Height (Sitting)	16	Shoulder Breadth
5	Acromial Height (Sitting)	17	Chest Depth (on a scapula)
6	Knee Height	18	Chest Depth (on spine)
7	Tragion to Top of Head	19	Bispinous (BiASIS) Breadth
8	Head Length	20	Chest Circumference at Axilla
9	Head Breadth	21	Waist Circumference
10	Shoulder Elbow Length	22	Hip Circumference at Buttocks
11	Elbow-Hand Length	23	Upper Thigh Circumference

The bispinous breadth (distance between left and right ASIS landmarks) was then set on the digitizing tool in Figure 12, which was used to assist the investigator when locating the ASIS points in the vehicle mockup. Body landmark locations were recorded in the laboratory hardseat show in Figure 11. The hardseat allows access to posterior spine and pelvis landmarks that are inaccessible in the automotive seat. The hardseat has a 14.5° "cushion" (pan) angle and a 23° back angle designed to produce postures similar to those in an automotive seat. Table 6 lists the landmarks recorded in the hardseat.

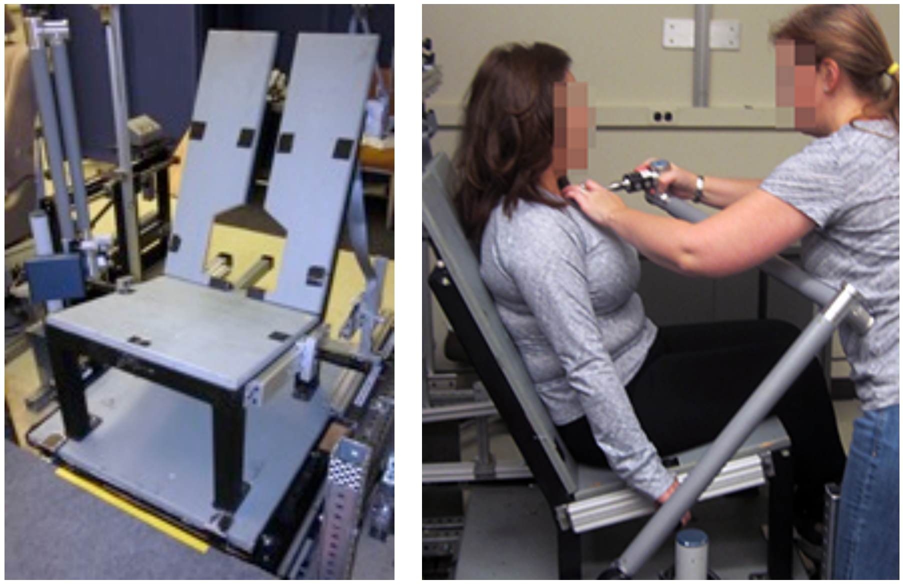


Figure 11. Hardseat for postures (left) and an investigator using a FARO Arm coordinate measurement machine to digitize skeletal landmarks

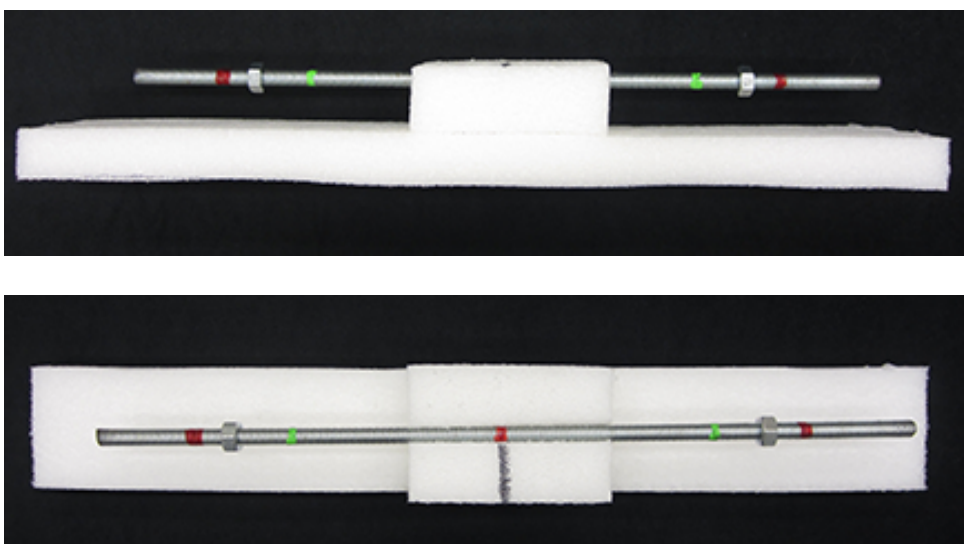


Figure 12. Tool used to aid in finding the ASIS points in the vehicle mockup. The locations of the nuts on the threaded rod were adjusted to the participants bispinous (bi-ASIS) breadth recorded during standard anthropometry.

Table 6. Hardseat Points

Back if Head	Lateral Femoral Epicondyle Lt and Rt
Top Of Head (Vertex)	Medial Femoral Epicondyle Lt and Rt
Tragion Rt and Rt	Lateral Fibular Head Lt and Rt
Ectoorbitale Lt and Rt	Medial Tibial Condyle Lt and Rt
Infraorbitale at Pupil Center Lt and Rt	Tibial Tuberosity Rt
Glabella	Suprapatella Lt and Rt
Acromion Lt and Rt (Anterior)	Infrapatella Lt and Rt
Medial Clavicle Lt and Rt	Heel Lt and Rt
Lateral Clavicle Lt and Rt	Malleolus Lateral Lt and Rt
Acromion Lt and Rt (Anterior)	Malleolus Medial Lt and Rt
Humeral Epicondyle Lateral Lt and Rt	Ball of Foot Lateral Lt and Rt
Humeral Epicondyle Medial Lt and Rt	Toe (Longest Tibiale) Lt and Rt
Ulnar Styloid Process Lt and Rt	Ball of Foot Medial Lt and Rt
Radial Styloid Process Lt and Rt	ASIS Lt and Rt
Lateral Hand Lt and Rt	PSIS Lt and Rt
Medial Hand Lt and Rt	
Suprasternale	<u>Estimates (Due to Clothing)</u>
Substernale	T4, T8, T12
C7 (Cervicale)	L1 - L5

3.5. In-Laboratory Baseline Belt Fit

3.5.1. Vehicle Mockup

Figures 13-16 shows the vehicle mockup used for testing, which was based on the mockup used in a previous study of posture and belt fit (Reed et al. 2013). A steering wheel and instrument panel from a 2010 Toyota Corolla were modified for mounting in the laboratory and set up in the left-side drive configuration typical of U.S. vehicles. Accelerator and brake pedals were mounted to an adjustable arm attached to a moveable floor, so that the both the fore-aft and vertical relationship between the floor and the steering wheel could be changed to represent a wide range of vehicle configurations. The pedals were connected to springs so that pressing the pedals produced typical amounts of travel. A seat from a 2010 Toyota Highlander that provided adjustability for height, cushion angle, and seat back angle was installed on a rail system that provided additional fore-aft adjustability. Powered seat mechanisms provided 239 mm of continuous fore-aft adjustability along a track inclined 5 degrees from horizontal, 50 mm of vertical adjustability, and cushion angle adjustment from 11.5 to 17.5 degrees. As is typical of powered seats, cushion angle adjustment was constrained at the highest and lowest seat positions. Seat back angle was continuously adjustable and essentially unlimited (no participant hit the end of the range of travel). The head restraint was removed to provide better access to the participant for measurements.

The seat belt assembly with sliding latch plate and retractor are from the second row of a model year 2011 Toyota Sienna was mounted on customized fixtures designed to permit adjustment of belt anchorage locations. The second-row belt was used to ensure sufficient webbing length for all participants. A rigid buckle stalk was attached to the seat with an adjustable fixture. The outboard lower anchorage was attached to the mockup, rather than the seat, simulating a belt mounted to the vehicle body. The retractor and vertically adjustable D-ring (4 stops) were mounted to B-pillar trim from a 2011 Toyota Sienna. The belt webbing width was 45 mm. The D-ring and lower anchorage were set to locations relative to the seat H-point (J826) as described by FMVSS 210. The lower anchorages were set to an angle of 52° relative to horizontal, which is in the middle of the FMVSS allowable range of 30° to 75°. The D-ring was mounted so that the pivot point when set to one setting above the lowest position was 21° relative to vertical.

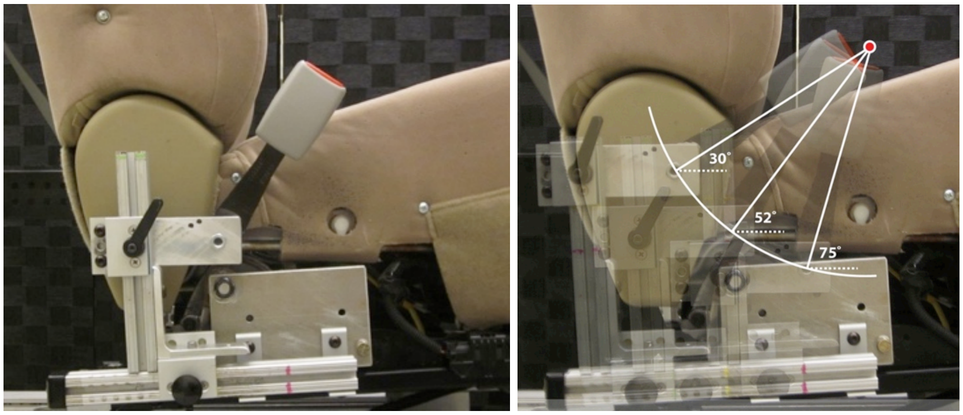


Figure 13. Lap belt buckle anchorage for this study set at 52° to seat H-point (J826) relative to horizontal (left) at the middle of the range permissible by FMVSS 210 (right)

Figure 14. Vehicle mockup detail of seat and upper anchorage with D-ring adjusted to one stop below bottom and its pivot center mounted 21° from vertical with respect to the seat H-point (J826)

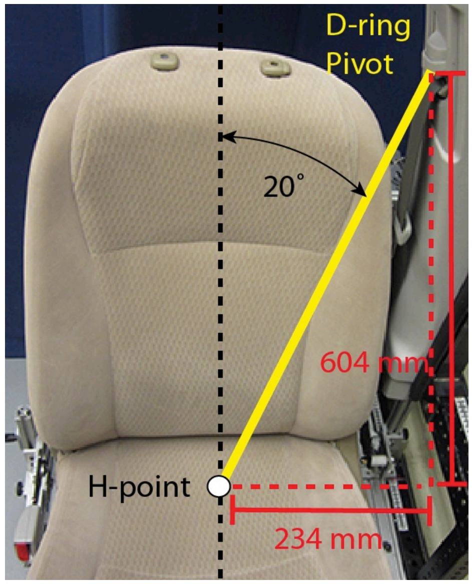


Figure 15. D-ring adjusted to one stop below bottom and its pivot center mounted 21˚ from vertical with respect to the seat H-point (J826

The package was set to dimensions of a typical midsized sedan as show in Figures 13- 16. The steering wheel was set to 550 mm aft of BOF (SAE L6), 646 mm above the heel surface (SAE H17) and was fixed at an angle of 28˚ relative to vertical. Seat height (SAE H30) was set to 270 mm at mid vertical travel. The starting position of the seat H-point aft of AHP was initially set to 805 mm for women and 907 for men. Seat back and cushion angles were initially set to 23˚ relative to vertical and 14.5˚ relative to horizontal respectively (SAE J826).

In both the vehicle mockup and in each of the participants' vehicles the orientation of the right-handed coordinate system followed SAE J1100 with +X pointing rearward parallel to the long axis of the vehicle/mockup, +Y pointing to the passenger side of the vehicle and +Z pointing up. However, the origin was placed outboard to the driver position.

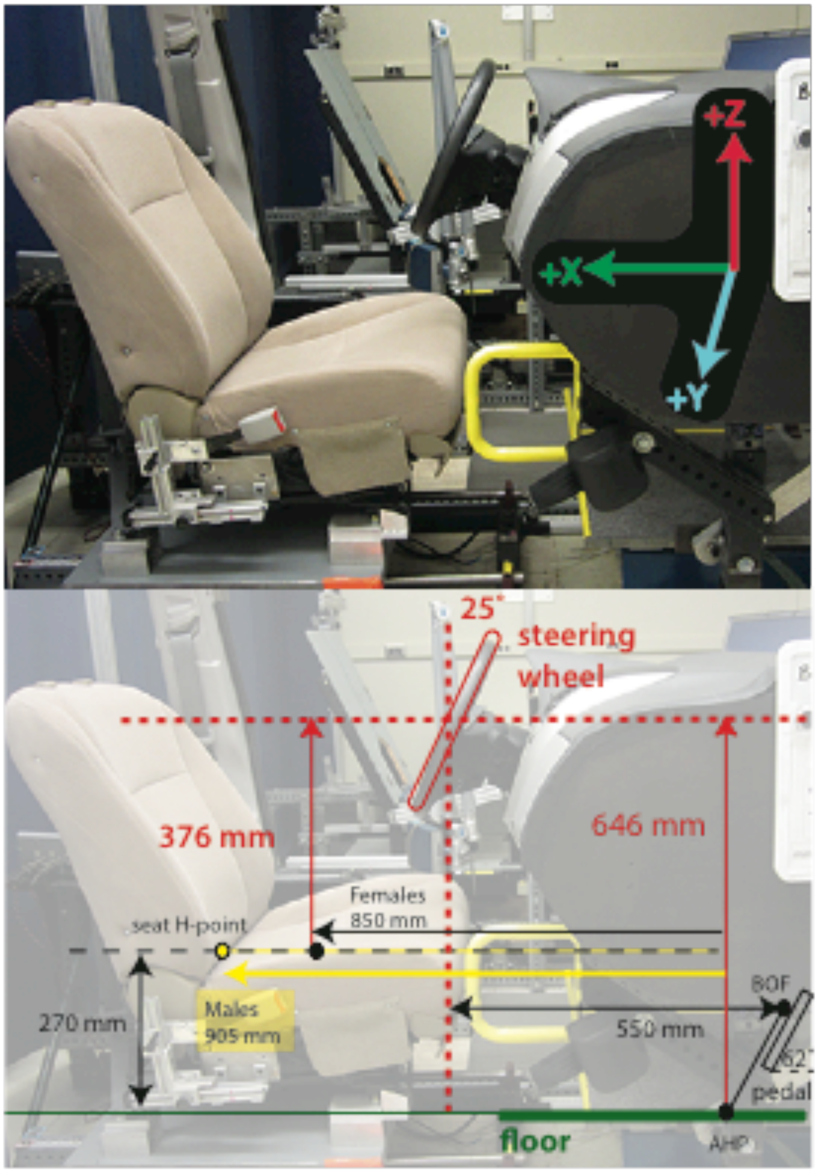


Figure 16. Package dimensions of vehicle mockup. Fore-aft and up-down H-point locations are starting positions; participants were able to adjust the seat fore-aft and up-down position, and the seat back and seat cushion angle to their preferred posture.

While seated in the driving mockup, the participant was trained in the operation of each seat adjuster and demonstrated use of the components for the investigator. The initial positions of each participant-adjustable component were set to the same midrange values prior to each trial. The participant entered the mockup and adjusted the seat (fore-aft position, vertical position, cushion angle, backrest angle) to obtain a comfortable driving posture. The participant then donned the belt and assumed a normal driving posture. After adjusting the seat during the first trial the seat was not adjusted again.

The investigator used the FARO Arm coordinate digitizer to record the three-dimensional locations of landmarks on the participant's body and on the mockup, seat, and belt (Table 7). In addition, a stream of points with approximately 5-mm spacing was recorded along the edges of lap and shoulder portions of the belt between the anchorages and latch plate (Figure 18). Streams of points were also recorded to characterize the shape of the participant while seated in the mockup. The contours recorded were the superior surface of the shoulder, the anterior surface of the clavicle, and two sagittal lines along the anterior from suprasternale to lap and from mid shoulder to mid thigh. After the measurements, the participant exited the mockup and was instructed to stand behind a screen while the investigators "made adjustments to the mockup." The investigator simply stowed the belt but did not adjust anything on the mockup and then asked the participant to sit in the mockup again. The participant donned the belt and the investigator took the same measurements on the participant, belts and mockup. This was repeated one more time for a total of three measurements.

Figure 17. Investigator reading script and demonstrating controls for adjustable components on the vehicle mockup (left) and participant adjusting the seat before donning the belt (right)

Table 7. Points Recorded on Participant and Vehicle Mockup

Participant	Mockup
C7 (Cervicale)	Accelerator Pedal
Back Of Head (Max Rearward)	Floor
Top Of Head (Max Height)	Steering Wheel Center
Tragion Lt	
Ectoorbitale Lt	Seat
Infraorbitale at Pupil Center Lt	*Measured before and after participant's adjustments*
Glabella	
Suprasternale	3 Points on Seat Cushion (references tracking up-down, fore-aft and tilt)
Substernale	
Medial Clavicle Lt	2 Points on Seat Back (references tracking recline angle)
Lateral Clavicle Lt	
Anterior of Acromion Lt	Restraint System
Lateral Humeral Epicondyle Lt	D-ring Reference Point
Ulnar Styloid Process, Lateral Lt	Lower Anchorage Reference Point
ASIS Lt and Rt	Buckle Reference Point
Suprapatella Lt and Rt	
Infrapatellat Lt	*Shoulder Belt:*
Lateral Femoral Epicondyle Lt	Inboard and Outboard Edge on Clavicle
Medal Femoral Epicondyle Rt	Top and Bottom Edge at Participant's Midline
Toe (Bottom edge of sole, longest shoe point) Lt	
Ball of Foot Lateral Lt	Inboard Edge at Participant's Suprasternale Height
Ball of Foot Medial Rt	
Heel (Bottom edge of sole at midline)Lt & Rt	*Lap Belt:*
Lateral Malleolus Lt	Top Edge and Bottom edge at ASIS lateral position (Lt & Rt) and at Participant's Midline
Medial Malleolus Rt	

Table 8. Streams of Continuous Point Data Recorded on Participant and Vehicle

Participant	Shoulder Belt
1) Along the top of the shoulder 2) Along the anterior of the clavicle 3) Mid Sagittal line running from suprasternale to lap 4) Sagittal line running anteriorly from shoulder to knee located laterally at mid shoulder	Top / inboard edge of the belt from latch plate to D-ring Lap Belt Top edge of the belt from latch plate to as close to the lower outboard anchor as possible

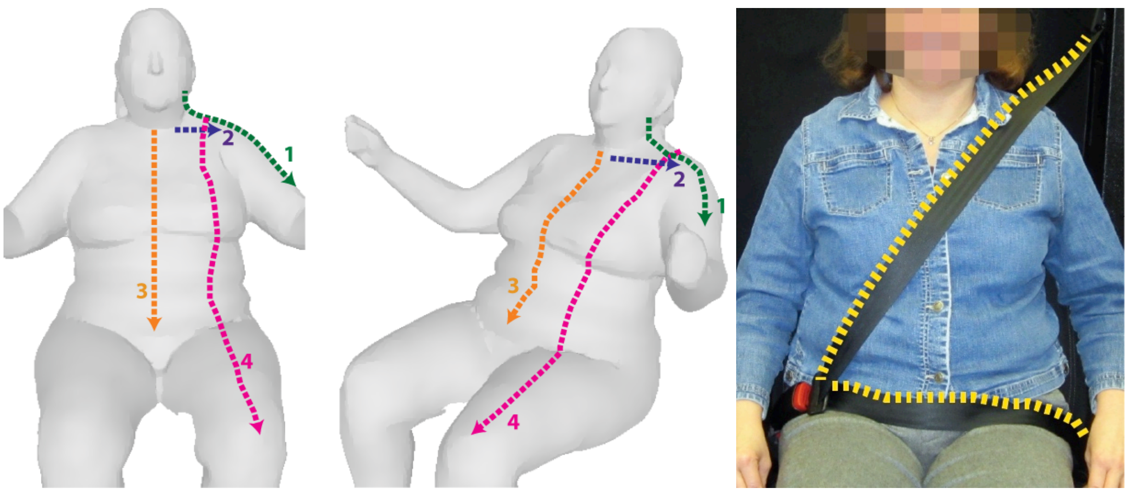


Figure 18. Illustration of the locations of streamed points on participant (left) and on belt (right)

3.5.2. Video Intervention and Belt Fit

After completing the baseline measurements in the mockup, the participants viewed the video intervention on a tablet computer in designated area of the laboratory (Figure 19), which required 1 minute 39 seconds. The participant then entered the driver mockup and repeated the belt donning and measurement procedure three times. During the third safety belt donning and measurement procedure, participants were instructed to orally describe the points of placement of their belt. This trial was recorded on video.

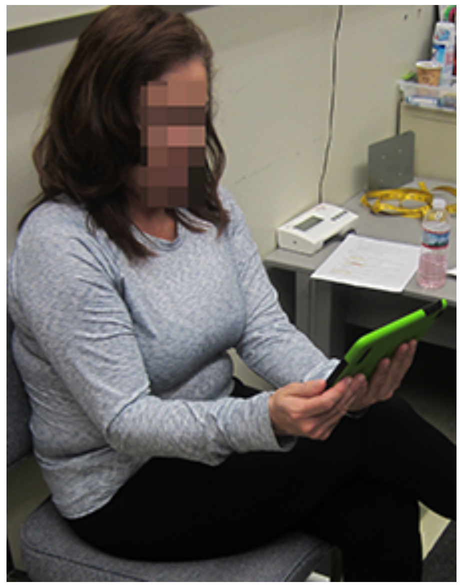


Figure 19. Participant viewing intervention video on tablet

3.5.3. In-Person Intervention and Belt Fit

The participant then entered the driver mockup for the third set of trials. Before handing the belt to the participant, the investigator read the scripted in-person intervention (Appendix B). The participant donned the belt. If the belt fit could be improved, the investigator helped the participant move the lap belt lower, locate shoulder belt more centered on the collarbone (by adjusting the D-ring up or down) or tightened the belt by pulling in the direction of the retractor. This process was repeated three times.

3.5.4. In-Vehicle Post Interventions

Upon completion of the in-laboratory trials the participant returned to his or her vehicle. After the participant entered the vehicle and was ready to drive, including donning the belt, the investigators repeated the point list and belt streams. The participant then completed the health beliefs questionnaire (Appendix H) and the illustration of proper belt fit (Appendix I).

3.5.5. Post Study Questionnaire and Debriefing

Participants were contacted by phone at least two weeks after their participation in the study and an investigator administered the health belief questionnaire again orally. Two months after the study completion, participants were mailed the debriefing statement in Appendix J to explain the true focus of the study.

3.6. Quantifying Belt Fit

Following methods used in a previous belt fit studies (Reed et al. 2012, Reed et al. 2013), lap belt fit was quantified by the fore-aft and vertical location of the upper/rearward margin of the lap portion of the belt at the lateral location of the anterior-superior iliac spine (ASIS) landmarks on the left and right sides of the pelvis (Figure 20). The correction for adiposity at the ASIS landmarks documented in Reed et al. (2013) was used. Shoulder belt fit was quantified by the lateral location of the inboard edge of the shoulder portion of the belt relative to the body midline at the height of the suprasternale landmarks (Figure 21). The Y-axis (medial lateral) distance between the body midline and belt is termed shoulder belt score (Reed et al. 2009, Reed et al. 2012, Reed et al. 2013 A fifth-order Bézier curve was fit to the lap and shoulder belt stream points to smooth measurement error.

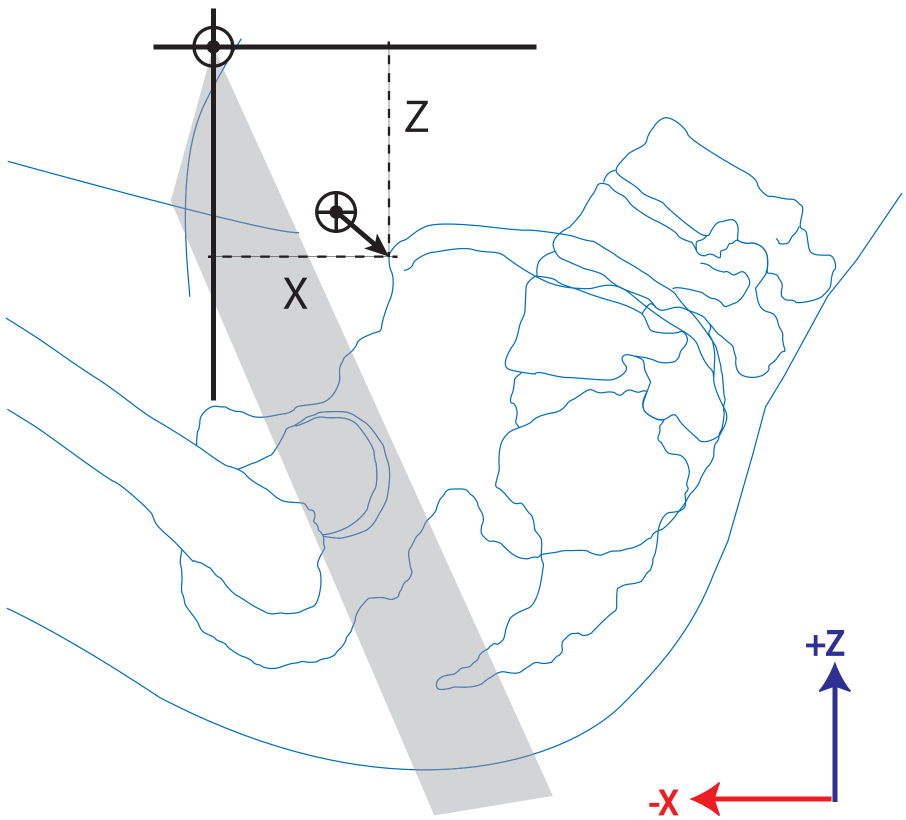


Figure 20. Locations of points recorded on the lap belt

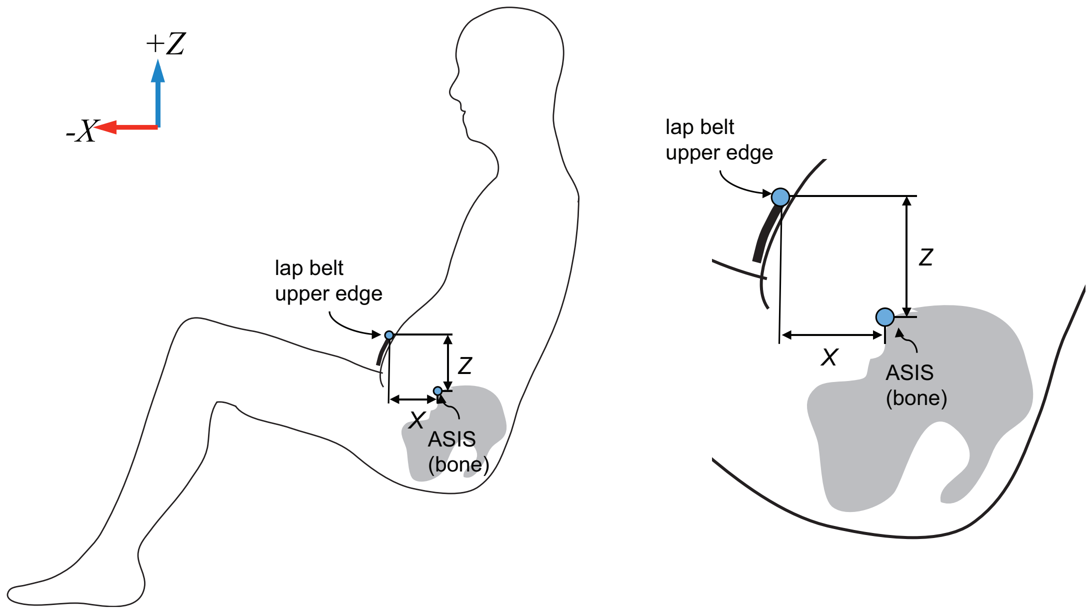


Figure 21. Dependent measures for lap belt fit. The upper/rearward edge of the lap portion of the belt is measured at the lateral position of the right and left the predicted ASIS location. The fore-aft (X) coordinate is positive rearward of the ASIS and the vertical coordinate is positive above the ASIS landmark.

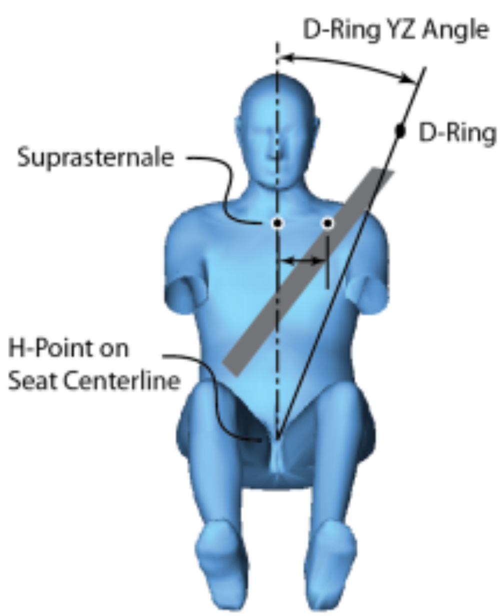


Figure 22. Torso (shoulder) belt fit measurement. Larger positive values indicate more-outboard belt placement. The definition of D-ring YZ Angle is also shown.

4. RESULTS

This analysis is based on comparisons using the mean of the left (outboard) and right (inboard) belt fit scores averaged across the three replicates for each test condition. Individual participant results are documented in Appendix K. Analysis of variance (ANOVA) and post hoc contrast tests were used to evaluate differences in mean lap belt X and Z scores across the test conditions. An alpha level of 0.05 was adopted for all post hoc t-tests.

4.1. In-Vehicle Belt Fit Measurement

Figure 23 shows the lap belt location with respect to ASIS for non-obese and obese participants for the baseline and post-intervention in-vehicle trials. Table 9 documents the mean and standard deviation values for the in-vehicle conditions.

Table 9. Mean (standard deviation) of Baseline and Post-Intervention In-Vehicle Lap Belt Scores (mm).

Condition	Mean Lap Belt X Score (SD)	Mean Lap Belt Z Score (SD)
Baseline In-Vehicle	-71.4 (41.5)	50.2 (29.3)
Post-Intervention In-Vehicle	-69.9 (34.3)	36.8 (18.9)

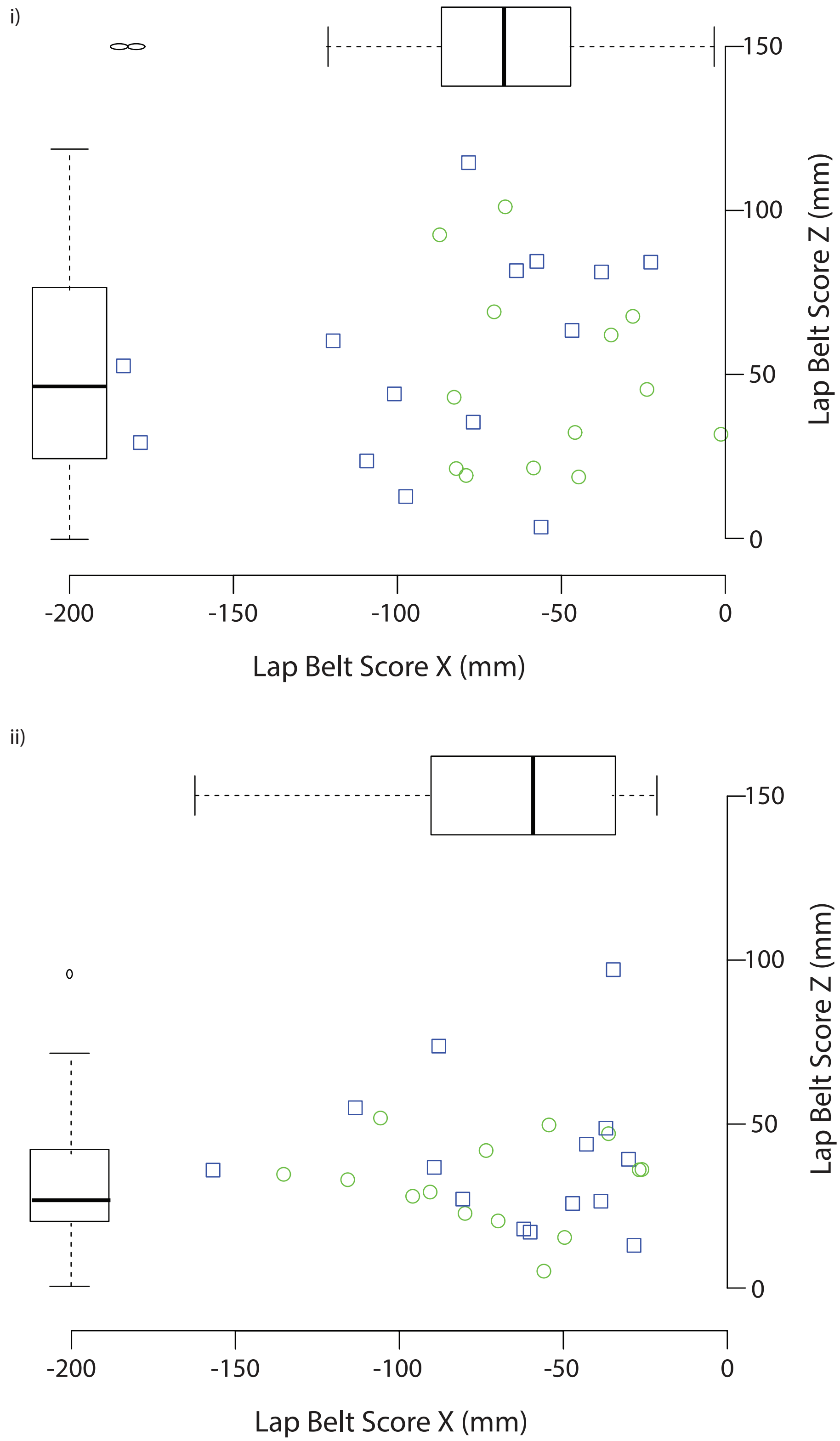


Figure 23. Lap belt location relative to ASIS landmark for obese (□, blue squares) and non-obese (○, green circles) for participants during: i) **Baseline**, and ii**) Post-Intervention In-Vehicle** trials. Box plots of the show median and interquartile range (IQR); whiskers indicate the maximum or minimum values within 1.5 IQR in distance from the nearest quartile of the Lap Belt Score X and Z.

Figure 24 shows the mean delta in the vertical lap belt z-position between the in-vehicle baseline and post-intervention belt fit measurements relative to body mass index (BMI). Based on this analysis, 71% of the obese and 50% of non-obese participants lowered the lap belt after the video intervention. The post-intervention vertical lap belt positions were on average 13.5 (SE=6.6) mm (p=0.0227) lower relative to the pelvis, across the participants. Three participants, one non-obese and two obese participants lowered the lap belt relative to pelvis by 67.8(13.8) mm, more than the width of the lap belt.

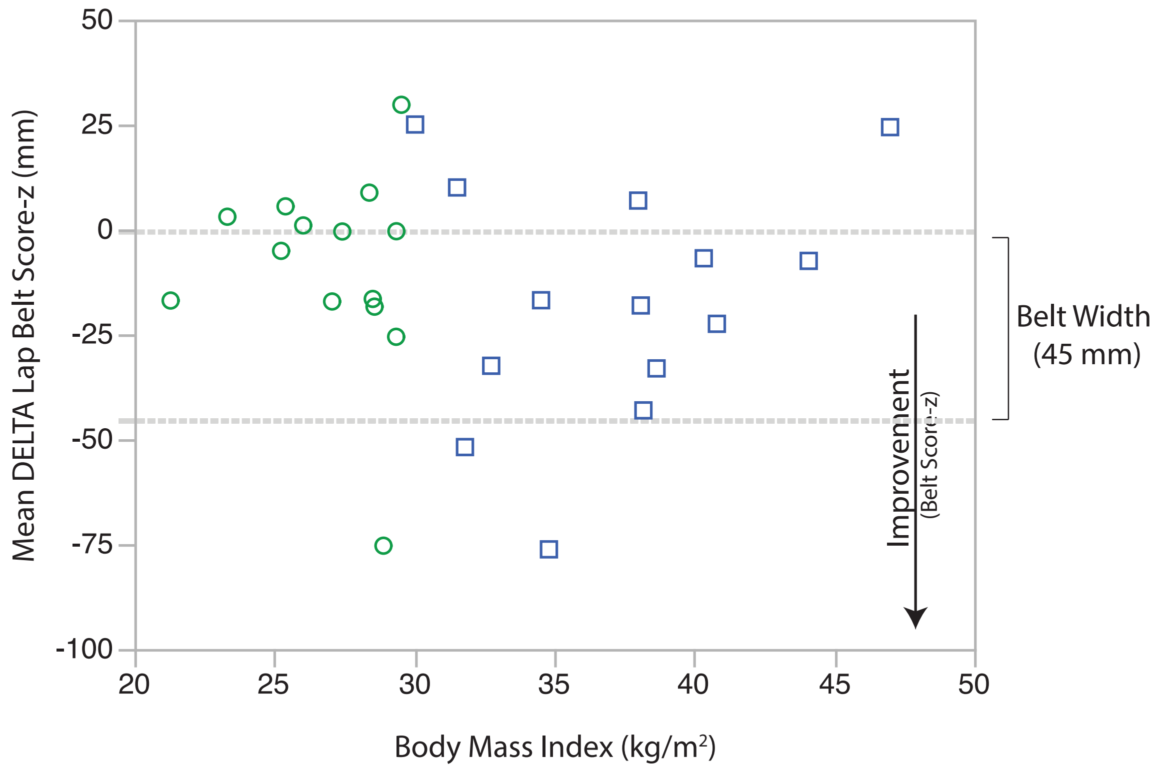


Figure 24. Mean delta between **baseline and post-intervention in-vehicle** measures of the mean vertical lap belt z-position (mm) versus body mass index (kg/m^2). BMI ≥ $30kg/m^2$ is considered obese (□, blue squares) and <$30kg/m^2$ non-obese (○, green circles). Belt width (45 mm) is provided as a visual criterion for improvement.

Mean delta in the fore-aft lap belt x-position between the in-vehicle baseline and post-intervention measures are illustrated in Figure 25. After the intervention, 54% of the participants positioned the lap belt more rearward after the intervention. The location of the post-intervention fore-aft lap belt x-position did not differ significantly from the baseline intervention. Three of the non-obese and five of the obese participants pulled the lap belt closer to pelvis by 48.5(15.6) mm, a change of more than 25% of the in-vehicle mean delta lap belt-x score distribution.

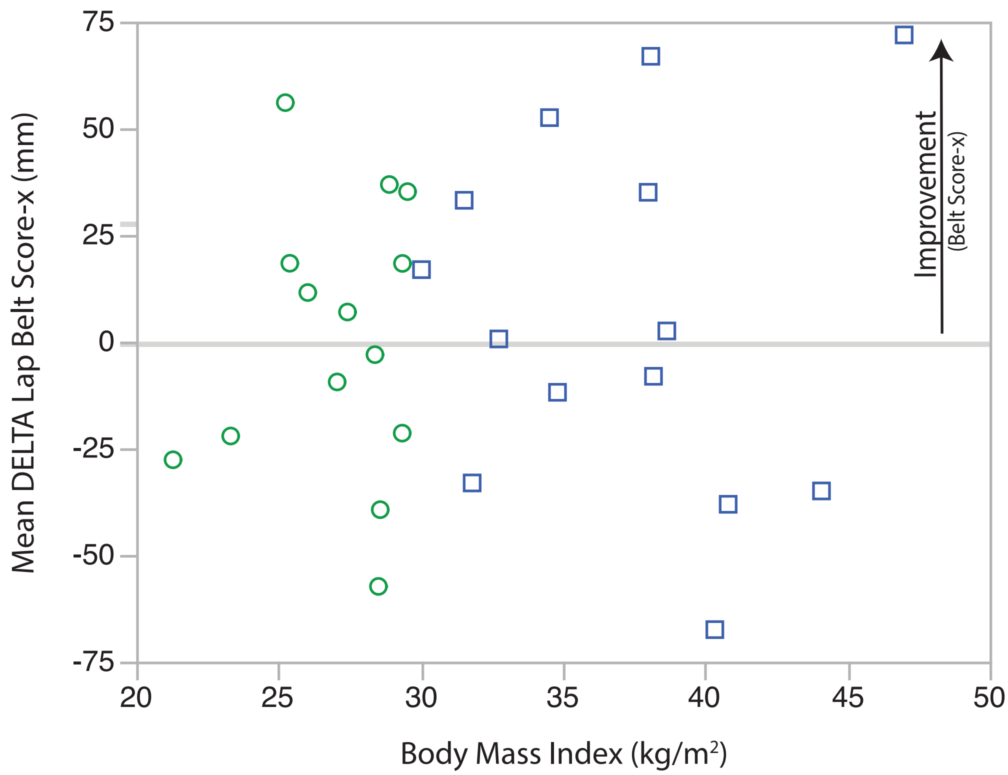


Figure 25. Mean delta between **baseline and post-intervention in-vehicle** measures of the mean fore-aft lap belt x-position (mm) versus body mass index (kg/m²). BMI ≥ 30kg/m² is considered obese (□, blue squares) and <30kg/m² non-obese (○, green circles).

4.2. Classification of Lap Belt Fit

The distribution of mean change (delta) in lap belt position between the baseline and intervention levels for both in-vehicle and laboratory measures are shown in Figures 26-27, Figures 32-33, and Figure 35 respectively. The vectors illustrate the delta in vertical (z) and fore-aft (x) lap belt positions relative to the pelvis. Four distinct groupings of belt fit emerged, based on improvements (or degradation) of the lap belt position. The four outcomes are as follows:

1. *Vertical Improvement (Z) & Horizontal Improvement (X)*: Lap belt was positioned lower (negative Δ), and more rearward (positive Δ) relative to the pelvis.

2. *Vertical Improvement (Z) & No Horizontal Improvement (X)*: Lap belt was positioned lower (negative Δ), and further forward (negative Δ) relative to the pelvis.

3. *No Vertical Improvement (Z) & Horizontal Improvement (X)*: Lap belt was positioned higher (positive Δ), and more rearward (positive Δ) relative to the pelvis.

4. *No Vertical Improvement (Z) & No Horizontal Improvement (X)*: Lap belt was positioned higher (positive Δ), and further forward (negative Δ) relative to the pelvis.

Figures 26-27 illustrate the classification results of the in-vehicle mean belt fit delta. For the in-vehicle evaluation, the *Vertical Improvement (Z) & No Horizontal Improvement (X)* grouping had the highest incidence of 39%. *Vertical Improvement (Z) & Horizontal Improvement (X)* grouping was observed for 29% of participants and *No Vertical Improvement (Z) & Horizontal Improvement (X)* grouping for 25% of the participants. Only 7% showed *No Vertical Improvement (Z) & No Horizontal Improvement (X)*.

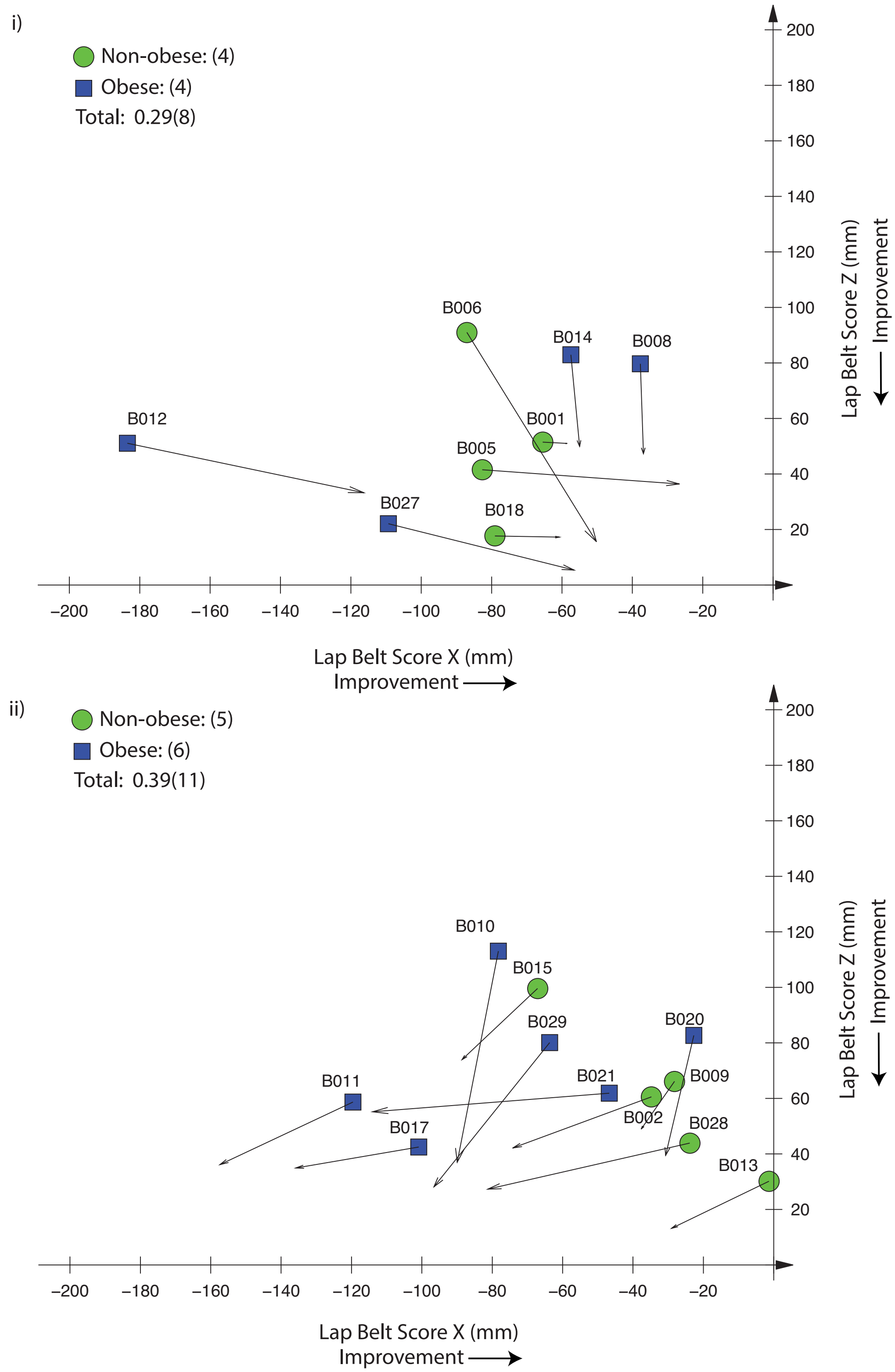
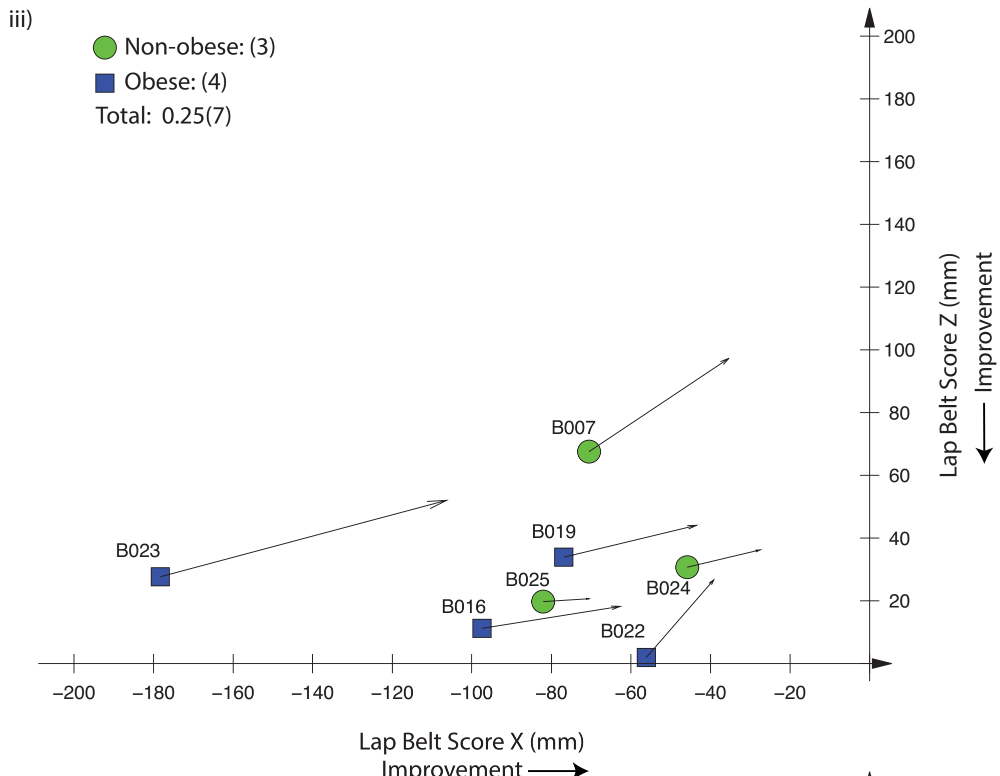


Figure 26. Magnitude (mm) and direction with respect to pelvis of the mean delta in lap belt position between **baseline and post-intervention in-vehicle** measurements. Data are classified as: i) *Vertical Improvement (Z) & Horizontal Improvement (X)*, and ii) *Vertical Improvement (Z) & No Horizontal Improvement (X).*



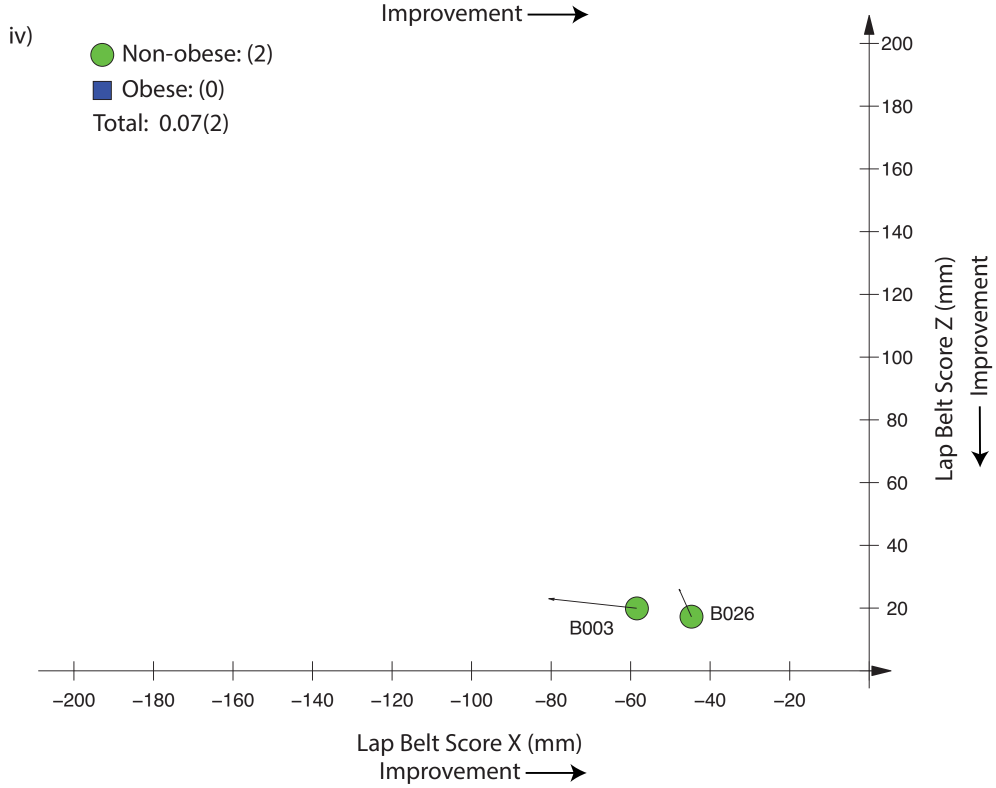


Figure 27. Magnitude (mm) and direction with respect to pelvis of the mean delta in lap belt position between **baseline and post-intervention in-vehicle** measurements. Data are classified as: iii) *No Vertical Improvement (Z) & Horizontal Improvement (X)*, and iv) *No Vertical Improvement (Z) & No Horizontal Improvement (X)*.

Table 10 lists the observed incidences, based upon the total participant sample and the mean vertical (z) and fore-aft (x) lap belt positions, averaged across the participant sample, for each lap belt classification. Significant differences between groupings included:

- *Vertical Improvement (Z) & No Horizontal Improvement (X)* and *No Vertical Improvement (Z) & Horizontal Improvement (X)* = 42 (SE = 9.7) mm (p=0.0002),
- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *No Vertical Improvement (Z) & Horizontal Improvement (X)* = 37.3 (SE = 10.3) mm (p=0.0014), and
- *Vertical Improvement (Z) & No Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* = 33.4 (SE = 28.6) mm (p=0.0398).

Participants classified as improving the fore aft X position, tightened the lap belt and shifted x-position rearward, closer to the pelvis. Significant differences between groupings included:

- *No Vertical Improvement (Z) & Horizontal Improvement (X)* and *Vertical Improvement (Z) & No Horizontal Improvement (X)* = 63.4 (SE = 10.4) mm (p<0.0001),
- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *Vertical Improvement (Z) & No Horizontal Improvement (X)* = 61.8 (SE = 10.0) mm (p<0.0001),
- *No Vertical Improvement (Z) & Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* = 44.3 (SE = 17.3) mm (p=0.0170), and
- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* = 42.8 (SE = 17.0) mm (p=0.0192).

Table 10. Number of participants (% of total) in each belt fit classification for the **in-vehicle** belt fit measurement and mean (SD) of the x and z lap belt positions with respect to pelvis (mm).

Classification	**Number of Participants (%)**	**Mean (SD) of Lap Belt Position Relative to Pelvis (mm)**	
		Lap Belt X Position	**Lap Belt Z Position**
Vertical Improvement (Z) & Horizontal Improvement (X)	8 (29%)	30.2 (26.5)	-22.7 (24.9)
Vertical Improvement (Z) & No Horizontal Improvement (X)	11 (39%)	-31.6 (19.0)	-27.5 (21.1)
No Vertical Improvement (Z) & Horizontal Improvement (X)	7 (25%)	31.7 (20.2)	14.6 (11.4)
No Vertical Improvement (Z) & No Horizontal Improvement (X)	2 (7%)	-12.6 (13.5)	5.9 (4.1)

Figure 28 plots the magnitude of the mean delta in the vertical (z) and fore-aft (x) lap belt positions between the in-vehicle baseline and in-vehicle post-intervention conditions as function of a participant's initial mean baseline lap z and x scores.

Among participants observed to improve vertical lap belt location the lap belt Z-position, the mean delta change was significantly smaller. Regression analysis determined that mean delta lap belt z-sore is predicted from initial vertical lap belt position. The R^2 value for this model is 0.60 (RMSE = 14.4, $p<0.0001$). For participants classified as *not* improving the vertical lap belt Z-position, both the initial belt position and magnitude of change were within one-belt width distance of the ASIS. The only exception was a non-obese participant observed to raise the vertical lap belt position as a result of a posture difference between the pre-and post-intervention in-vehicle measurements (B007).

Participants classified as improving the fore aft X position, shifted x-position rearward, closer to the pelvis, effectively tightening the belt. This improvement showed a strong relationship relative with the initial horizontal belt position (R^2 = 0.72, RMSE = 12.6, $p<0.0001$). An improvement in vertical lap belt fit was typically associated with participants observed to shift the horizontal belt position more forward of the pelvis post-intervention, notionally loosening the belt.

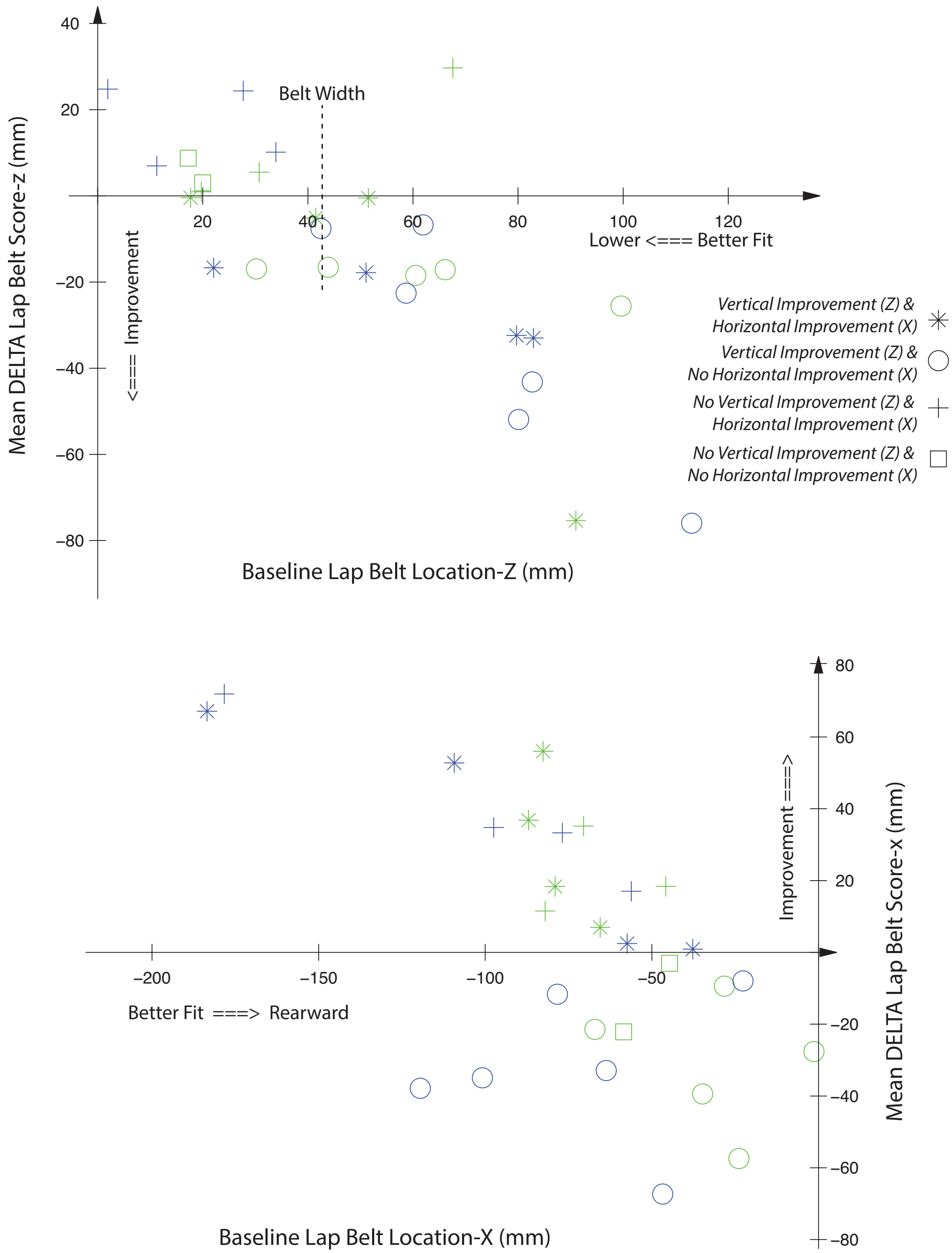


Figure 28. Magnitude (mm) of the mean delta in lap belt position between **baseline and post-intervention in-vehicle** measurements relative to the **baseline mean vertical lap belt z-location** (mm) and the **baseline mean horizontal lap belt x-location** (mm). Belt fit classifications are coded by symbol. Participants are coded by colour: green – non-obese (BMI <30kg/m²) and blue – obese participants (BMI ≥ 30kg/m²).

4.3. In-Laboratory Belt Fit Measurement

Figure 29 shows the lap belt location with respect to ASIS for non-obese and obese participants for the baseline, post-video, and post-personal intervention trials. Plots illustrate the measures recorded for each of the three replicates per participant. Table 11 documents the mean and standard deviation values for the in-laboratory conditions.

Table 11. Mean (standard deviation) of Baseline, Post-Video, Post-Personal Intervention In-Laboratory Lap Belt Scores (mm).

Condition	**Mean Lap Belt X Score (SD)**	**Mean Lap Belt Z Score (SD)**
Baseline In-Laboratory	-46.8 (33.1)	55.3 (23.1)
Post-Video Intervention In-Laboratory	-51.3 (33.9)	44.2 (19.3)
Post-Personal Intervention In-Laboratory	-50.7 (33.3)	38.8 (20.4)

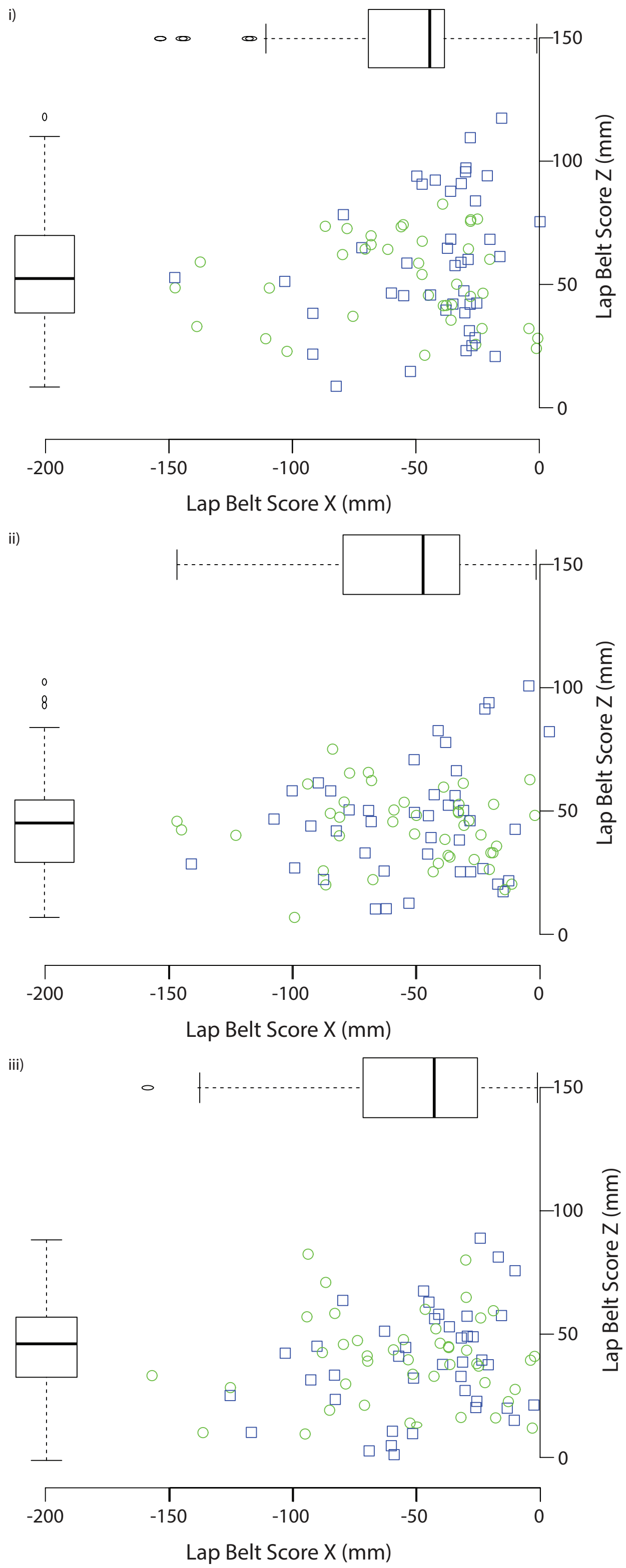


Figure 29. Lap belt location relative to ASIS landmark for obese (□, blue squares) and non-obese (○, green circles) for participants during: i) **Baseline**, ii) **Post-Video Intervention**, and iii) **Post-Personal-Intervention In-Laboratory** trials. Box plots of the show median and interquartile range (IQR); whiskers indicate the maximum or minimum values within 1.5 IQR in distance from the nearest quartile of the Lap Belt Score X and Z.

4.3.1. Baseline vs. Post-Video Intervention

Figure 30 shows the mean change in the vertical lap belt position between the in-laboratory baseline and post-intervention belt fit measurements relative to body mass index (BMI). After the intervention, 73% of the obese and 100% of the non-obese participants lowered the lap belt. On average, the post-video intervention vertical lap belt positions were 11.1 (SE = 3.2) mm (p=0.0006) lower relative to the pelvis. Three obese participants lowered the lap belt relative to pelvis by 32.9(10.3) mm, more than the width of a lap belt.

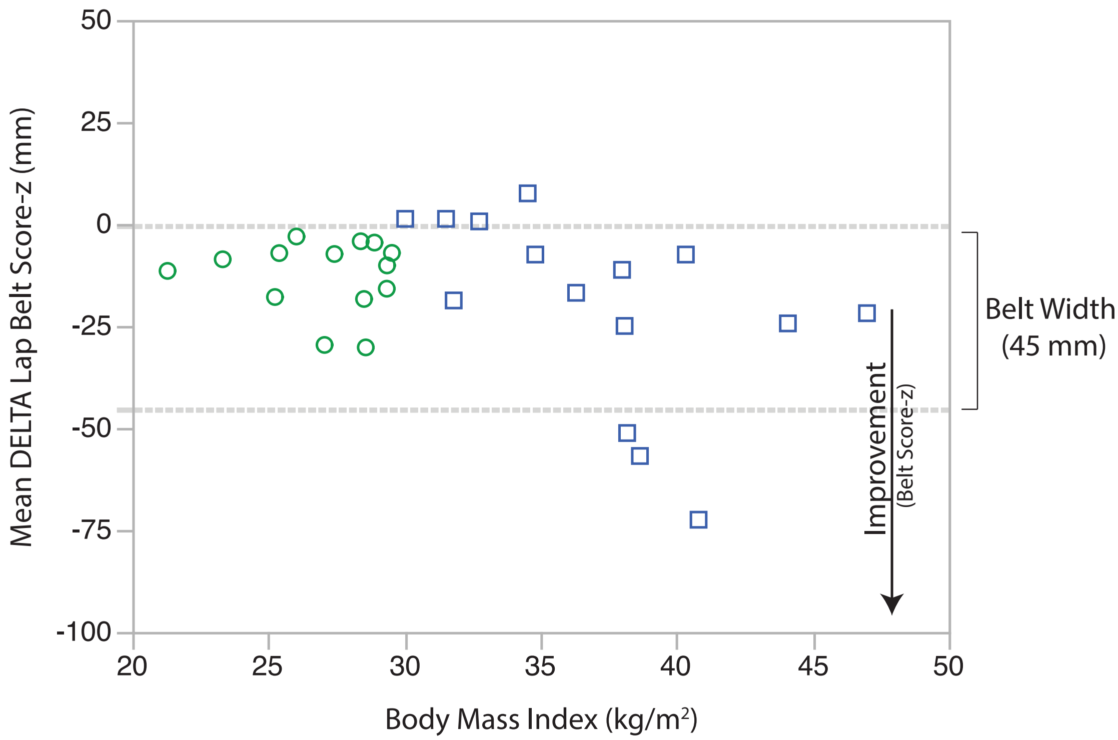


Figure 30. Mean delta between **baseline and post-intervention in-laboratory** measures of the mean vertical lap belt z-position (mm) versus body mass index (kg/m^2). BMI ≥ 30kg/m^2 is considered obese (□, blue squares) and <30kg/m^2 non-obese (○, green circles). Threshold limit of a belt width (45mm) is provided as a visual criterion for improvement.

Mean delta in the fore-aft lap belt x-position between the in-laboratory baseline and post-intervention belt fit measurements are illustrated in Figure 31. 55% of the all the participants snugged the lap belt after the intervention. Differences in Post-intervention fore-aft lap belt x-positions were not found to be significant. Four of the non-obese and five of the obese participants tightened the lap belt closer to pelvis by 13.5(5.9) mm, more than a quartile of the in-laboratory mean delta lap belt-x score distribution.

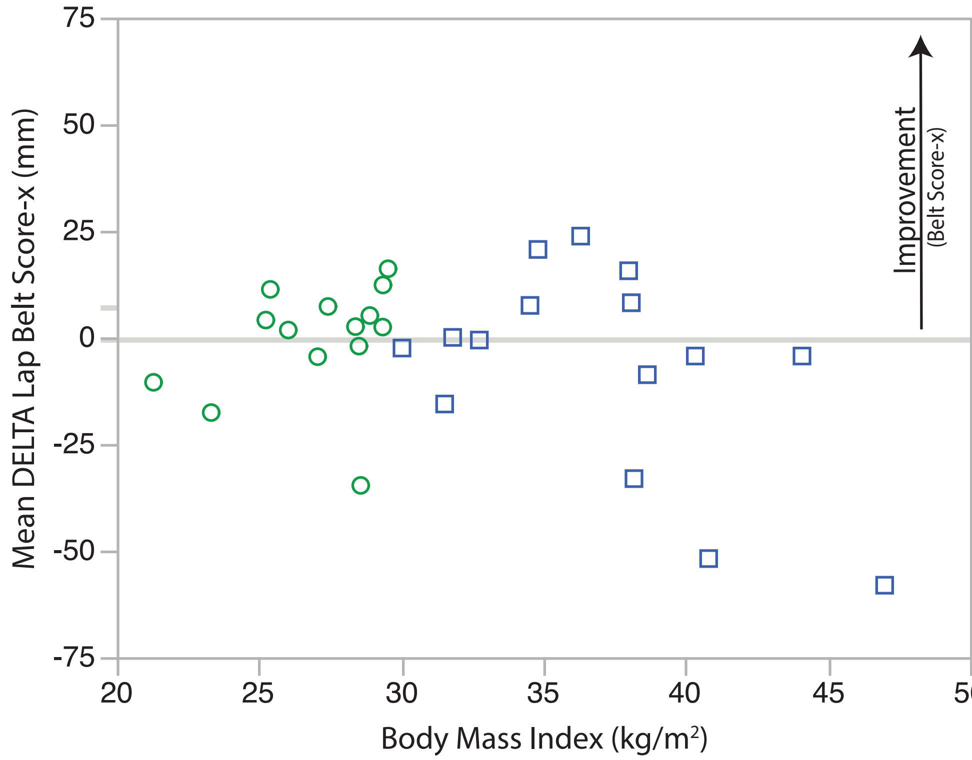


Figure 31. Mean delta between **baseline and post-intervention in-laboratory** measures of the mean fore-aft lap belt x-position (mm) versus body mass index (kg/m²). BMI ≥ 30kg/m² is considered obese (□, blue squares) and <30kg/m² non-obese (○, green circles).

Figures 32 and 33 illustrate the classification results of the in-laboratory mean belt fit delta. For the in-laboratory evaluation, the *Vertical Improvement (Z) & Horizontal Improvement (X)* grouping had the highest incidence of 52%. The *Vertical Improvement (Z) & No Horizontal Improvement (X)* grouping was observed for 38% of participants. The remaining participants were classified as No *Vertical Improvement (Z) & Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* groupings at 3% of the sample.

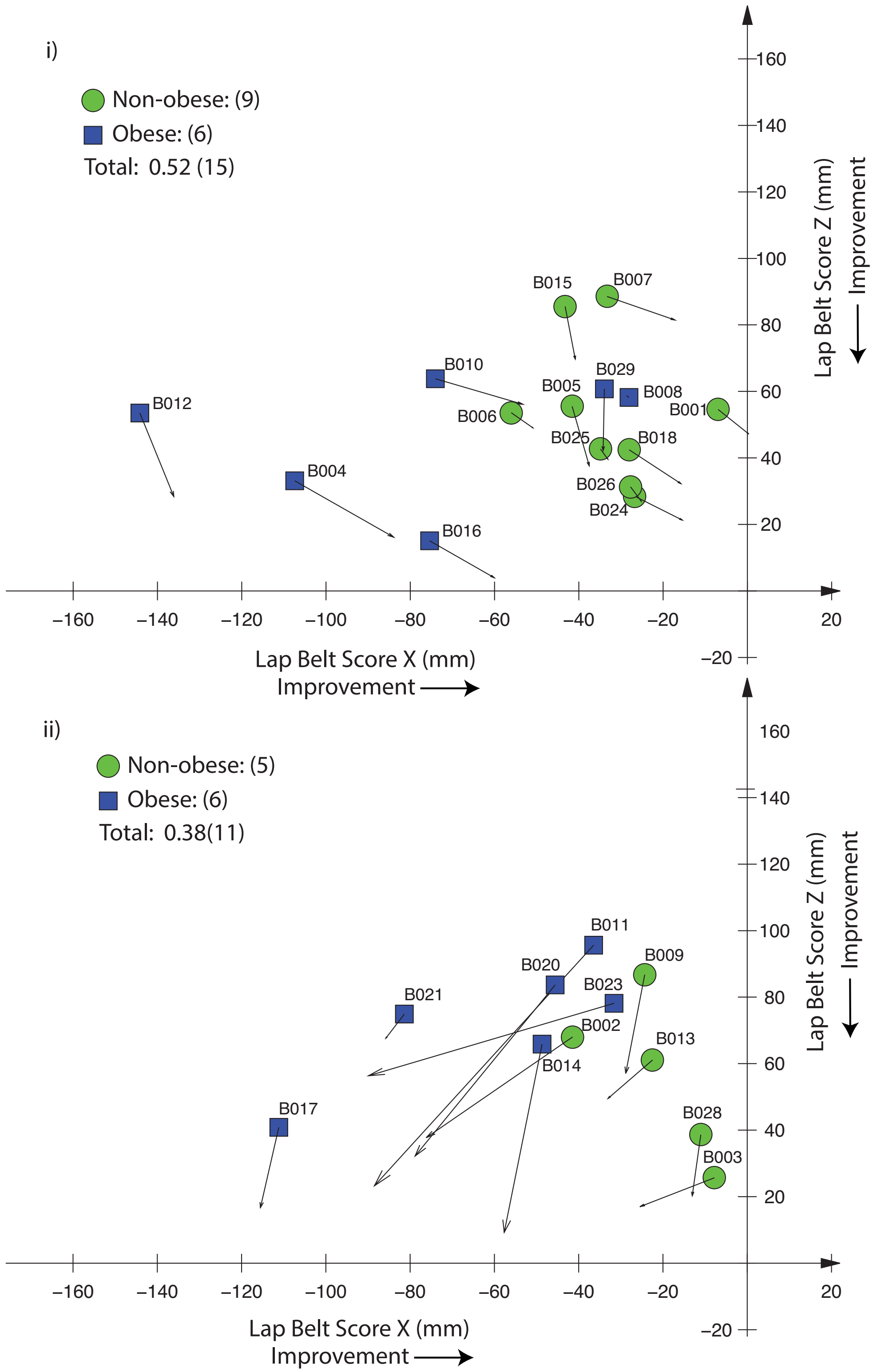


Figure 32. Magnitude (mm) and direction with respect to pelvis of the mean delta in lap belt position between **baseline and post-intervention in-laboratory** measurements. Data are classified as: i) *Vertical Improvement (Z) & Horizontal Improvement (X)*, and ii) *Vertical Improvement (Z) & No Horizontal Improvement (X).*

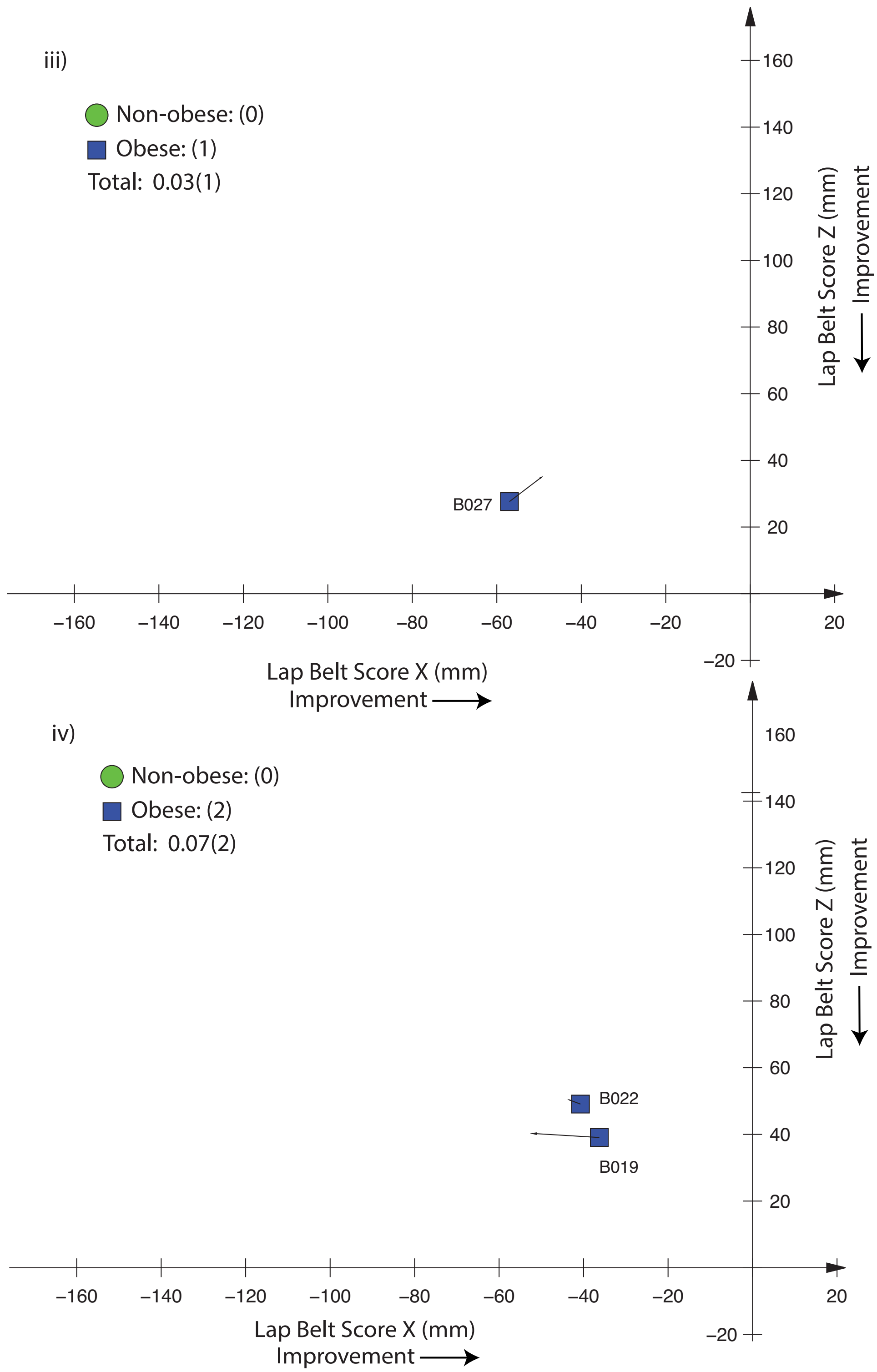


Figure 33. Magnitude (mm) and direction with respect to pelvis of the mean delta in lap belt position between **baseline and post-intervention in-laboratory** measurements. Data are classified as: iii) *No Vertical Improvement (Z) & Horizontal Improvement (X)*, and iv) *No Vertical Improvement (Z) & No Horizontal Improvement (X)*.

Table 12 lists the observed incidences, based upon the total participant sample and the mean vertical (z) and fore-aft (x) lap belt positions, averaged across the participant sample, for each lap belt classification observed during the baseline and post-video intervention in-laboratory belt fit measurement. On average, participants classified as improving the vertical lap belt z-position, lowered the lap belt significantly closer to the pelvis. Significant differences between groupings included:

- *Vertical Improvement (Z) & No Horizontal Improvement (X)* and *No Vertical Improvement (Z) & Horizontal Improvement (X)* = 37.5 (SE =15.1) mm (p=0.0199),
- *Vertical Improvement (Z) & No Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* = 31.5 (SE =11.1) mm (p=0.009), and
- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *Vertical Improvement (Z) & No Horizontal Improvement (X)* = 19.8 (SE =5.7) mm (p=0.002).

Participants classified as improving the fore aft X position, tightened the lap belt and shifted x-position rearward, closer to the pelvis. Significant differences between groupings included:

- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *Vertical Improvement (Z) & No Horizontal Improvement (X)* = 29.6 (SE =5.6) mm (p<0.0001).

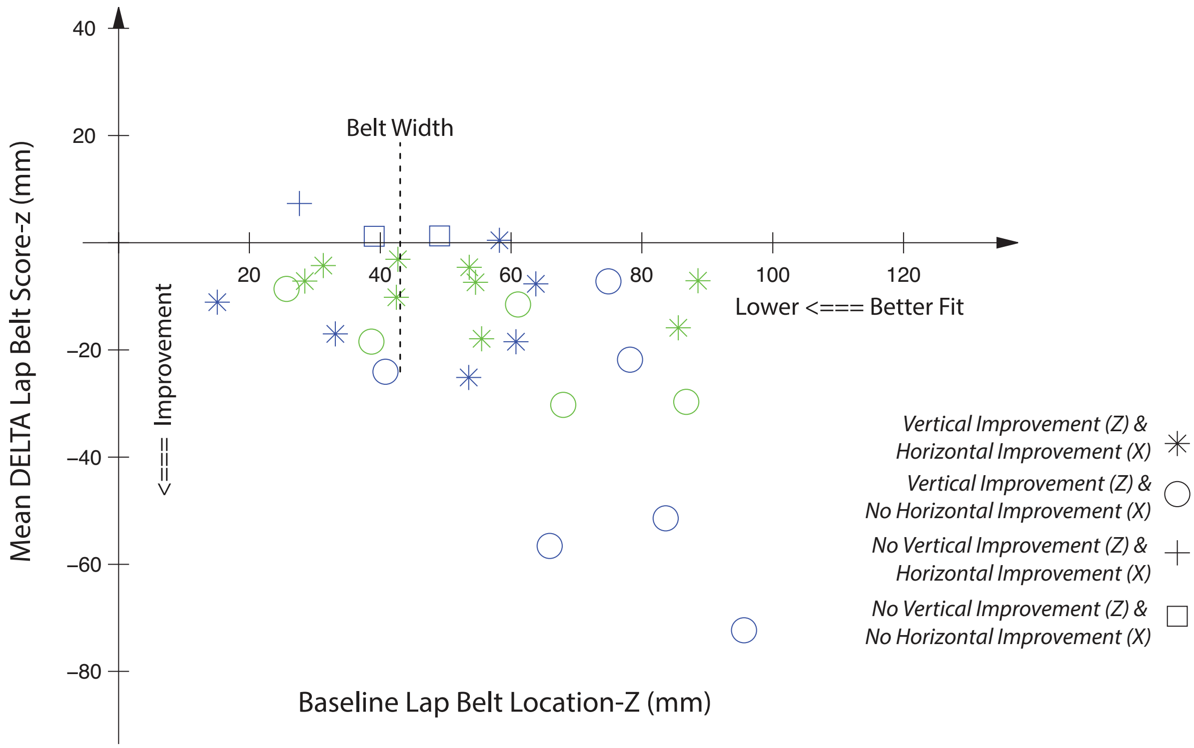
Table 12. Number of participants (% of total) in each lap belt fit classifications for the **in baseline and post-video intervention in-laboratory** belt fit measurement. Mean (SD) of x and z lap belt positions with respect to pelvis (mm).

Classification	**Number of Participants (%)**	**Mean (SD) of Lap Belt Position Relative to Pelvis (mm)**	
		Lap Belt X Position	**Lap Belt Z Position**
Vertical Improvement (Z) & Horizontal Improvement (X)	15(52%)	8.6 (7.6)	-10.4 (7.0)
Vertical Improvement (Z) & No Horizontal Improvement (X)	11 (38%)	-20.9 (20.3)	-30.2 (21.2)
No Vertical Improvement (Z) & Horizontal Improvement (X)	1(3%)	7.6	7.3
No Vertical Improvement (Z) & No Horizontal Improvement (X)	2(7%)	-9.3(9.3)	1.2 (0.03)

Figure 34 plots the magnitude of the mean delta in the vertical (z) and fore-aft (x) lap belt positions between the in-laboratory baseline and post-video intervention condition as function of a participant's initial mean baseline lap z and x scores.

Among participants observed to improve vertical lap belt location following the intervention, the mean delta change was significantly smaller when the initial vertical position was closer to the ASIS (R^2 = 0.25, RMSE = 15.5 p=0.01). The three participants whose vertical belt scores did not improve had initial belt positions that were within 50 mm of the ASIS.

The magnitude of mean delta in fore aft X position was not associated with the baseline horizontal belt x-position, regardless of whether the score improved following the video-intervention.



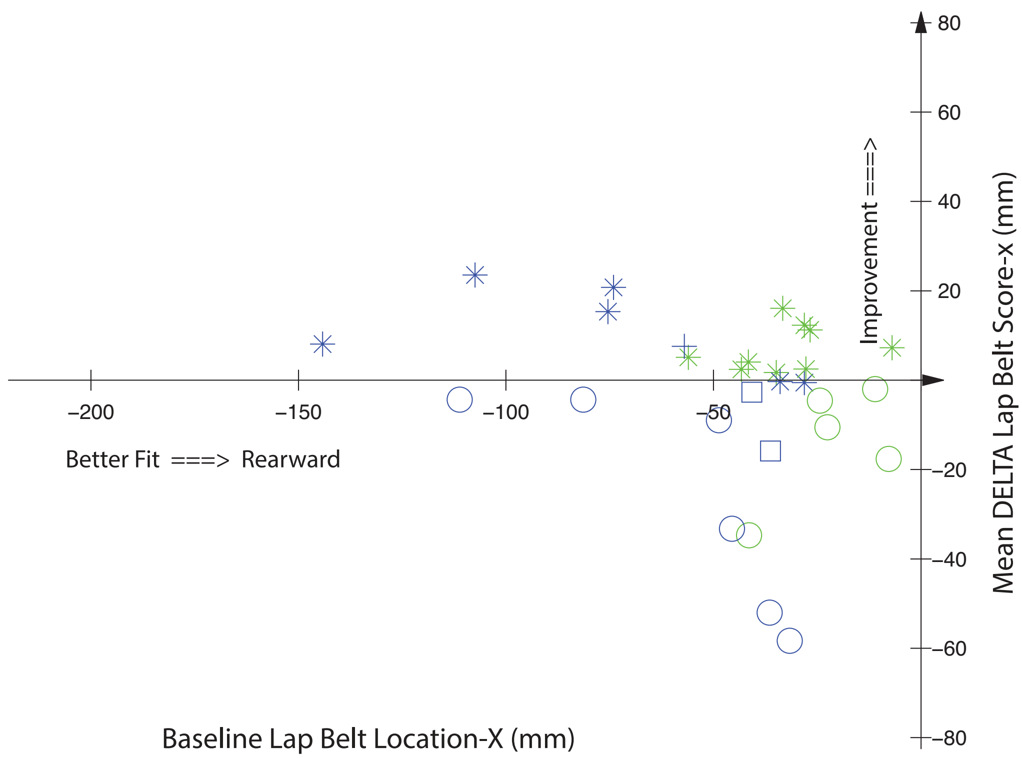


Figure 34. Magnitude (mm) of the mean delta in lap belt position between **baseline and post-video intervention in-laboratory** measurements relative to the **baseline mean vertical lap belt z-location** (mm) and the **baseline mean horizontal lap belt x-location** (mm). Belt fit classifications are coded by symbol. Participants are coded by colour: green – non-obese (BMI <30kg/m^2) and blue – obese participants (BMI ≥ 30kg/m^2).

4.3.2. Baseline vs. Post-In-Person Intervention

Figure 35 illustrates the classification results for the change from the laboratory baseline scores to the scores following the in-person intervention. The *Vertical Improvement (Z) & Horizontal Improvement (X)* grouping had the highest incidence of 52%. The *Vertical Improvement (Z) & No Horizontal Improvement (X)* grouping was observed for 38% of participants. The remaining 10% of participants were classified as *No Vertical Improvement (Z) & No Horizontal Improvement (X)*.

Table 13 lists the observed incidences, based upon the total participant sample and the mean vertical (z) and fore-aft (x) lap belt positions, averaged across the participant sample, for each lap belt classification observed during the baseline vs. post-in-person intervention in-laboratory belt fit measurement. Significant differences between groupings included:

- *Vertical Improvement (Z) & No Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* = 22.9 (SE =4.9) mm ($p<0.0001$),
- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* = 12.0 (SE =4.8) mm ($p=0.0198$), and
- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *Vertical Improvement (Z) & No Horizontal Improvement (X)* = 10.9 (SE =3.0) mm ($p=0.0014$).

Participants classified as improving the fore aft X position, tightened the lap belt and shifted x-position rearward, closer to the pelvis. Significant differences between groupings included:

- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *Vertical Improvement (Z) & No Horizontal Improvement (X)* = 36.3 (SE =6.1) mm ($p<0.0001$), and
- *Vertical Improvement (Z) & Horizontal Improvement (X)* and *No Vertical Improvement (Z) & No Horizontal Improvement (X)* = 21.3 (SE =9.6) mm ($p=0.0356$).

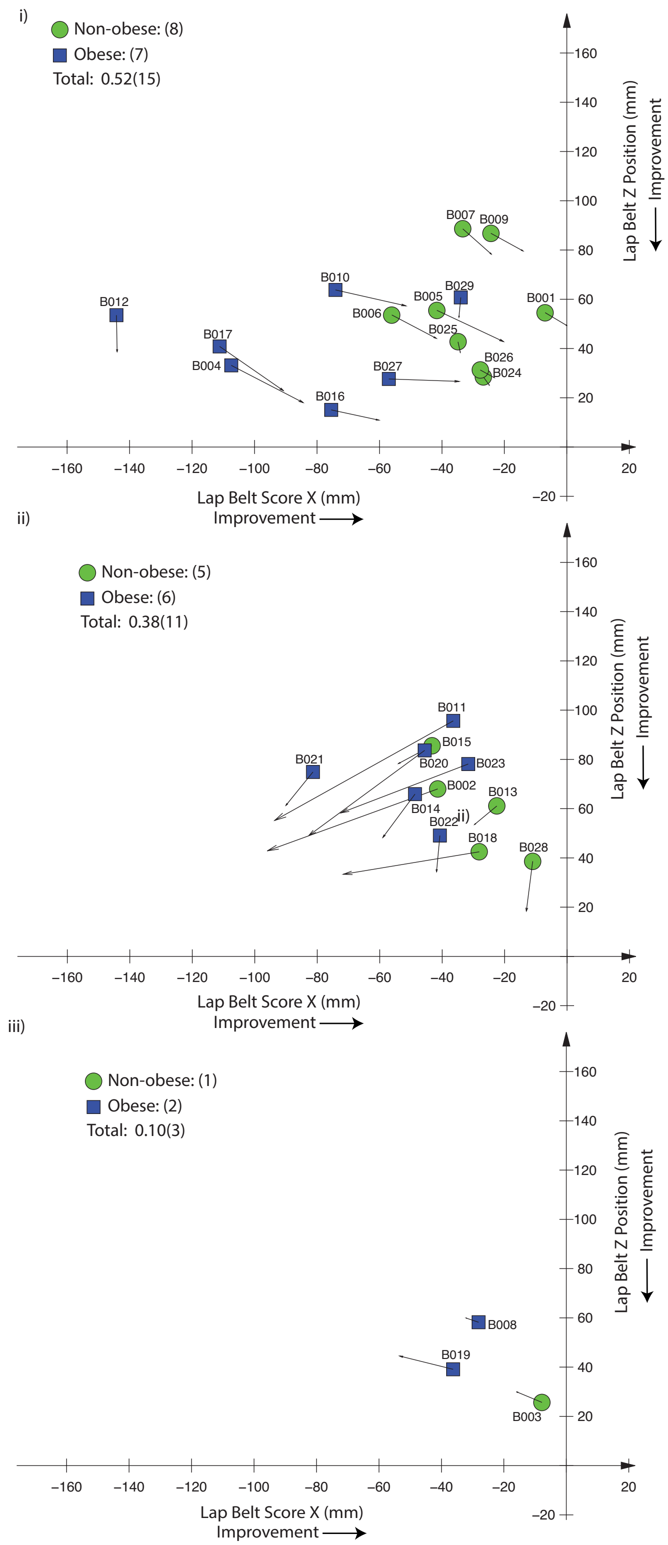
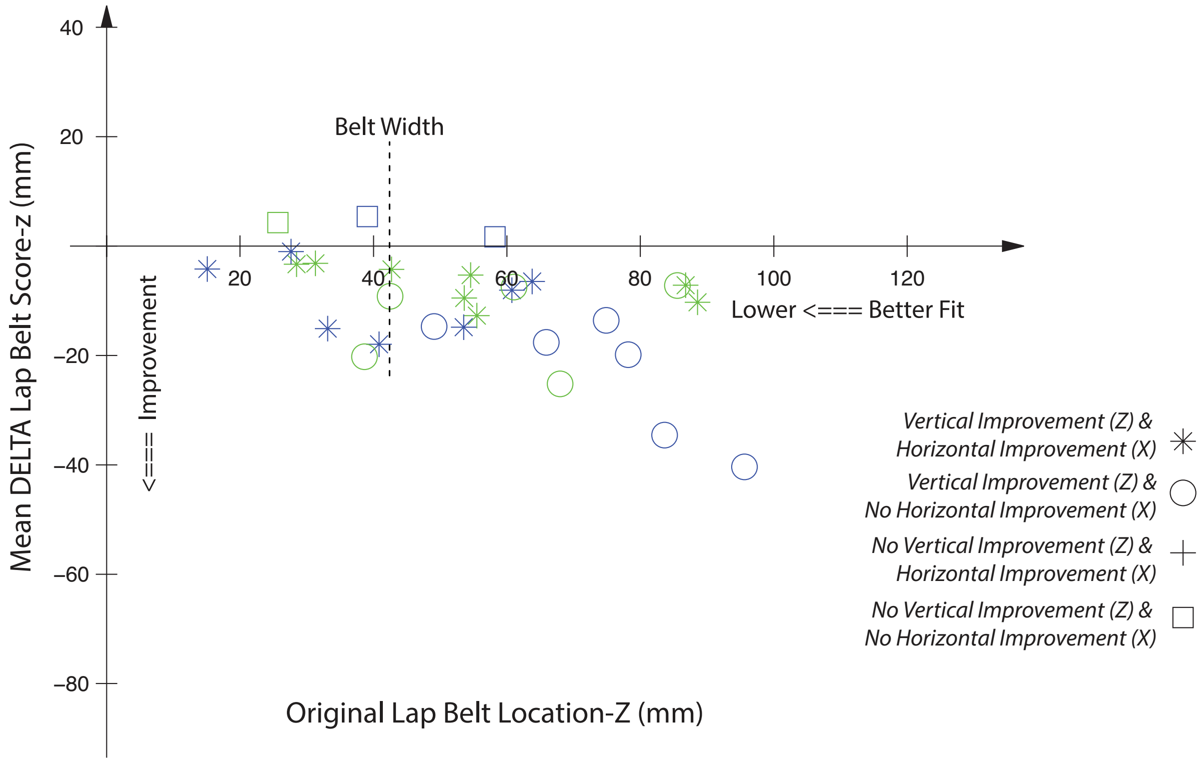


Figure 35. Magnitude (mm) and direction with respect to pelvis of the mean delta in lap belt position between **baseline and post-in-person intervention in-laboratory** measurements. Data are classified as: i) *Vertical Improvement (Z) & Horizontal Improvement (X)*, and ii) *Vertical Improvement (Z) & No Horizontal Improvement (X)*, and iii) *No Vertical Improvement (Z) & No Horizontal Improvement (X)*.

Table 13. Number of participants (% of total) in each lap belt fit classifications for the **baseline and post-in-person in-laboratory** belt fit measurement. Mean (SD) of x and z lap belt positions with respect to pelvis (mm).

Classification	Number of Participants (%)	Mean (SD) of Lap Belt Position Relative to Pelvis (mm)	
		Lap Belt X Position	**Lap Belt Z Score**
Vertical Improvement (Z) & Horizontal Improvement (X)	15(52%)	11.5 (8.9)	-8.2 (5.1)
Vertical Improvement (Z) & No Horizontal Improvement (X)	11 (38%)	-24.8 (21.8)	-19.1 (10.8)
No Vertical Improvement (Z) & No Horizontal Improvement (X)	3 (10%)	-9.8(9.7)	3.8 (1.9)

Figure 36 plots the magnitude of the mean delta in the vertical (z) and fore-aft (x) lap belt positions between the in-laboratory baseline and post-in-person intervention condition as function of a participant's initial mean baseline lap z and x scores. Among participants observed to improve vertical lap belt location the lap belt Z-position following the in-person intervention, the mean delta change was predicted from the baseline lap belt score (R^2 = 0.26, RMSE = 8.5 p=0.0076). Similar to the post-video intervention condition, the magnitude of mean delta in fore aft X position was not predicted by the baseline horizontal belt x-position, for neither those who were observed to improve or not improve the horizontal belt score following the post-in-person-intervention.



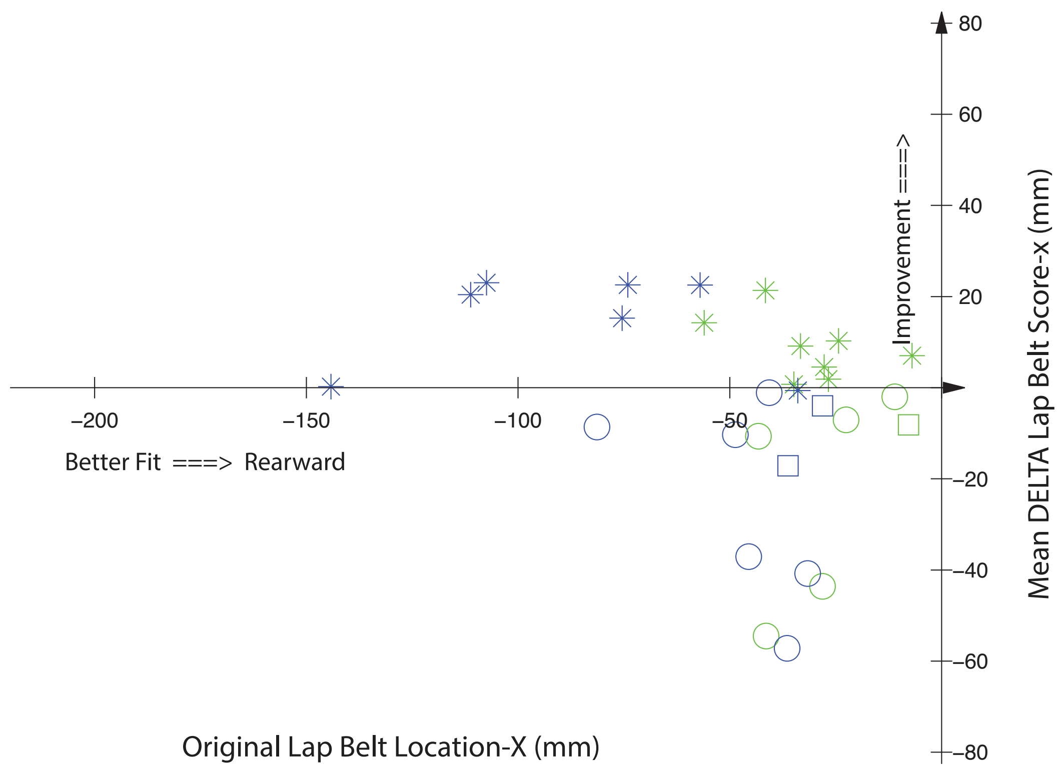


Figure 36. Magnitude (mm) of the mean delta in lap belt position between **baseline and post-in-person intervention in-laboratory** measurements relative to the **baseline mean vertical lap belt z-location** (mm) and the **baseline mean horizontal lap belt x-location** (mm). Belt fit classifications are coded by symbol. Participants are coded by colour: green – non-obese (BMI <30kg/m^2) and blue – obese participants (BMI ≥ 30kg/m^2).

4.4. Qualitative Description of Seat Belt Donning

All participants were asked to verbalize the donning of their seat belt after the post-intervention measurement. Most participants were able to articulate their actions in line with the recommendations described in the video. However not all participants noted descriptions about the three key components: placement of the lap belt, shoulder belt, and ensuring a snug fit. There were some who reported all three elements , for example:

- "making sure (it's) flat, low on my hips, I pull on the upper part so it's tight and then I check where it is on my collar bone,"
- "pulling belt looking for the buckle placing clip into buckle pulling it tight placing it below my gut top of my thighs, adjusting the belt so that it's right above my collar bone or whatever bone that is and making sure."

Typically two components were noted, for example:

- "have it across my hips and centered across my collar bone," and
- "bring seatbelt across my body finding the latch hooking it up, making sure it (is) down on my thigh and fits my collar bone really well, I like this one I wish it were on my car."

Of note, with some of those examples, they did not articulate that they were to have a tight fit but many gestured with a tug on the shoulder belt to indicate tightness.

Many participants also described their actions related to content that was received from watching the video, for example:

- "adjusting it, (the) lap belt onto my hips, onto my collar bone points of contact, to fit my bones (and) protect me from injury and that's what the video told me."

Others relayed content that was directly mentioned in the video, such as avoiding placement over "vital organs" or paraphrased content. For example:

- "make sure get it buckled sometimes I have to fight with it, have to try and remember to lower it to below my hips because vital organs are above it and to put it on my collarbone here (pointed)," and
- "pull it across my body so to the buckle pull it down so it goes over my hips, below my stomach where there's soft tissue making sure it goes across my chest another set of bones for maximum protection."

Some participants identified that this is a behavior they will need to carry forward:

- "have to try and remember to lower it to below my hips because vital organs are above it."

There were also some participants who communicated a general description of safety benefits for wearing a seatbelt, for example:

- "I'm putting the seatbelt on cause if I get in a car accident it's going to save my life. (Make sure it's) snug. Because I saw the little movie and that's what it says to do," and
- "I put on my seatbelt as a matter of safety because that's what I do."

A summary of the frequency by which participants mentioned all of three belt fit components and specific mention of each component is reported in Table 14.

Table 14. Summary of the frequency by which participants reported elements of the video.

	Reported	
	N	**%**
Element mentioned		
All	13	50
Lap belt fit (vertical lap belt)	10	38
Shoulder belt fit	9	35
Snug (horizontal lap belt)	2	8

Note. If participants mentioned all three elements of the video this was coded as all. If they mentioned one or two of the components this was coded under the element separately. There were 3 cases of missing data.

4.5. Beliefs About Correct Seat Belt Use

In response to the Health Belief Model (HBM) questionnaire, the majority of participants strongly endorsed attitudes that are theorized to predict greater seat belt use and correct seat belt use (Appendix H). Participants also endorsed being regular seat belt users, with 25 participants indicating they 'always' wear a seat belt, that is, they responded with a 7 on a 7-point scale [1 (never) -7 (always)]. The remaining 4 participants responded by rating with a score of 6. Fewer participants regularly checked the fit of their seat belt, using the same scale, 10 participants responded with a score of 3 or less and 14 participants responded with a score of 5 or more, with only 2 people indicating that they always check fit (responding with a score of 7).

With regard to their attitudes and beliefs as guided by the Health Belief Model (HBM) participants were consistent with strong endorsement of seat belt wearing and correct seat belt use. This included consideration of the seriousness of using a seat belt and using it correctly. There were two items reflecting seriousness of correct use; 24 and 25 participants respectively rated endorsement of the seriousness of correct use as a 7 on a 7-point scale [1(strongly disagree) - 7 (strongly agree)]. Seriousness of overall seat belt use was similarly highly endorsed with a score of 7 used by 25 participants. Susceptibility to injury was strongly endorsed by most participants with regard to the use of the lap belt, shoulder belt and snug fit (median = 7 for all). Participants also endorsed the benefits to the use of the lap belt, shoulder belt, and a snug fit (median 7 for all three items).

With regard to the theoretically guided moderating factors (norms, confidence, habit), again items were strongly endorsed by participants. There were 25 participants who rated the item of norms with a score of 7 (the highest possible rating), there were also 22 who rated the item related to confidence with a 7 (5 participants used the rating of 6), 25 who reported that they could easily take a moment to check correct use (using a score of 7), and 22 who used the strongest endorsement for seat belt use as a habit. There was less consistently a high endorsement of feelings of guilt for failing to wear a seat belt (mean score of 5.28).

4.6. Qualitative Description of the Video Intervention

Participants rated their satisfaction and perception of the video. Initially they used a 10-point Likert-type scale rating items from 1- not at all to 10 – a great deal. A high proportion of participants strongly endorsed the video as informative, median = 9, mean = 8.7. Participants typically rated the video as enjoyable (mean = 6.8) and interesting (mean = 7.7). Further, the video appears to be able to be comprehended easily, with little indication that it was too difficult or too simplified (means 1.7 and 2.7 respectively).

Qualitative responses also reflected the informative nature of the video. Many example quotes are provided in this section. The most frequent response to what participants "liked best" was that the video was informative or that they learnt something, for example:

- it was "information I didn't know,"
- "provided good info about placement of seat belt,"
- "I didn't realize the importance of the belt placement," and
- "learning about safety, seat belt positioning."

Other comments regarding what was liked best related to specific information components of the video, for example:

- "reminds to pull the belt to take up slack,"
- "I liked that they showed how to adjust the seat belt and explained why adjustments were made."

The remaining comments related to delivery considerations:

- "it stayed brief, while dealing with the essentials of seat belt safety,"
- "multiple people doing it,"
- "the demonstrations with narrative, and short demo (of) expected behavior. Used heavier people."

When asked specifically about the graphics, almost all participants indicated that they liked the images (only one said no). Two participants indicated that they didn't recall the graphics and one indicating they were primarily listening to the narration: "they were OK. I don't remember them too much, since I was mostly listening to the instructions."

Few indicated that they had ever received instruction on how to correctly don a seat belt. Among the responses participants indicated that they had previously learned from:

- "reading the manual for my car,"
- "in elementary and pre-school care safety programs," and
- "yes."

However two participants indicated that they had not learned anything but did suggest that being reminded was important that they were already doing it correctly.
Participants most typically commented on a general learning, for example:

- “how to properly place a seat belt,”
- “how to adjust a seat belt.”

Many mentioned specific positions and/ or snugness was the key learning, for example:

- “position belt on the lap,”
- “position of the belt, tightening of the belt,”
- “snug and low on lap belt,” and
- “Lower strap should be against thighs.”

Most of the remaining participants gave specific mention or reference to bones, for example:

- “To pull the waist strap below the vital organs and to make sure the shoulder strap crossed the collar bone,”
- “Low across thighs and diagonal across collar bone,”
- “Position of the lap belt relative to the hips and the proper position of the shoulder belt relative to the collar bone,” and
- “I learned to put the belt around the areas with large bones.”

There were few comments about what was least liked. Often participants left the item blank, some comments included:

- “not very exciting,”
- “there was only one type of car used. I have an older car without shoulder height adjustments,” and
- “it was somewhat dry.”

Few however indicated any suggestions for change, one suggested adding information about booster seats for children, four indicated options for changing graphics or color, for example, “I'd say more striking graphics, less washed out from what I remember however, it may detract from the instructions”. Although of note, the participant wasn’t sure this would be the best option. Two participants suggested music be added, although it should be noted that there was music in the video and a further two participants suggested greater diversity of cars be used, for example, “use more than one type of car”, for example, “use more than one type of car”.

A summary of the frequency of responses is provided in Table 15.

Table 15. Summary of frequency of qualitative responses to perceptions of video.

	Reported	
	N	**%**
Liked best		
Informative	16	57
A specific element	7	25
A delivery method	15	54
Liked least		
Nothing	18	64
Main/ key learning		
General seatbelt safety	14	50
Lap belt position (vertical lap belt position)	13	46
Shoulder belt position	8	29
Snug fit (horizontal lap belt position)	7	25
Graphics		
Liked	26	93
Suggested improvements		
Any comments	9	32
Previous knowledge of fit		
Any	6	21

5. DISCUSSION

5.1. Accomplishment

This is believed to be the first study to develop and evaluate the effectiveness of a video-based tutorial intended to improve belt fit by increasing knowledge on the appropriate way to wear a seat belt. The results provide preliminary evidence that interventions could improve belt fit. Data from both the in-vehicle and in-laboratory belt measures found that 93% of participants improved some aspect of lap belt fit in response to the intervention. In-vehicle post-intervention measures found that 29% of participants improved both vertical (Z) and horizontal (X) lap belt scores, 39% improved vertical lap belt score (Z) only, and 25% improved horizontal lap belt score (X) only. Participants who lowered the lap belt location (Z) after the intervention, showed an improvement of 40 mm on average. This delta value is only slightly less than the width of the belt used in this study (45 mm). Among those participants who shifted the horizontal lap belt location rearward, closer to the pelvis, an average improvement of 50 mm was observed. Indices of behavioral modifications also aligned with the belt fit score improvements. Most participants were able to articulate their actions in line with the recommendations described in the video and strongly endorsed attitudes that are theorized to predict greater seat belt use and proper seat belt use.

5.2. Limitations and Future Work

While the findings are promising more research will be needed to establish whether this or another intervention would be effective outside of the laboratory setting. A randomized, controlled study would be needed to robustly evaluate a belt fit intervention. Although improvements in belt fit were demonstrated in this short-duration study, further investigation will be needed to determine if the participants continued to place their belts more appropriately in subsequent weeks and months.

This work is limited by sample size of 29 adults. Previous research by Reed et al. (2013) determined that body mass index was the most important factor determining lap belt fit. However, the sample size of the current study was not large enough to investigate the effects of anthropometric covariates such as obesity and age. These participants, who all volunteered for a University research study, may not be representative of the population as a whole with respect to their receptivity to safety messages.

The results demonstrate the potential for public health interventions to improve belt fit. Multi-faceted interventions that combine education with other components should be considered. Potential approaches include hands-on education by clinicians, written materials for distribution, demonstrations of proper belt fit, and an on-line messaging through video, websites, and social media. Points of consideration should include: the efficacy of the safety messaging; evaluation of the specific script describing how a safety belt should be routed with respect to an individual's anatomy to ensure proper fit; effectiveness of the message reaching vulnerable populations (i.e., obese and elderly).

Further research is needed to determine whether the belt fit improvements noted in this study have practical implications for occupant safety. Conceptually, improved belt fit should result in reductions in crash injury risk, but those reductions have not yet been quantified. Computational human modeling of crash scenarios is the most feasible method for estimating the potential benefits of improved belt fit.

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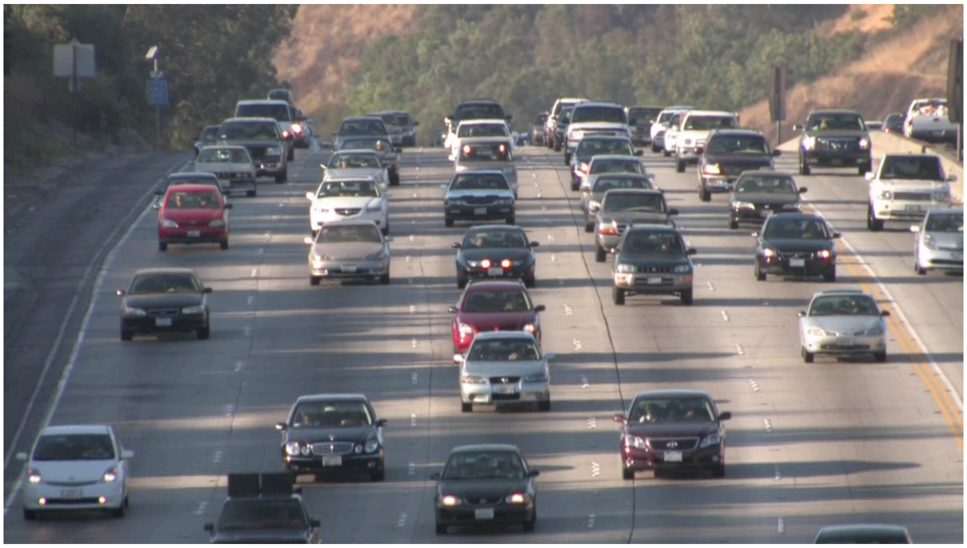
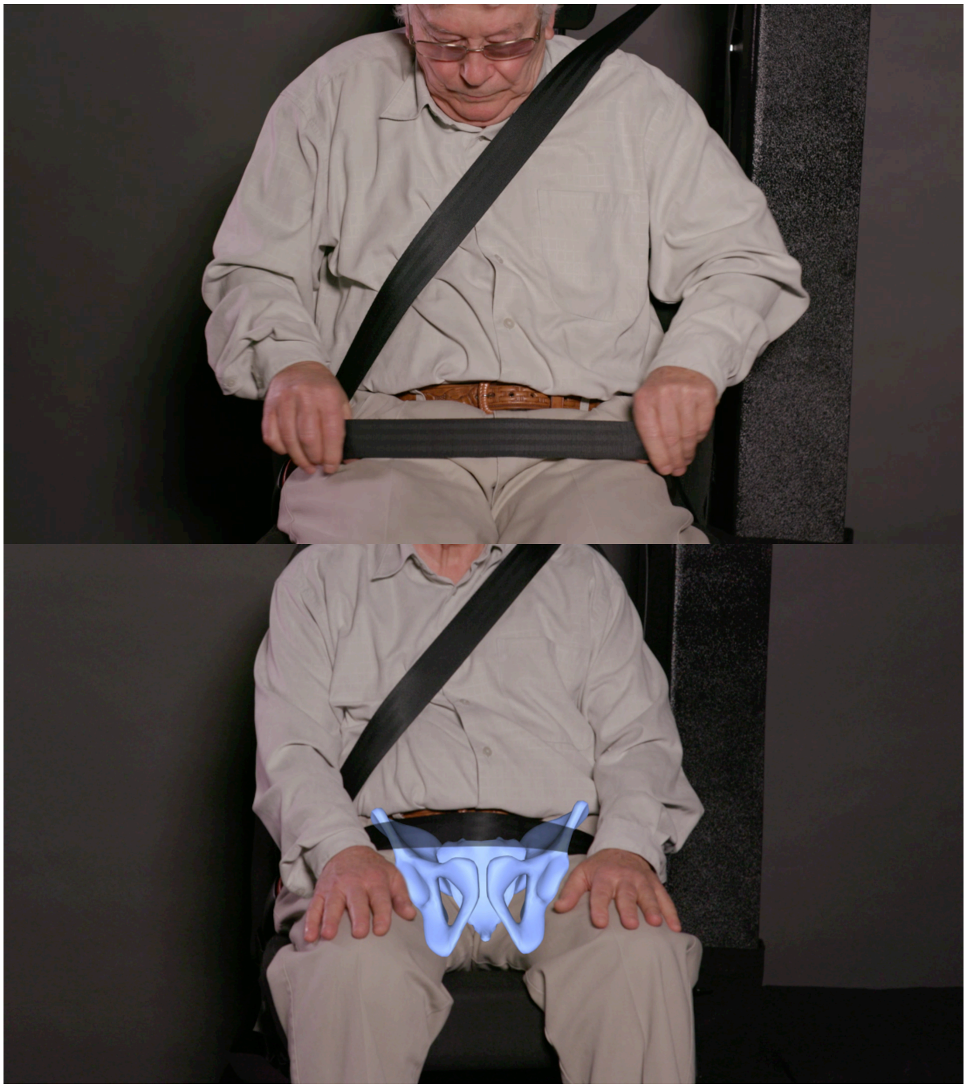
APPENDIX A. Video intervention Script and Story Board

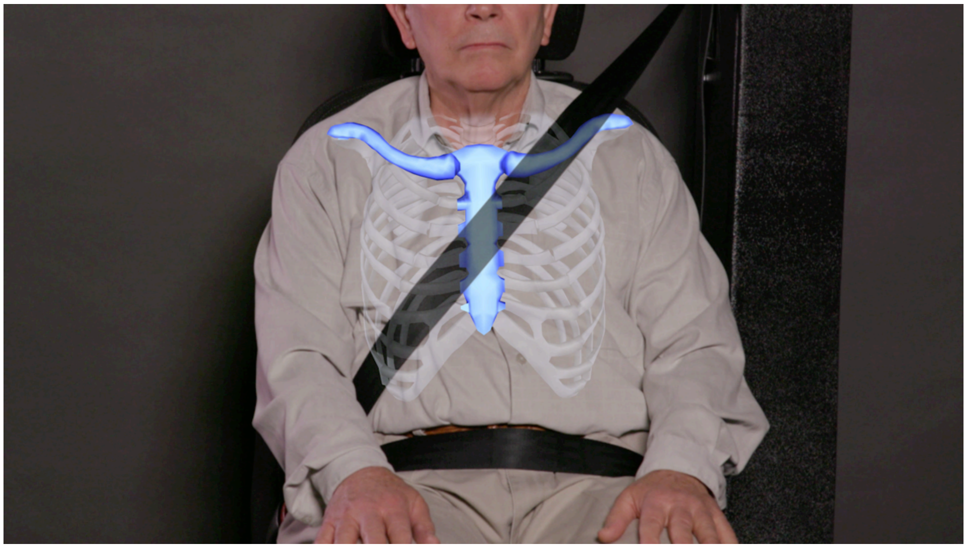


Narrator: Seat belts save over 35 lives in the US every day.

Narrator: And now…research has determined there is a way to reduce injuries even more…simply by making sure that when you put on your seatbelt …it is positioned snugly, in just the right way. The way it was designed to protect you…using the strongest parts of your body…your bones.



Narrator: You want to make sure that the belt is very low touching your thighs so that it is positioned over the hipbones…as opposed to higher up on your belly where critical organs are.



Narrator: For the shoulder belt you want to make sure it sits across the collarbone, midway between the neck and the shoulder. The belt should also route diagonally across your chest.

Narrator: Also, it is critical to make sure the belt is snug.

Narrator: So when you put on your seat belt, first be sure to push the lap belt down as low as possible so it touches your thighs.

Narrator: Then check to make sure the shoulder belt is across your collarbone.

Narrator: Pull the belt so it is snug across your body.

Narrator: For a proper fit, if you are wearing a heavy cost you may need to open it or adjust the belt.

Narrator: Many vehicles have height adjustors on the column behind your window that will enable you to adjust the belt to make it fit just right.

Narrator: Having your belt low across your lap, high across your collarbone, and snug means you have positioned the belt the way it was designed for maximum protection.

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Appendix B. In-Person Intervention

(Belt is in stowed position)

Making sure the belt is in the best place on our bodies is simple and we hope will be come as automatic as buckling-up when getting in the vehicle.

Belts need to be on your strongest bones in a crash. These are you hips *(point to thigh/abdomen junction on subject)* and collar bone (*point to about 2" out from suprasternale on clavicle of subject)*.

(Investigator pickups and holds latch plate)

It is important to get the lap portion of the belt very low and very snug so that it is as close to your hips as possible- that means below your stomach and abdomen.

(Investigators hands latch plate to subject)

Place the belt down on your thighs and then pull it in tight.

(Investigator moves belt down or tighter if needed)

To get this snug fit, you will need to open or lift bulky clothes.

(Investigator moves clothing up away from lap belt if needed and retightens)

The shoulder portion of the belt should be centered on your collarbone – close to your neck but not touching. Most vehicles have a height adjuster by your shoulder that might improve your fit.

(Investigator moves D-ring up to improve fit if needed)

It is great that people are putting on the belt; we just would like to make people aware that it should be on the strongest bones and snug.

Appendix C. Consent Form

Study ID: HUM00104350 IRB: Health Sciences and Behavioral Sciences Date Approved: 11/30/2015

University of Michigan Transportation Research Institute

Evaluating an Intervention to Improve Belt Fit for Drivers

This study is funded by the Toyota Collaborative Safety Research Center. The purpose of this study is to measure people measure the posture of people in vehicles and the locations of vehicle components.

You will be measured while wearing your own clothes and then in clothing provided to you (cotton pants and loose-fitting T-shirt). The investigators will take measurements of your body that describe your body proportions and size. Your body dimensions will be measured with calipers, rulers, and tape measures as you lie, sit and stand.

Your seating posture and position will be recorded using a digital coordinate measurement device as you sit in your own vehicle and different vehicle configurations in our laboratory vehicle mockup. You will be asked to adjust seat positions and angles to your preference and comfort. After each configuration, you will be asked to complete some brief surveys, which involve both opened-end and numerical rating scale responses.

The investigator will touch points on your body to record their locations with a measurement probe. Measurement points include landmarks on your head, chest, pelvis, and extremities. You have observed a demonstration of the measurement point locations and agree that it is acceptable for the experimenter to touch those locations.

Photographs and videos will be taken during testing to document your posture and component settings. Your face will be obscured in any photographs used in publications or presentations.

Your participation in this study is voluntary. If you choose not to participate, no data will be obtained from you.

You will be paid $12 per hour for your participation in one testing session that will last approximately 2 hours. You may discontinue your involvement at any time with payment for participation up to the stopping point prorated by rounding up to the quarter hour. Your travel expenses will not be reimbursed and are a cost of participation.

Two weeks following your participation in the study, you will be contacted via a phone call to complete a follow-up brief survey. Your participation in this telephone survey is voluntary. If you choose not to participate, no data will be obtained from you.

The Transportation Research Institute is a research organization and, as such, your records and personal information may be reviewed by research staff. They will be used in scientific publications and presentations only in coded form not identifying you. The data obtained from you will be retained indefinitely for analysis. The data will be stored on computer systems at the University of Michigan Transportation Research Institute. The key linking your personal information to the data obtained from your participation will be destroyed at the conclusion of the testing phase of the research project.

Benefits: You may not receive any direct benefits from being in this study. The result of this study may help keep everyone safe and ensure the effectiveness of vehicle safety devices in the future.

Risks: The researchers have taken steps to minimize the risks of this study. Even so, you may still experience some risks related to your participation, even when the researchers are careful to avoid them. These risks include injury due to exertion when performing the requested tasks. Please tell the researchers about any concerns or problems you have during the study. By signing this form, you do not give up your right to seek payment if you are harmed as a result of being in this study.

Please contact the study team should you have any questions about the study: Dr. Monica Jones at 734-936-0788 or Dr. Matthew Reed at 734-936-1111. If you have questions about your rights as a research participant, or wish to obtain information, ask questions or discuss any concerns about this study with someone other than the researcher(s), please contact the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board, 2800 Plymouth Rd. Building 520, Room 1169, Ann Arbor, MI 48109-2800, (734) 936-0933, or toll free, (866) 936-0933, irbhsbs@umich.edu.

One copy of this document will be kept together with research records on this study. A second copy will be give to you.

By signing below, you agree to the conditions set forth above and agree that you have had an opportunity to discuss your concerns regarding your participation in the proposed study.

By signing this document, you agree to your participation in a research study. By signing below, you indicate that you are willing to have photographs and video taken of you to document your body size, shape, posture, and position. You may not participate in the study if photographs and video are not taken. Your identity will be obscured in any photographs or videos of you are used in publications or presentations.

____________________	______________________________	__________
Participant Name	Participant Signature	Date
Witness Name	Witness Signature	

Principal Co-Investigators:
Monica L.H. Jones, Ph.D.
734-936-0788 (work)

Matthew P. Reed, Ph.D.
734-936-1111 (work)

Appendix D. Scripted Instructions Read by Investigator to Participant

Introduction Script

Thank you for volunteering today. Over the next couple of hours, you will be participating in a scientific study investigating how people sit in vehicles. We are going to ask you to do some different things so that we can take measurements on your body.

First we will use a Faro Arm to measure your and your vehicle. We will need to place several stickers on your vehicle to take these measurements. An investigator will take the rounded tip of the arm and touch it to points on your body and on your vehicle. A computer records the location of the tip. You will need to sit very still while we take these measurements. We will be touching your head, shoulders, chest, hips and limbs during these measurements.

Then we will go up stairs where we have a vehicle mockup, where we will repeat these measures with another Faro Arm.

We will also measure you by using a specialized set of rulers called anthropometers. We will measure the size of your head, arms, legs, hips, lower back and chest.

Driver Mockup Instruction Script

Overview: At this station we will ask you to sit in this driver seat, and then we will record your posture using this measurement arm. As we did in your vehicle, I will feel for the location of a bone, then touch that location with this tip and press a button.

In the First Condition:

Please have a seat. This mockup has <u>seat and belt adjustments</u>.

This is a simple seat but I am required to show you how the controls work.
When you push this lever the seat back recline changes. Please try it out.
This button controls the up-down, forward-backward and tilt of the seat cushion.
I will demonstrate. Please try it out.

Please place your right foot on the accelerator and your left foot flat on the floor. Then adjust the seat to a comfortable position for driving, as though you were going to be driving for a long time.

Please put on the seat belt.

Please sit as though you were driving with your hands on the steering wheel and your right foot on the accelerator and your left on the floor.

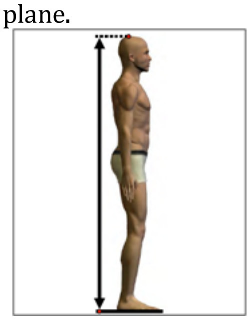
If they naturally sit centered left-right, in a symmetrical posture with the left foot flat on the floor and hands near the 2 and 10 position proceed to next instruction. Otherwise:

- If they are not centered left-right ask them to do so being sure to use the terms left and right, otherwise they might change their hip position forward-backward. For example say – Please move your rear-end left (or right) so that you are lined up with the seat.
- If their hands are in a different position or their feet are in some odd position, ask them to move their hands to 10 and 2, or place the left foot flat on the floor.
- If they say that this is how they usually or prefer to sit, say – I understand, but for this study we ask that everyone sit in a more standard driving position
- Further explanation if needed – We are not measuring your personal preference in this study, but rather how people's bodies fit in vehicles.

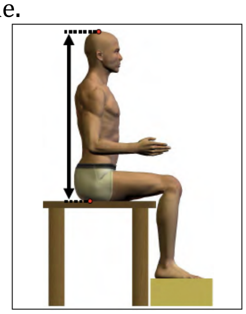
Relax your shoulders and look forward as though you are looking down the road. This is the position that I will need you to "freeze" in while I take measurements. Please stay frozen until I tell you to "unfreeze." I may move your hands so that I can reach points on your body, but please keep the rest of your body frozen.
After finishing measurements:
Now please be very careful as you step out to the right. Please stand or sit facing away from the seat while I set up the next condition.

APPENDIX E. Standard Anthropometry

1. Weight
2. Stature
DESCRIPTION: The vertical distance from a standing surface to the top of the head.
LANDMARK: Top of head (vertex).
PROCEDURE: Participant is in the anthropometric standing position with the head in the Frankfurt plane. Stand at one side of the participant, and use an anthropometer to measure the vertical distance between the standing surface and the top of the head. Move the blade of the anthropometer across the top of the head to ensure measurement of the maximum distance. Use firm pressure to compress the participant's hair. The measurement is taken at the maximum point of quiet respiration.
INSTRUMENT: Anthropometer.
CAUTION: Be sure that the head is in the Frankfurt plane.

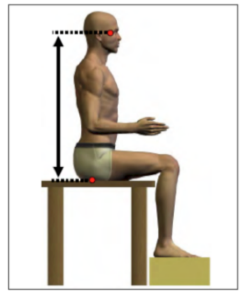



3. Erect Sitting Height
DESCRIPTION: The vertical distance between a sitting surface and the top of the head.
LANDMARK: Top of head (vertex).
PROCEDURE: Participant is in the anthropometric sitting position with the head in the Frankfurt plane. Stand at the right rear of the participant, and use an anthropometer to measure the vertical distance between the sitting surface and the top of the head. Use sufficient pressure to compress the hair. The measurement is made at the maximum point of quiet respiration.
INSTRUMENT: Anthropometer.
CAUTION: Be sure the head is in the Frankfurt plane.

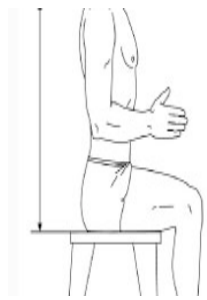



4. Eye Height (Sitting)
DESCRIPTION: The vertical distance between a sitting surface and the top of the head.
LANDMARK: Top of head (vertex).
PROCEDURE: Participant is in the anthropometric sitting position with the head in the Frankfurt plane. Stand at the right rear of the participant, and use an anthropometer to measure the vertical distance between the sitting surface and the top of the head. Use sufficient pressure to compress the

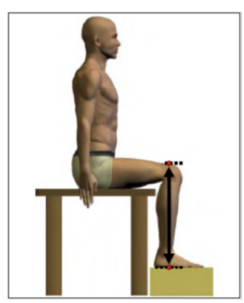
hair. The measurement is made at the maximum point of quiet respiration.
INSTRUMENT: Anthropometer.
CAUTION: Be sure the head is in the Frankfurt plane.

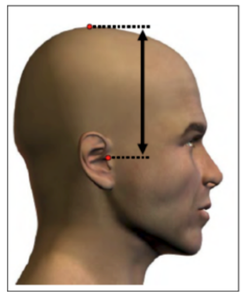
5. Acromial Height (Sitting) – ANSUR I
The vertical distance between a sitting surface and the acromion landmark on the tip of the right shoulder is measured with an anthropometer. The subject sits erect looking straight ahead. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The measurement is made at the maximum point of quietest respiration.



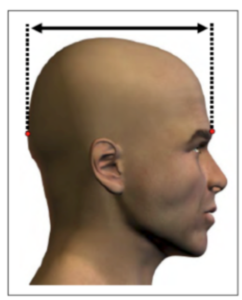
6. Knee Height
DESCRIPTION: The vertical distance between a footrest surface and the suprapatella landmark.
LANDMARK: Suprapatella, right.
PROCEDURE: Participant sits with the thighs parallel, the knees flexed 90°, and the feet in line with the thighs. The arms are relaxed at the sides. Stand at the right of the participant, and use an anthropometer to measure the vertical distance between the footrest and the drawn suprapatella landmark at the top of the knee.
INSTRUMENT: Anthropometer.

7. Tragion to Top of Head
DESCRIPTION: The vertical distance between the right tragion landmark on the cartilaginous flap in front of the earhole and the horizontal plane tangent to the top of the head.
LANDMARKS: Tragion, right and Top of head (vertex).
PROCEDURE: Participant sits with the head in the Frankfurt plane. Stand to the right of the participant, and use a beam caliper with paddle blade to measure the vertical distance between the right tragion landmark and the top of the head. The fixed blade is on tragion. Be sure the beam is parallel to the long axis of the head. Exert sufficient pressure to obtain contact between the paddle blade and the skin.
INSTRUMENT: Beam caliper with paddle blade.

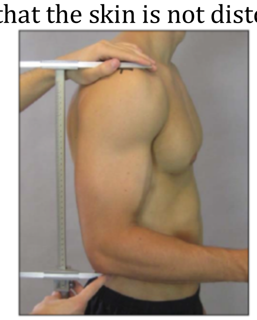
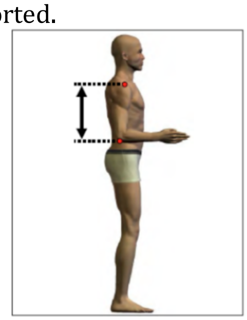



8. Head Length
DESCRIPTION: The distance from the glabella landmark between the brow ridges to opisthocranion.
LANDMARKS: Glabella and Opisthocranion.
PROCEDURE: Participant sits. Stand at the right of the participant. Use a spreading caliper to measure in the midsagittal plane, the distance between the glabella landmark and opisthocranion. Place one tip of the caliper on glabella, and move the other tip up and down on the back of the head in the midsagittal plane until the maximum measurement is obtained. Use light pressure on glabella and enough pressure on opisthocranion to compress the hair.
INSTRUMENT: Spreading caliper.

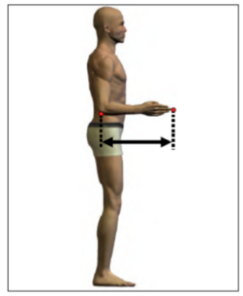
9. Head Breadth
DESCRIPTION: The maximum horizontal breadth of the head above the ears.
LANDMARKS: Euryon, right and left.
PROCEDURE: Participant sits. Stand behind the participant, and use a spreading caliper to measure the maximum horizontal breadth of the head above the ears (euryon, right and left). Exert sufficient pressure to obtain contact between the caliper and the skin.
INSTRUMENT: Spreading caliper.


10. Shoulder-Elbow Length
DESCRIPTION: The distance between the right acromion landmark and the olecranon landmark on the bottom of the right elbow.
LANDMARKS: Acromion, right and Olecranon, bottom.
PROCEDURE: Participant stands erect with the upper arm hanging at the side and the elbow flexed 90°. The hand is straight, and the palm faces inward (medially). Stand at the right of the participant, and use a beam caliper to measure the distance between the drawn acromion landmark on the tip of the shoulder and the bottom of the elbow (olecranon, bottom). The measurement is made parallel to the long axis of the upper arm. Place the fixed blade of the caliper on acromion. Exert only enough pressure to attain contact between the caliper and the skin.
INSTRUMENT: Beam caliper.
CAUTION: Be sure that the zero edge of the blade of the caliper is on acromion when the measurement is made and that the skin is not distorted.

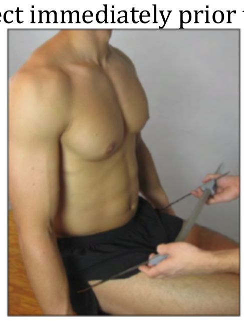
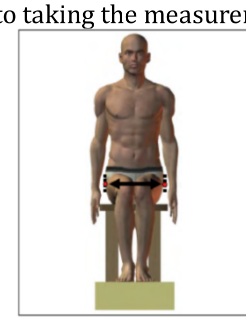



11. Elbow- Hand Length
DESCRIPTION: The horizontal distance between the back of the tip of the right elbow to the tip of the right middle finger.
LANDMARKS: Olecranon, rear; Dactylion III, right.
PROCEDURE: Participant stands erect with the upper arms hanging at the side and the right elbow flexed 90°. The hand is held out straight with the palm facing inward. Stand to the right of the participant, and use a beam caliper to measure the horizontal distance between the back of the tip of

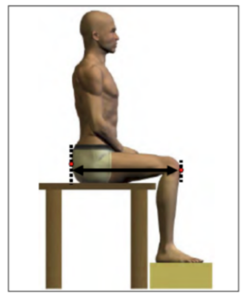
the elbow (olecranon, rear) to the tip of the middle finger (dactylion III). Place the fixed blade on olecranon.

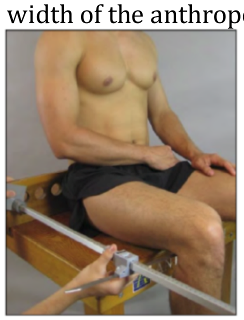
12. Maximum Hip Breadth
DESCRIPTION: Maximum hip (or thigh) breadth of a seated participant.
PROCEDURE: Participant sits erect with the feet and knees together and the arms relaxed at the sides. Stand in front of the participant, and use a beam caliper to measure the most lateral points on the hips or thighs (whichever are broader). The blades of the caliper are kept at approximately a 45° angle to the horizontal and moved up and down to locate the maximum breadth. Exert only enough pressure to ensure that the caliper blades are on the body.
INSTRUMENT: Beam caliper.
CAUTION: The recorder should help the participant hold the knees together. Make sure the participant's torso is still erect immediately prior to taking the measurement.

13. Buttock-Knee Length – Snyder
DESCRIPTION: The horizontal distance between a buttock plate placed at the most posterior point of either buttock and the anterior point of the right knee.
LANDMARK: Knee point, anterior.
PROCEDURE: Participant is in the anthropometric sitting position, but with arms relaxed on the lap. Stand at the right of the participant, and slide the buttock plate toward the participant until it makes light contact with the most posterior point on either buttock. When the plate is in position lock it in place. Use an anthropometer to measure the horizontal distance between the buttock plate and the front of the knee (knee point, anterior). The base of the anthropometer is anchored on the buttock plate. Exert only enough pressure on the instrument to attain contact between the anthropometer blade and the knee.
INSTRUMENTS: Anthropometer, Buttock plate.
CAUTION: To ensure that the anthropometer is horizontal, be sure that the base of the anthropometer is fully against the buttock plate.

14. Buttock-Popliteal Length
DESCRIPTION: The horizontal distance between a buttock plate placed at the most posterior point of either buttock and the back of the right knee (the popliteal fossa at the dorsal juncture of the calf and thigh).
LANDMARK: Popliteal fossa at the dorsal juncture of the calf and thigh.
PROCEDURE: Participant is in the anthropometric sitting position with the arms relaxed on the lap. Stand at the right of the participant, and slide the buttock plate toward the participant until it makes light contact with the most posterior point on either buttock. When the plate is in position, lock it in place. Use an anthropometer to measure the horizontal distance from the buttock plate to the back of the knee. This is done in such a way that the blade of the anthropometer is placed as high and as far forward as possible in the popliteal fossa behind the knee (dorsal juncture of the calf and thigh) without compressing tissue. Exert only enough pressure on the instrument to attain contact between the anthropometer blade and the skin.
INSTRUMENTS: Anthropometer, Buttock plate.
CAUTION: To ensure that the anthropometer is horizontal, be sure that the base of the anthropometer is fully against the buttock plate. The computer will add 1 cm to the recorded dimension to account for the width of the anthropometer blade.

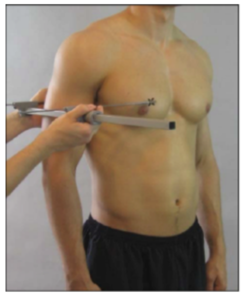


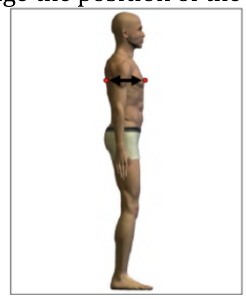

15. Biacromial Breadth
DESCRIPTION: The distance between the right and left acromion landmarks on the tips of the shoulder.
LANDMARKS: Acromion, right and left.
PROCEDURE: Participant is in the anthropometric sitting position. Stand behind the participant, and use a beam caliper to measure the distance between the drawn right and left acromion landmarks at the tips of the shoulders. The beam should be parallel to the coronal plane. If the acromial landmarks cannot be seen from behind, stand in front of the participant. The measurement is taken at the maximum point of quiet respiration. Use sufficient pressure to maintain firm contact with the skin.
INSTRUMENT: Beam caliper.
CAUTION: The participant must not be allowed to change the position of the shoulders.


16. Shoulder Breadth
DESCRIPTION: The maximum horizontal distance between the lateral margins of the upper arms on the deltoid muscles.
PROCEDURE: Participant is in the anthropometric sitting position. Stand behind the participant, and use a beam caliper to locate the greatest horizontal distance between the outside edges of the deltoid muscles on the upper arms. This is done by brushing the caliper blades up and down the upper arms. When the blades lightly touch the skin on both sides, withdraw the instrument to read off the measurement. The measurement is made at the maximum point of quiet respiration. Note that the deltoid landmarks are NOT used for this dimension.
INSTRUMENT: Beam caliper.

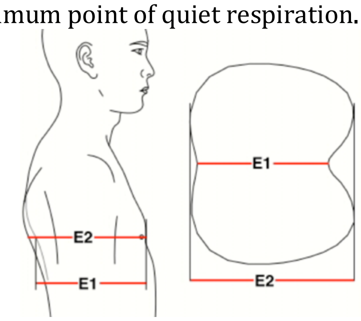

17. Chest Depth (on scapula) – (E2 in illustration)
DESCRIPTION: The horizontal distance between the right chest point anterior landmark and the back at the same level.
LANDMARK: Chest point, anterior, right.
PROCEDURE: Participant is in the anthropometric standing position. Stand at the right of the participant, and use a beam caliper to measure the horizontal distance between the chest at the level of the right chest point anterior landmark and the back at the same level. Place the fixed blade of the caliper on the back. On women, the landmark will be an adhesive dot on the bra. Before taking the measurement verify that this landmark has not shifted. This measurement is taken at the maximum

point of quiet respiration. Exert only enough pressure to maintain contact between the caliper and the skin (or bra).
INSTRUMENT: Beam caliper.
CAUTION: Participant must not be allowed to change the position of the shoulders.

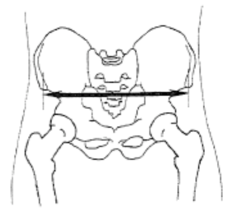




18. Chest Depth (on spine) – (E1 in illustration)
The horizontal distance between the sternum, at the level of the right bust point on women or the nipple on men (and children), and the spine at the same level is measured with a curved caliper. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed. The measurement is taken at the maximum point of quiet respiration.

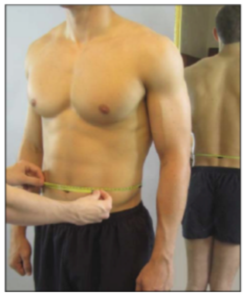


19. Bispinous Breadth – ANSUR I
The straight-line distance between the right and left anterior superior iliac spine landmarks is measured with a bema caliper. The subject stands looking straight ahead with the heels together and the weight distribute equally on both feet.

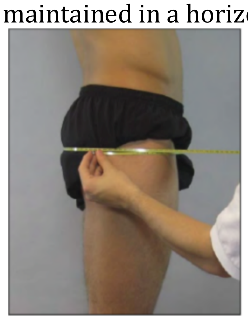



20. Chest Circumference at Axilla
DESCRIPTION: The maximum circumference of the chest at the fullest part of the breast.
LANDMARK: Chest point, anterior, right.
PROCEDURE: Participant is in the anthropometric standing position in front of a mirror. Stand in front of the participant, and use a tape to measure the horizontal circumference of the chest at the level of the right chest point anterior landmark. On women, the landmark will be an adhesive dot on the bra. Before taking the measurement verify that this landmark has not shifted. Use the mirror to check the position of the tape as it crosses the participant's back. This dimension will cross very soft tissue at the armpit and bust, and some compression of the tissue will inevitably occur. Be sure, however, to keep this to a minimum. Exert only enough tension on the tape to maintain contact between the tape and the skin. The tape will span body hollows in this measurement. The measurement is taken at the maximum point of quiet respiration.
INSTRUMENT: Steel tape.


21. Waist Circumference
DESCRIPTION: The horizontal circumference of the waist at the level of omphalion encompassing the waist (omphalion) landmarks.
LANDMARKS: Waist (omphalion), right, left, anterior and posterior.
PROCEDURE: Participant is in the anthropometric standing position in front of a mirror. Stand in front of the participant, and use a tape to measure the horizontal distance around the torso at the level of the center of the navel. The tape will pass over the drawn waist (omphalion) landmarks at the front,




22. Hip Circumference at Buttocks
DESCRIPTION: The horizontal circumference of the trunk at the level of the maximum protrusion of the right buttock.
LANDMARKS: Buttock point, right lateral and left lateral and Buttock point, posterior.
PROCEDURE: Participant stands erect on a table with heels together. Ask the participant to hold up the right leg of the shorts to expose the landmark. Stand at the participant's right, and use a tape to measure the horizontal circumference of the trunk at the level of the maximum protrusion of the right buttock. The tape should pass over the posterior buttock point (not drawn) and the buttock point landmarks drawn on the right and left hips. If necessary, ask male participants to adjust the genitalia so as to interfere as little as possible with the tape. Exert only enough tension on the tape to maintain contact between the tape and the skin.
INSTRUMENT: Steel tape.
CAUTION: The tape must be maintained in a horizontal plane.




23. Upper Thigh Circumference
DESCRIPTION: The circumference of the thigh at its juncture with the buttock.
LANDMARK: Gluteal furrow point, right.
PROCEDURE: Participant stands erect on a table with the weight distributed equally on both feet. The legs are spread apart just enough so that the thighs do not touch, and the right hand is on the chest. Stand at the right of the participant, and use a tape to measure the circumference of the thigh at its juncture with the buttock (gluteal furrow point). The measurement is made perpendicular to the long

axis of the thigh. Exert only enough tension on the tape to maintain contact between the tape and the skin.
INSTRUMENT: Steel tape.
CAUTION: The participant must not tense the thigh muscles. The tape must not be placed in a furrow.

<u>Definitions</u>
Acromion: The most lateral bony point on the acromion process of the scapula (shoulder blade). It is near the shoulder joint center of rotation.
Axilla: the armpit
Bust point: The anterior point of the bra cup
Chest point: The most anterior right point on the chest.
Buttock Point: Point at the level of the maximum protrusion of the right buttock.
Glabella: The most prominent point palpable on the forehead between the eyebrows (Supra-orbital ridges) and above the junction of the nose (nasofrontal suture) with the forehead.
Iliocristale: The highest palpable point of the right and left iliac crests of the pelvis, one half the distance between the anterior superior iliac and posterior superior iliac spines.
Procedure- Participant stands in the anthropometric standing position. Stand in front of the participant. Use both hands to locate the anterior and posterior points of the iliac crests and note one half the distance between them. At this midpoint, use the tip of the finger to move upwards on the right side to locate the highest palpable point, and draw a short horizontal line through the landmark. Draw two dots anterior to the line. Repeat the process on the left side.
Gluteal furrow point: the lowest point of the lowest furrow or crease at the juncture of the right buttock and the thigh.

Appendix F. Questionnaire 1: Demographics

Demographic Related Questions

1. What is your age? _______________ years

2. Please indicate your gender:
   - ☐ Male
   - ☐ Female
   - ☐ Other (please specify):_______

3. Please indicate your race/ethnicity:
   Please check all that apply.
   - ☐ African American
   - ☐ White
   - ☐ Hispanic/Latino
   - ☐ Asian
   - ☐ American Indian
   - ☐ Other (please specify): ____________________

4. What is your current employment status?
   - ☐ Full-time employment
   - ☐ Part-time employment
   - ☐ Unemployed, looking for work
   - ☐ Unemployed, not interested in returning to work
   - ☐ Unemployed, disabled, retired

5. Which of the following best describes your household's total pay from working/income before taxes last year?
   Please note that this question will not be reported to the IRS or any other person.
   - ☐ Less than $10,000
   - ☐ $10,000 - $19,999
   - ☐ $20,000 - $39,999
   - ☐ $40,000 - $59,999
   - ☐ $60,000 - $79,999
   - ☐ $80,000 - $99,999
   - ☐ $100,000 or more
   - ☐ Don't know

6. How many years of education have you completed?
   - ☐ 8th grade or less
   - ☐ Some high school or working on GED
   - ☐ High school graduate or GED
   - ☐ Some college
   - ☐ College graduate
   - ☐ Any post-graduate education

Driving Related Questions

1. In the past 3 months, how many times did you drive in a typical week?
   - ☐ I don't drive
   - ☐ Less than once
   - ☐ Once
   - ☐ Twice
   - ☐ Three or more

2. In the past year, how many crashes, if any, have you been involved in as a driver?
   ________________ (0, 1, 2, 3, 4+)

3. In the past 12 months how many times have you been given a ticket, not counting parking tickets? ________________ (0, 1, 2, 3, 4+)

4. How often do you use seat belts when you drive as a driver in a car?
   - ☐ Always
   - ☐ Nearly always
   - ☐ Sometimes
   - ☐ Seldom
   - ☐ Never
   - ☐ Don't know

5. How often do you use seat belts when you ride as a passenger in the front seat of a car?
   - ☐ Always
   - ☐ Nearly always
   - ☐ Sometimes
   - ☐ Seldom
   - ☐ Never
   - ☐ Don't know

6. How often do you use seat belts when you ride as a passenger in the rear seat of a car?
   - ☐ Always
   - ☐ Nearly always
   - ☐ Sometimes
   - ☐ Seldom
   - ☐ Never
   - ☐ Don't know

Appendix G. Questionnaire 2: Video Intervention Evaluation

I found the Video …	Not at all									A great deal
Enjoyable	1	2	3	4	5	6	7	8	9	10
Boring	1	2	3	4	5	6	7	8	9	10
Interesting	1	2	3	4	5	6	7	8	9	10
Informative	1	2	3	4	5	6	7	8	9	10
Too difficult to understand	1	2	3	4	5	6	7	8	9	10
Too simplified	1	2	3	4	5	6	7	8	9	10

1. What did you like best about the video?

2. What did you like least about the video?

3. What were the main things you learned?

4. Did you like the graphics in the video?

5. What improvements do you think could be made to the video tutorial?

6. Have you ever previously had instruction on how to wear a seat belt?

Appendix H. Questionnaire 3: Health Beliefs

How strongly do you agree with each of the statements?	Strongly Disagree						Strongly Agree
People who are important to me approve of me using my seat belt	1	2	3	4	5	6	7
Not using my seat belt properly would make me feel very guilty	1	2	3	4	5	6	7
Wearing a seat belt protects me from getting seriously hurt in an accident	1	2	3	4	5	6	7
How I wear the seatbelt matters	1	2	3	4	5	6	7
Being injured in a crash due to not wearing seatbelt properly could lead to long-standing health problems	1	2	3	4	5	6	7
Where the lap belt is placed on a person is related to the chance of being injured in an accident	1	2	3	4	5	6	7
Where the shoulder belt is placed on a person is related to the chance of being injured in an accident	1	2	3	4	5	6	7
How snug or loose the seatbelt is related to the chance of being injured in an accident	1	2	3	4	5	6	7
Wearing a seat belt low, across your hip bones, touching your thighs, is an effective safety precaution	1	2	3	4	5	6	7
Wearing a seat belt across the middle of your shoulder is an effective safety precaution	1	2	3	4	5	6	7
Adjusting your seatbelt to ensure that it is snug is an effective safety precaution	1	2	3	4	5	6	7
Using a seatbelt is a habit, which I do without thinking	1	2	3	4	5	6	7
Taking an extra moment to check my seatbelt fit is something that I can learn to do	1	2	3	4	5	6	7
How confident do you feel that you can achieve good safety belt fit?	1	2	3	4	5	6	7
After viewing the video tutorial, will you be more likely to assess your safety belt fit when you drive?	1	2	3	4	5	6	7
	Strongly Disagree						Strongly Agree

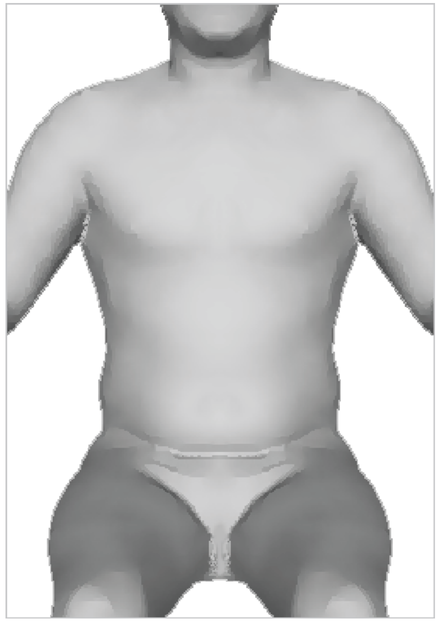
How would you describe the following parts of proper belt fit?	Extremely difficult, very uncomfortable						Easily accomplished
Wearing the seat belt low, across the hip bones, touching the thighs	1	2	3	4	5	6	7
Wearing the seat belt across the middle of the shoulder	1	2	3	4	5	6	7
Adjusting seatbelt to be snug	1	2	3	4	5	6	7
Achieving a good safety belt fit is	1	2	3	4	5	6	7

How often do you do these things?	Never						Always
How often do you use a seat belt?	1	2	3	4	5	6	7
How often do you check the fit of your seat belt?	1	2	3	4	5	6	7

Appendix I. Questionnaire 4: Participant Illustration of Good Belt Fit

On the illustrations below please draw where the lap and shoulder seat belt should be located to ensure maximum safety protection.

Draw <u>lap</u> and <u>shoulder</u> belt for maximum safety protection:



Draw <u>lap</u> and <u>shoulder</u> belt for maximum safety protection:

Appendix J
Evaluating an Intervention to Improve Belt Fit for Drivers
De-Brief

Biosciences Group
University of Michigan Transportation Research Institute

Thank you for taking part in our study.

This study is funded by the Toyota Collaborative Safety Research Center. As you may recall, when the study objectives were first introduced it was indicated that the purpose was to measure the posture of people in vehicles and the locations of vehicle components. Researchers may have indicated that "vehicle components" referred to safety devices in the vehicle (i.e. air bags, side air curtains, safety belt pre-tensioners).

As you may know, sometimes for an experiment to be valid it is necessary that the participants are not fully informed about the nature, set-up, or true purpose of the experiment until after it is completed. In such cases sufficient information is provided to ensure the safety and well-being of the participant, with full disclosure occurring later. This letter is to provide you with complete information about the experiment.

The objective of this research study is to evaluate whether a training intervention can improve drivers' safety belt fit. In an effort to educate drivers to improve belt fit, a video was produced to increase knowledge about the benefits of seatbelts and how to wear them correctly. The study is designed to test the efficacy of the video. The objective of the video is to increase knowledge about the benefits of safety belts and how to wear them correctly. Messaging is targeted to how a safety belt should be routed with respect to an individual's anatomy to ensure a proper fit. Overall, the goal is to improve vehicle occupant safety.

The reason why we didn't disclose this information at the time of the study was to ensure we were able to obtain a baseline measurement of belt fit, in both the vehicle and laboratory driver mock-up, prior to watching the video intervention.

We apologize for having subjected you to these deceptions, even if they seem minor, and we appreciate your willingness to take a chance to participate in this study and help us with our research. Your feelings are very important to us, and we truly hope you understand why we felt it necessary to deceive you. It was done in the spirit of acquiring important scientific information about human behavior. Whether our hypothesis is confirmed or disconfirmed, your participation has helped us learn something important about people and their behaviors. We are very grateful that you decided to help us. However, if you do not want us to include your data in our study, now that you know about the deception and the true purpose of the study, that is your right. If you would like to have your data withdrawn, please feel free to contact Dr. Monica Jones (mhaumann@umich.edu) or Dr. Matthew Reed (mreed@umich.edu). If you have questions about your rights as a research participant, or wish to obtain information, ask questions or discuss any concerns about this study with someone other than the researcher(s), please contact the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board, 2800 Plymouth Rd. Building 520, Room 1169, Ann Arbor, MI 48109-2800, (734) 936-0933, or toll free, (866) 936-0933, irbhsbs@umich.edu.

Best Regards,

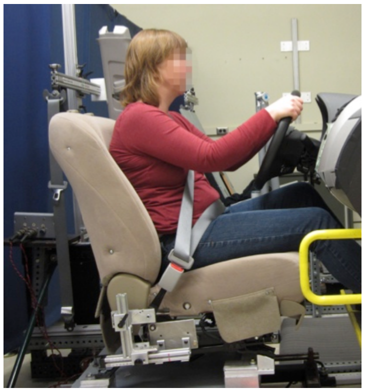
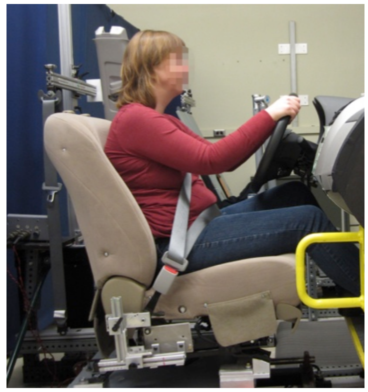
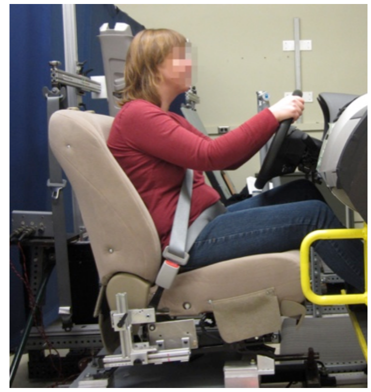
Monica L.H. Jones, PhD
On behalf of research team
Principal Investigator
University of Michigan
Transportation Research Institute
734-936-0788

Matthew P. Reed, PhD
On behalf of research team
Principal Investigator
University of Michigan
Transportation Research Institute
734-936-1111

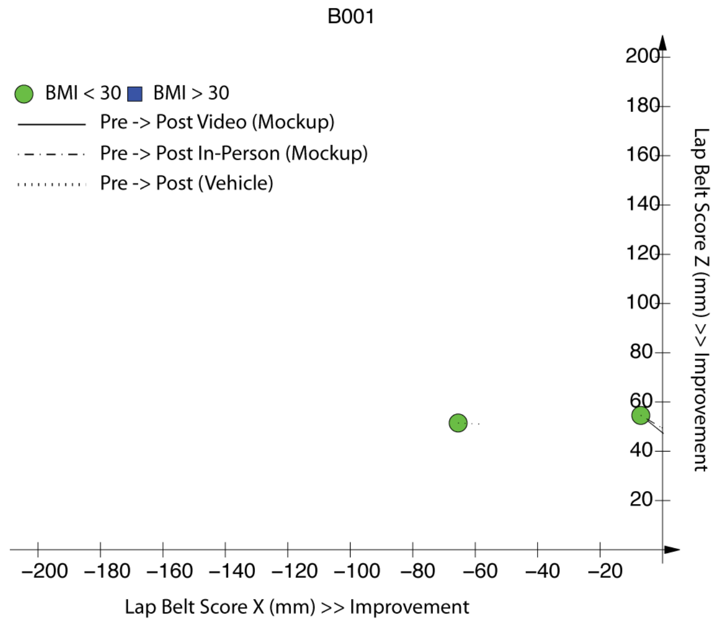
Appendix K. Individual Participant Lap Belt Fit Scores

B001

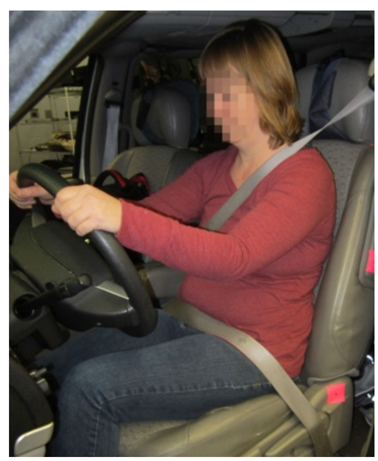
Mockup

Pre Interventions | Post Video | Post In-Person



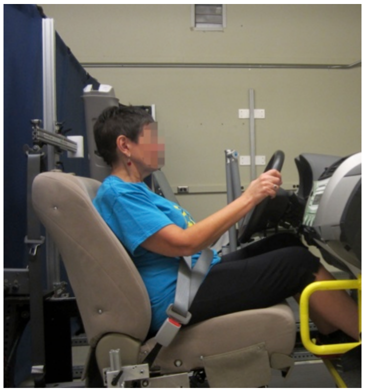
In-Vehicle

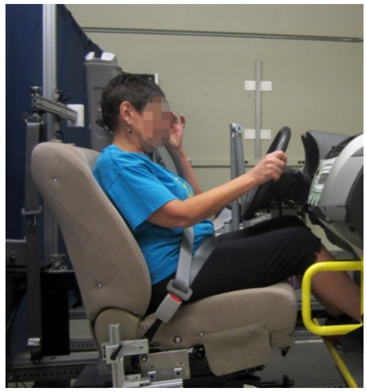



Pre Interventions | Post Interventions

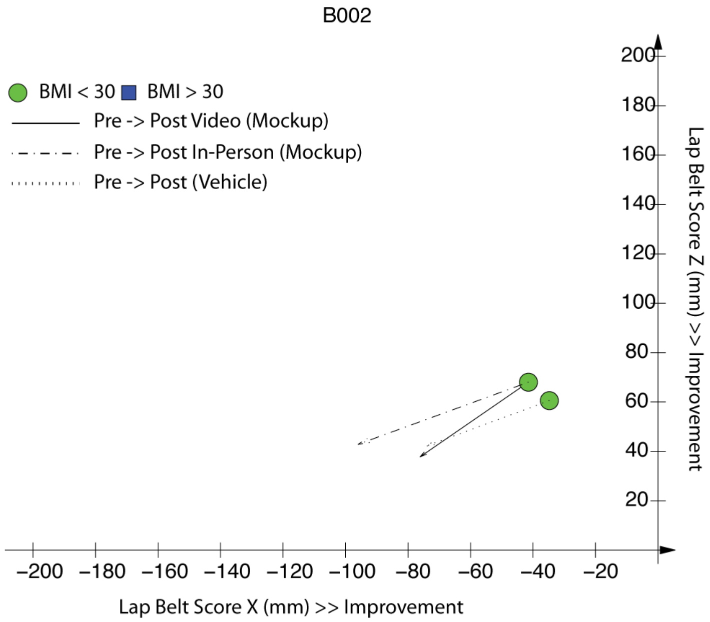
B002

Mockup





Pre Interventions   Post Video   Post In-Person



In-Vehicle

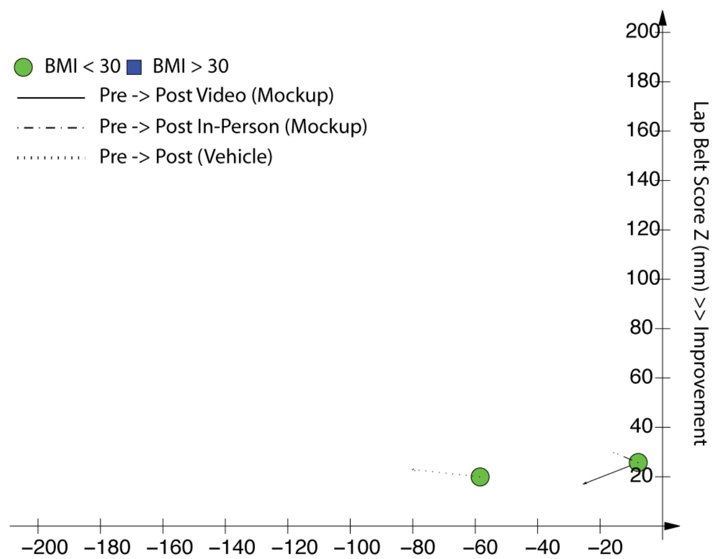
Pre Interventions   Post Interventions

B003

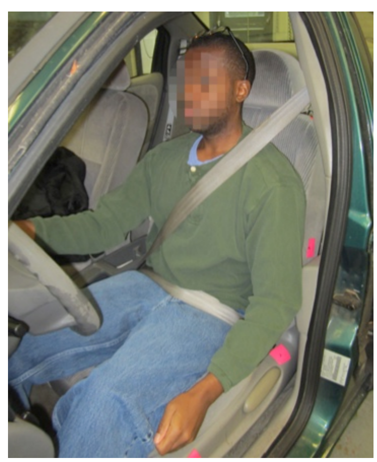
Mockup

Pre Interventions | Post Video | Post In-Person

B003



In-Vehicle



Pre Interventions | Post Interventions

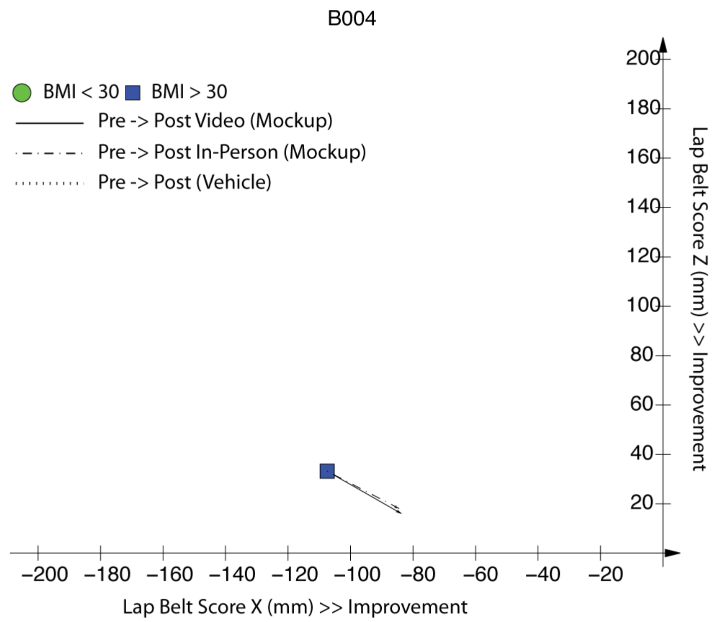
B004

Mockup

Pre Interventions

Post Video

Post In-Person



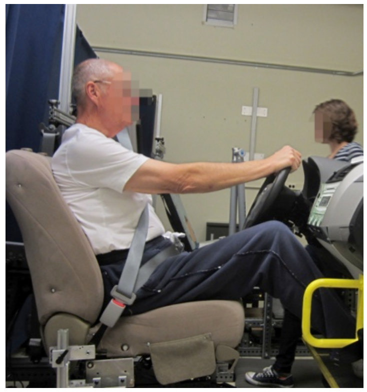
In-Vehicle

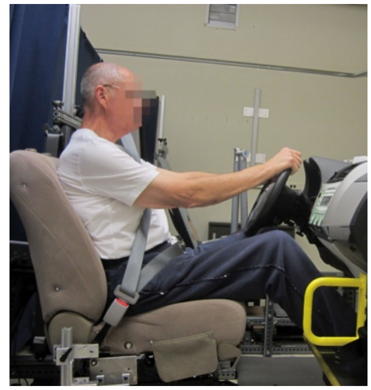
Pre Interventions

Post Interventions

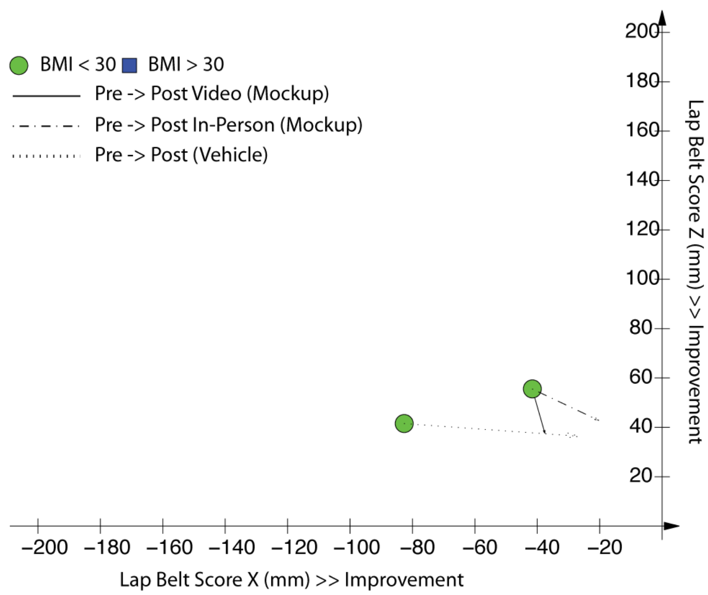
B005

Mockup





Pre Interventions | Post Video | Post In-Person



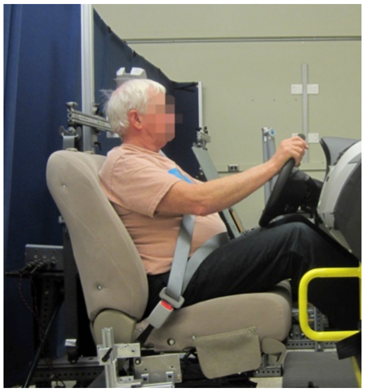
In-Vehicle

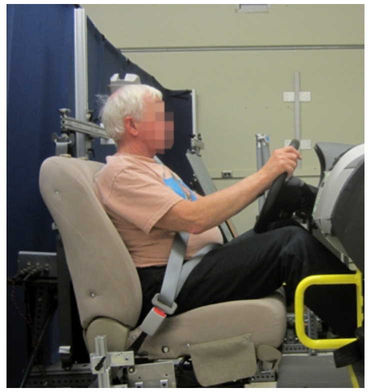
Pre Interventions

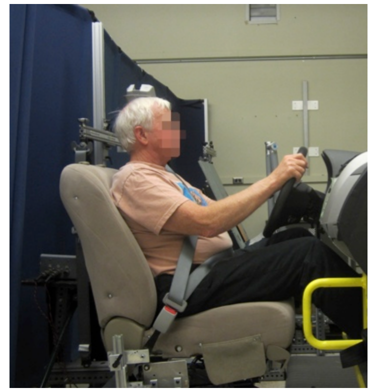
Post Interventions

B006

Mockup

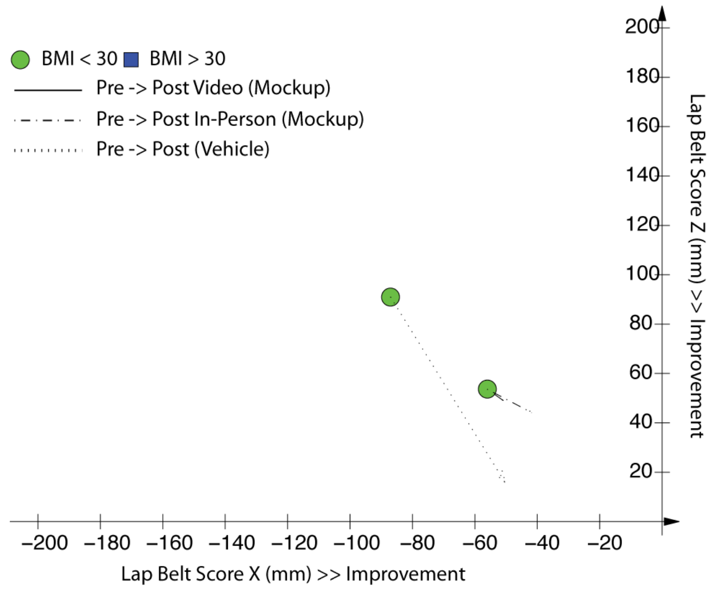






Pre Interventions | Post Video | Post In-Person

B006

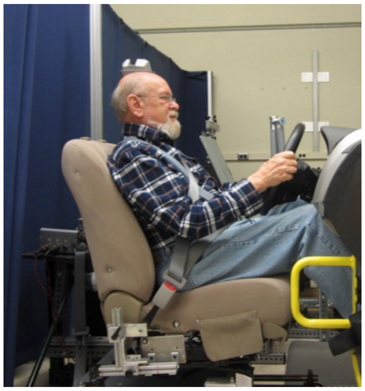


In-Vehicle

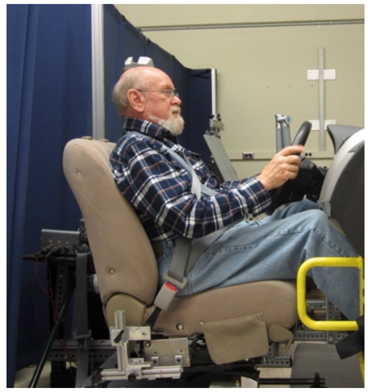
Pre Interventions | Post Interventions

B007

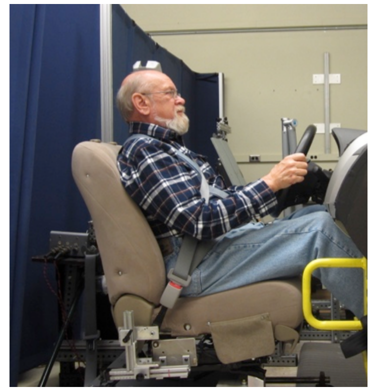
Mockup



Pre Interventions

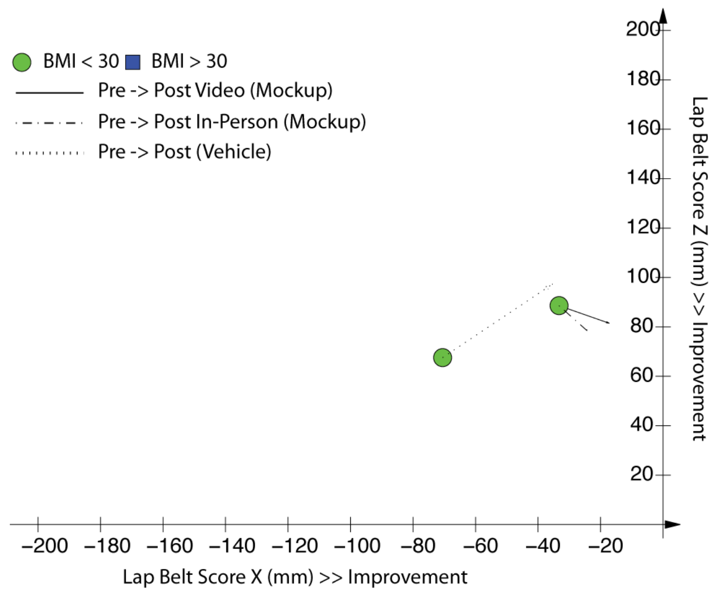


Post Video



Post In-Person

B007



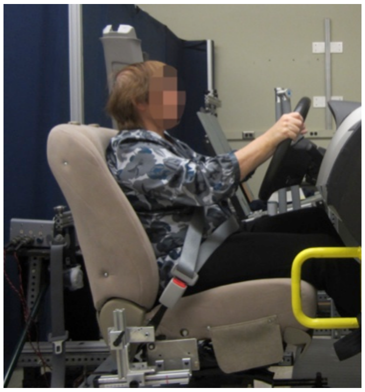
In-Vehicle

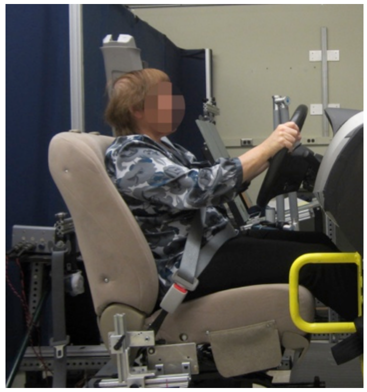
Pre Interventions

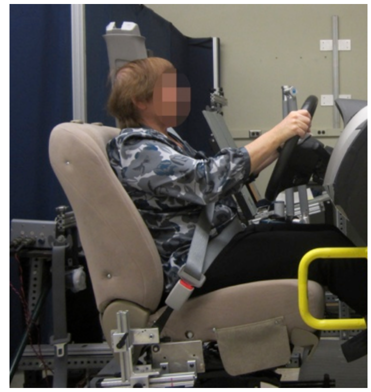
Post Interventions

B008

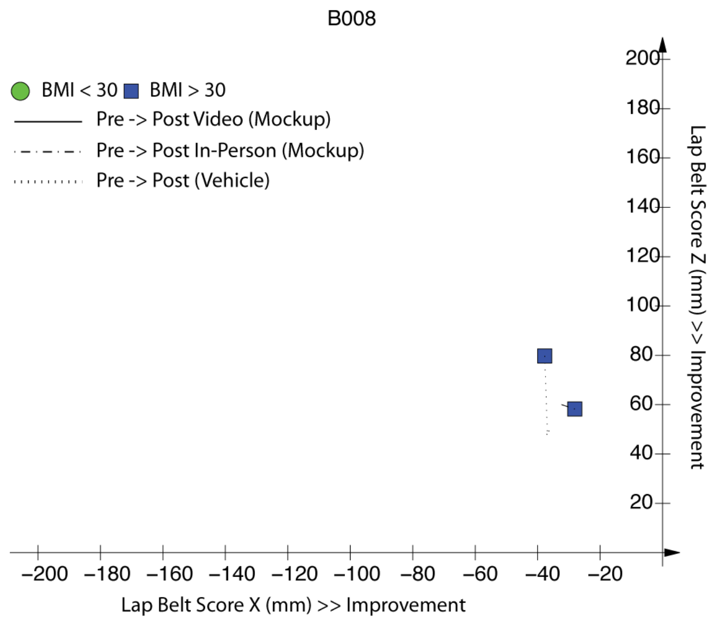
Mockup



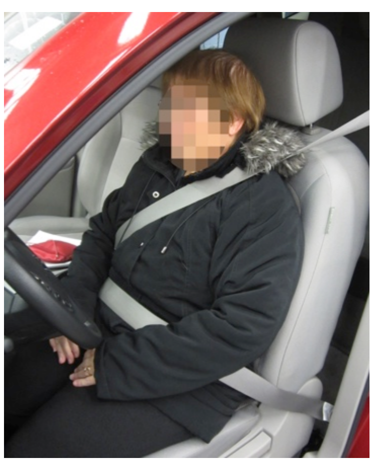




Pre Interventions | Post Video | Post In-Person



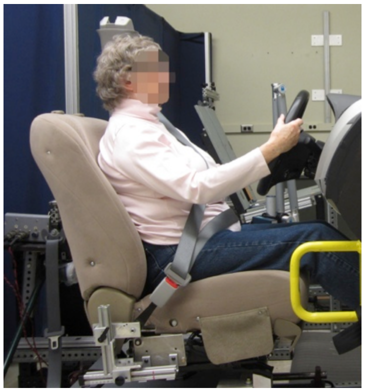
In-Vehicle

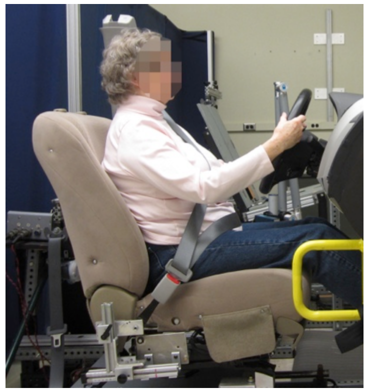


Pre Interventions | Post Interventions

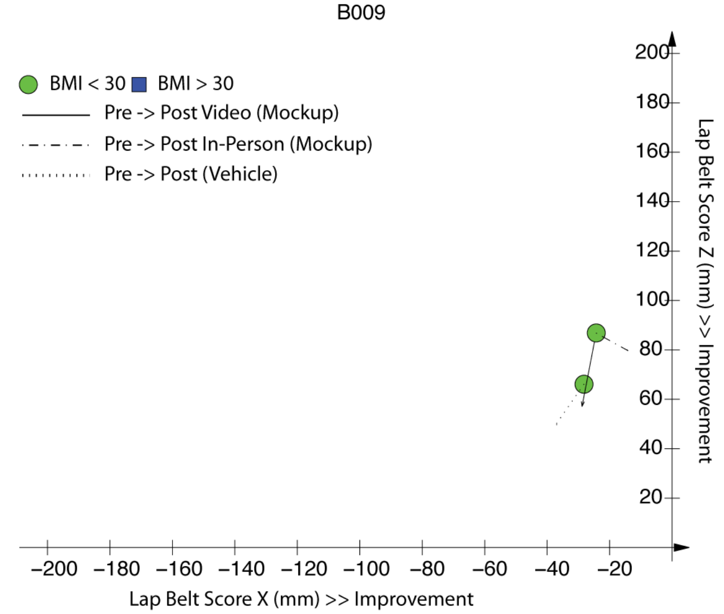
B009

Mockup





Pre Interventions | Post Video | Post In-Person



In-Vehicle

Pre Interventions | Post Interventions

B010

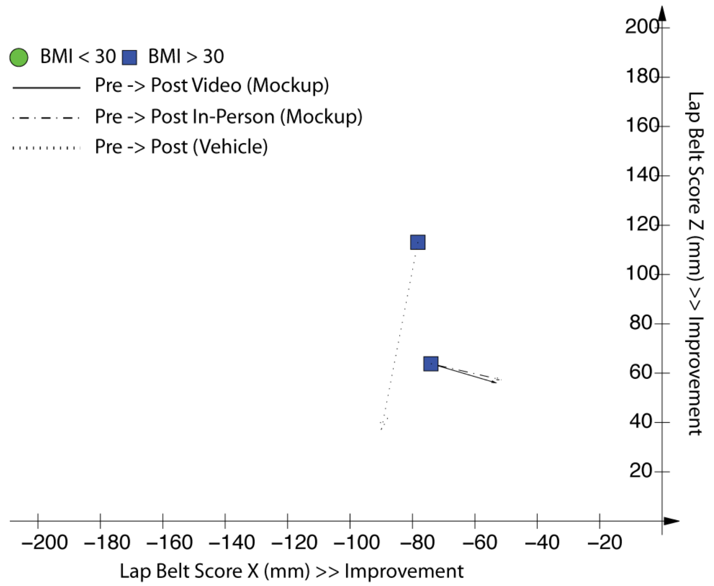
Mockup

Pre Interventions

Post Video

Post In-Person

B010



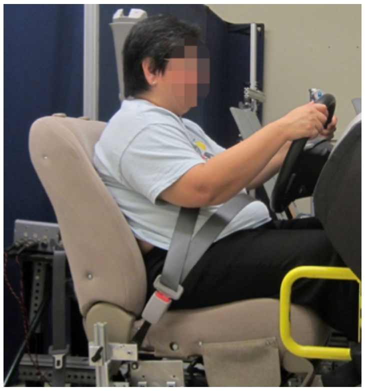
In-Vehicle

Pre Interventions

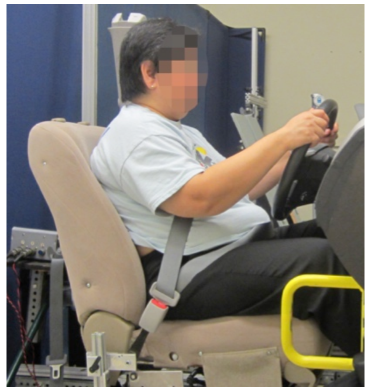
Post Interventions

B011

Mockup



Pre Interventions



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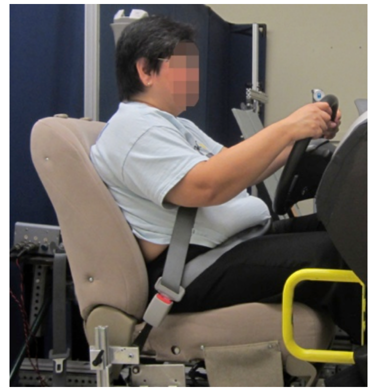
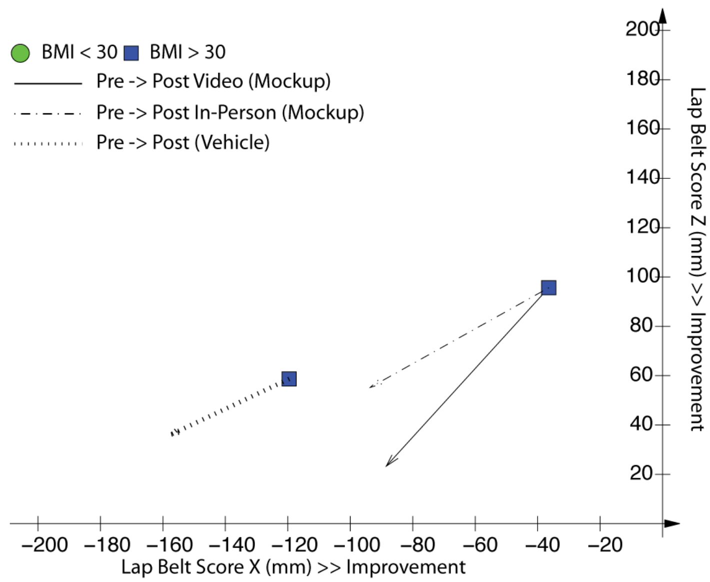


Post In-Person

B011



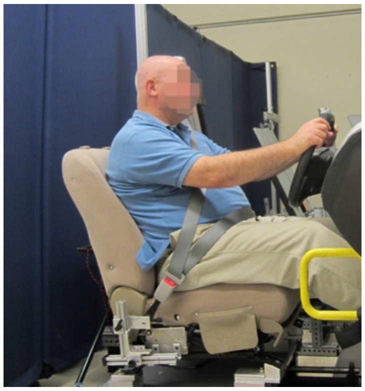
In-Vehicle

Pre Interventions

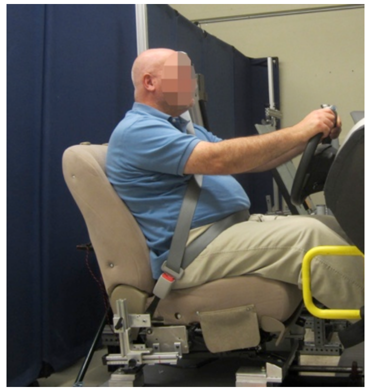
Post Interventions

B012

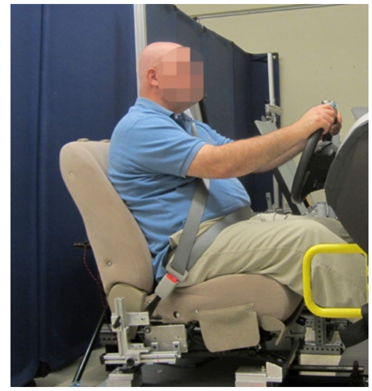
Mockup



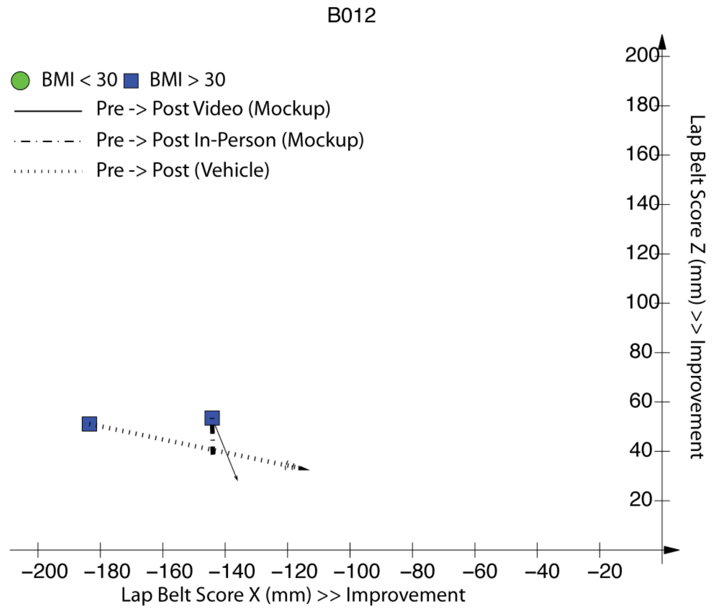
Pre Interventions



Post Video



Post In-Person



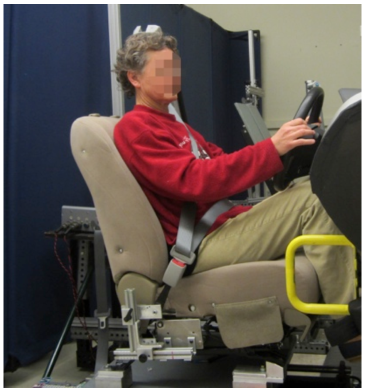
In-Vehicle

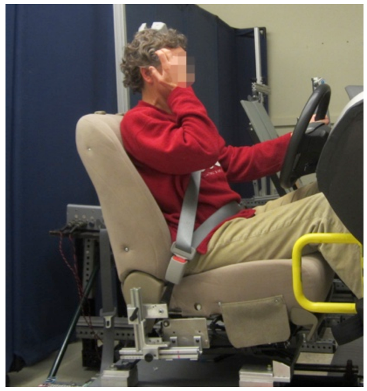
Pre Interventions

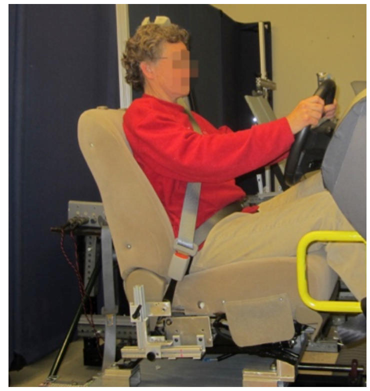
Post Interventions

B013

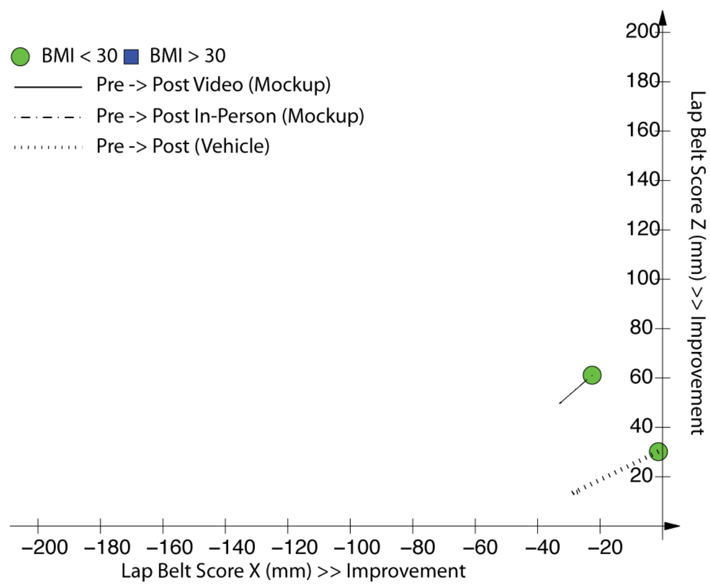
Mockup



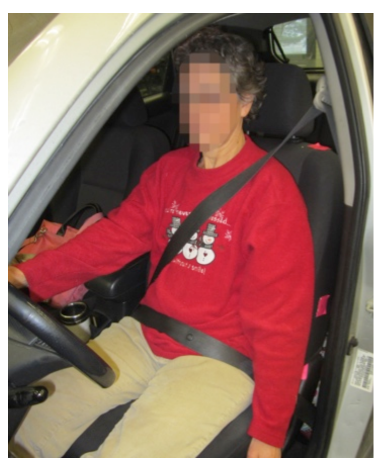




Pre Interventions | Post Video | Post In-Person



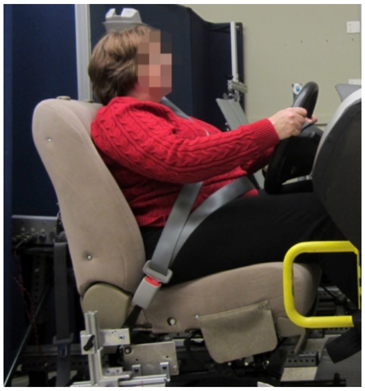
In-Vehicle



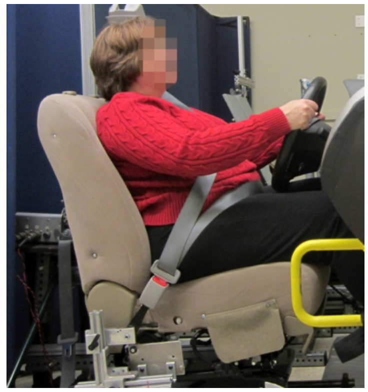
Pre Interventions | Post Interventions

B014

Mockup



Pre Interventions



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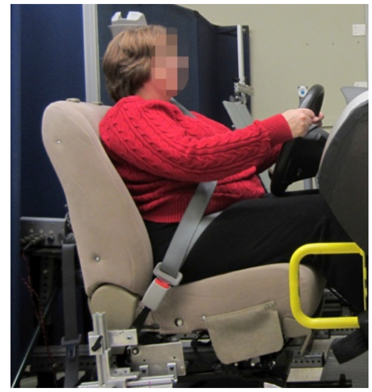
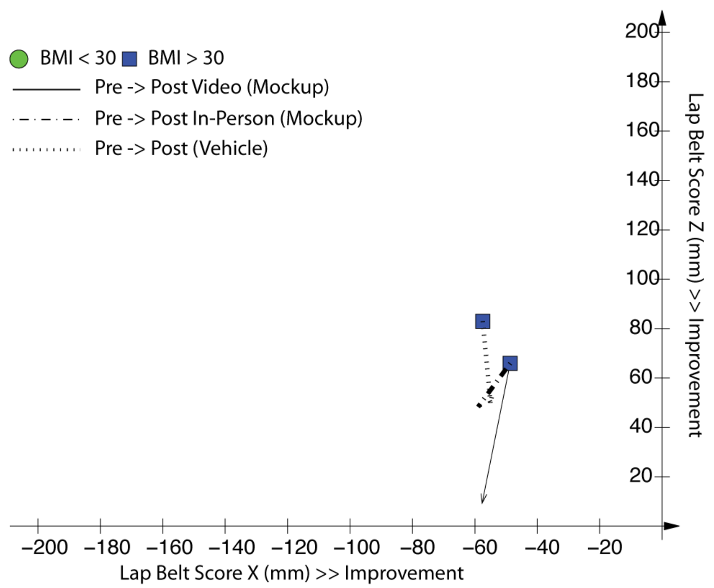
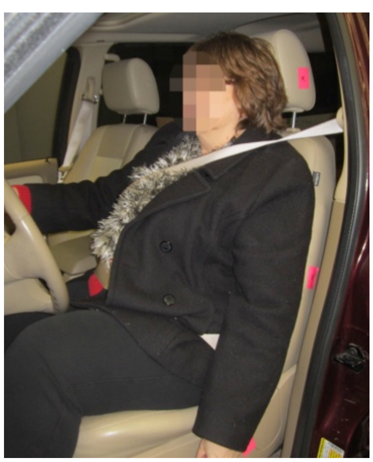


Post In-Person

B014



In-Vehicle

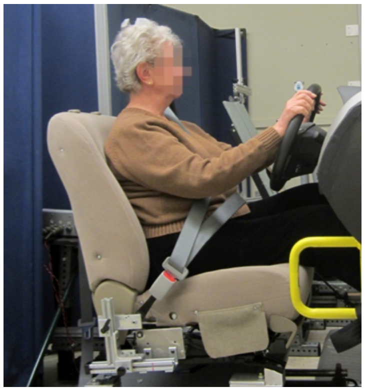


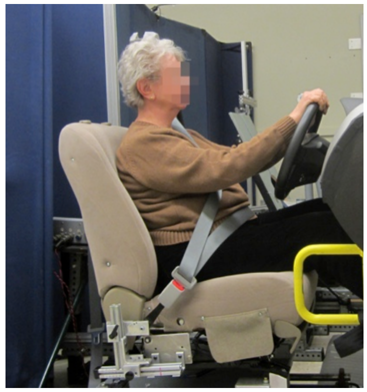
Pre Interventions

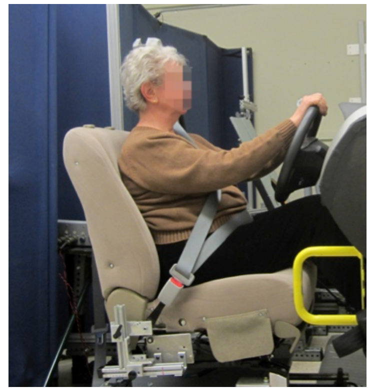
Post Interventions

B015

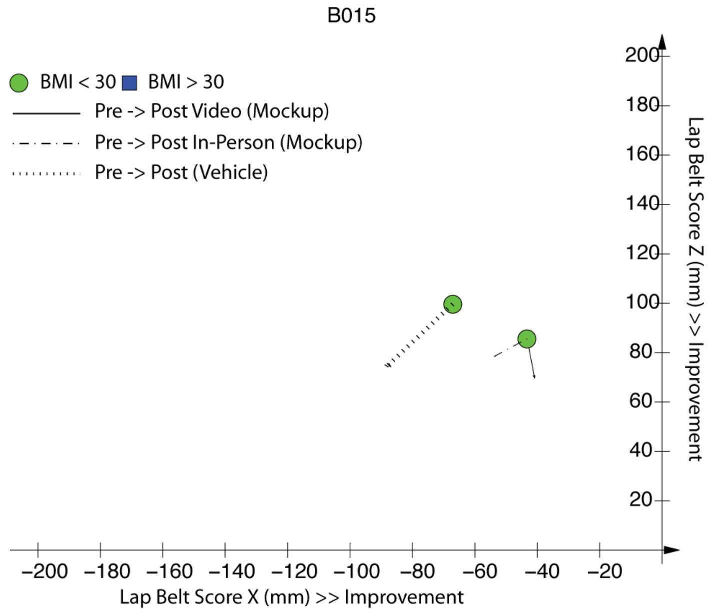
Mockup



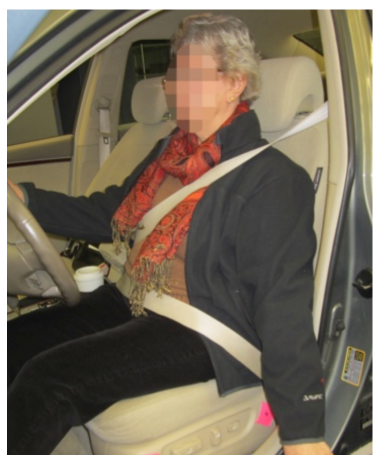




Pre Interventions | Post Video | Post In-Person



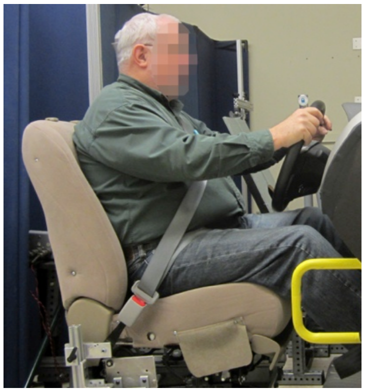
In-Vehicle

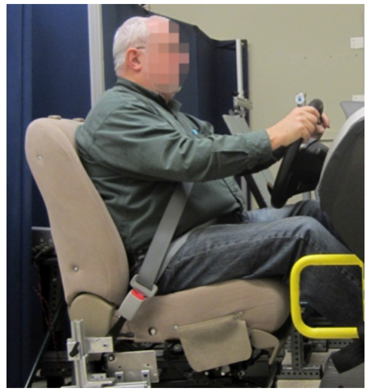


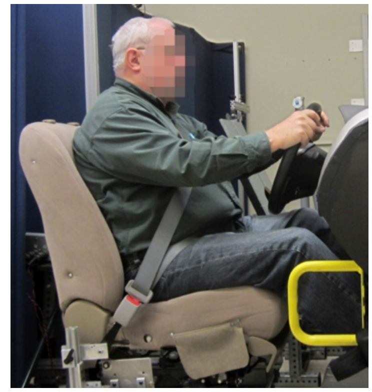
Pre Interventions | Post Interventions

B016

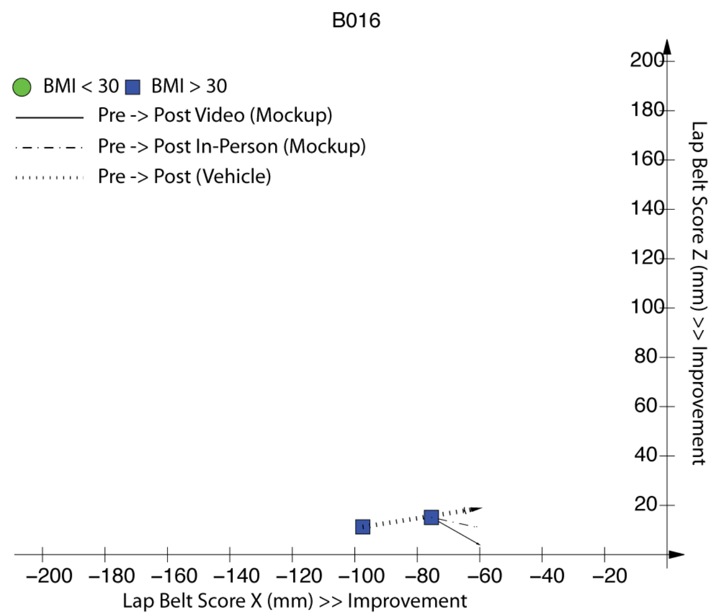
Mockup



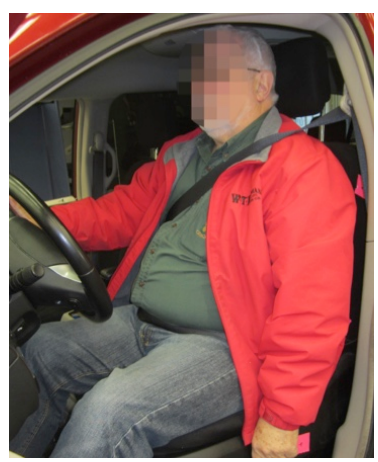




Pre Interventions | Post Video | Post In-Person



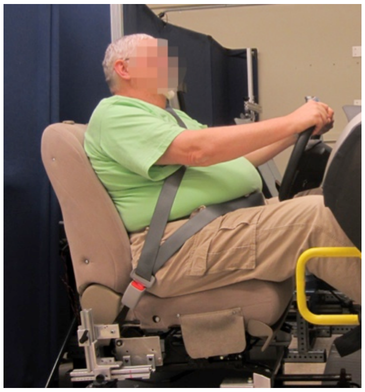
In-Vehicle



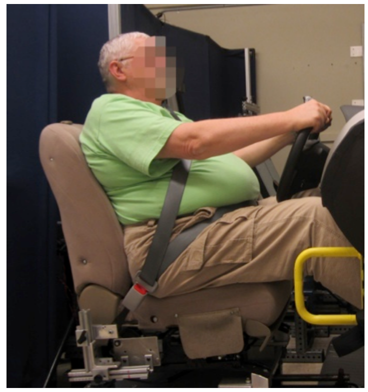
Pre Interventions | Post Interventions

B017

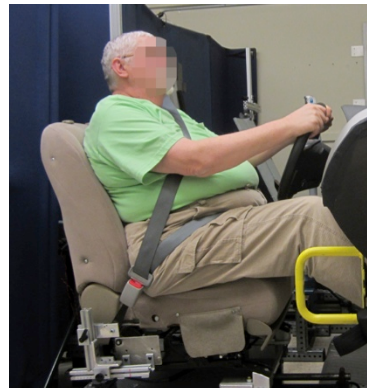
Mockup



Pre Interventions

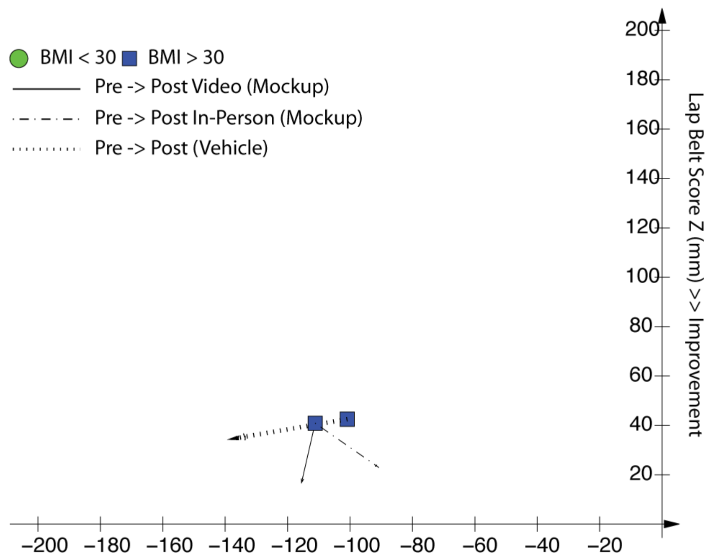


Post Video



Post In-Person

B017

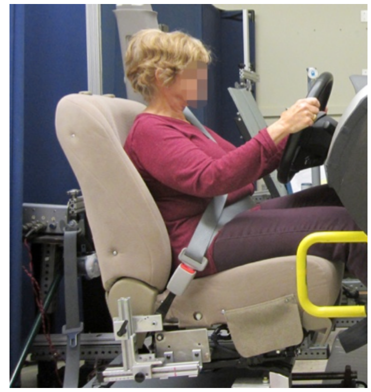


In-Vehicle

Pre Interventions

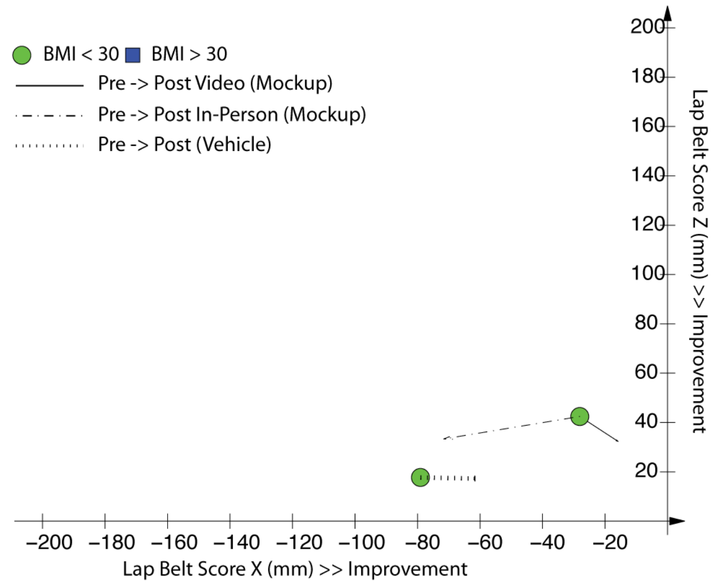
Post Interventions

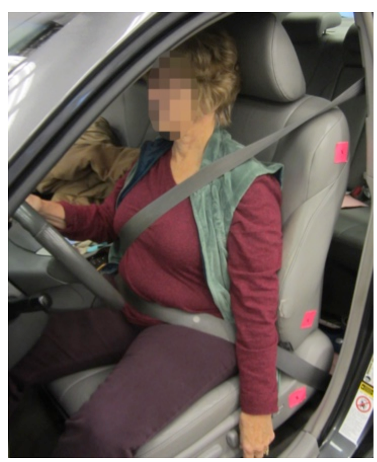
B018



Mockup

Pre Interventions | Post Video | Post In-Person



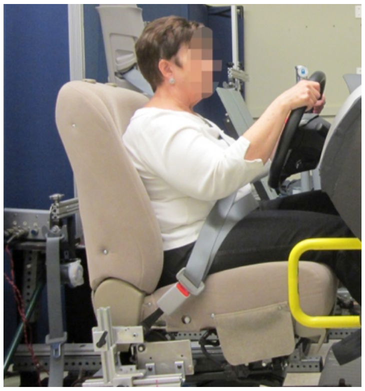


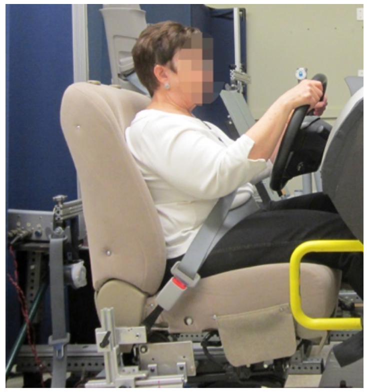
In-Vehicle

Pre Interventions | Post Interventions

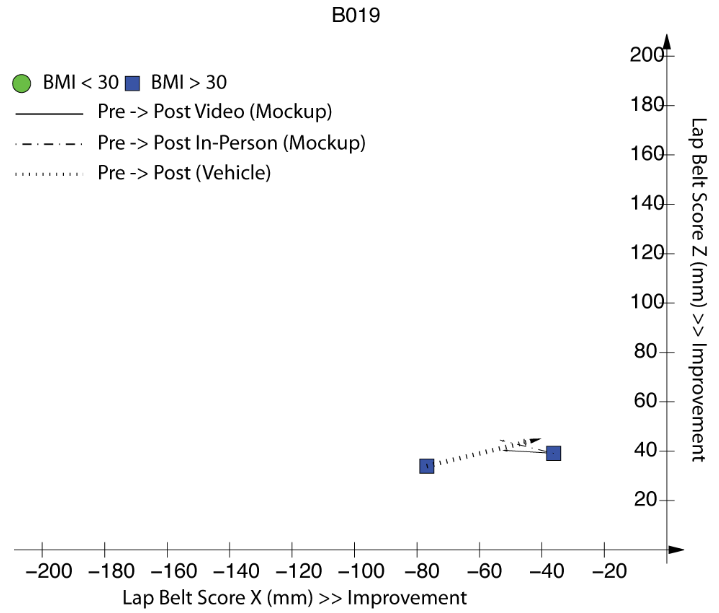
B019

Mockup

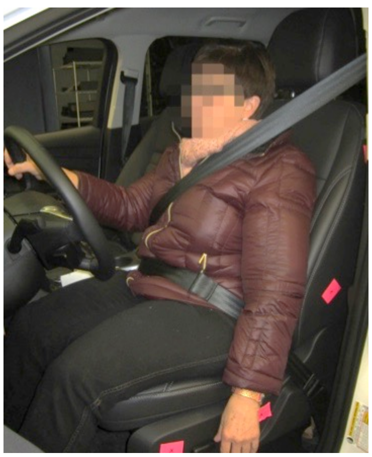


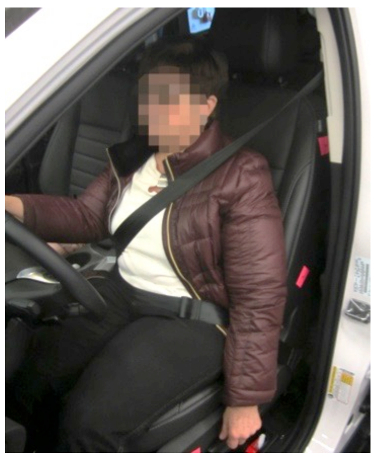


Pre Interventions	Post Video	Post In-Person



In-Vehicle

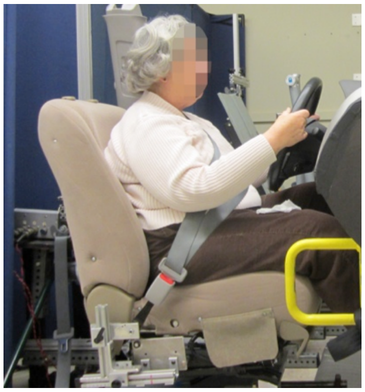




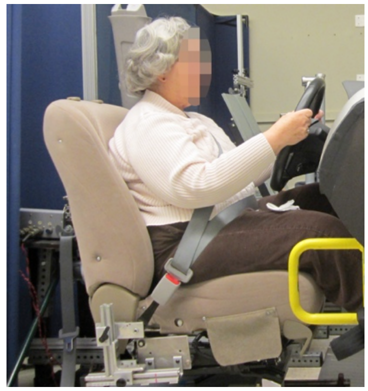
Pre Interventions	Post Interventions

B020

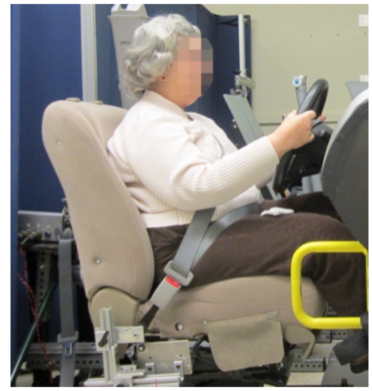
Mockup



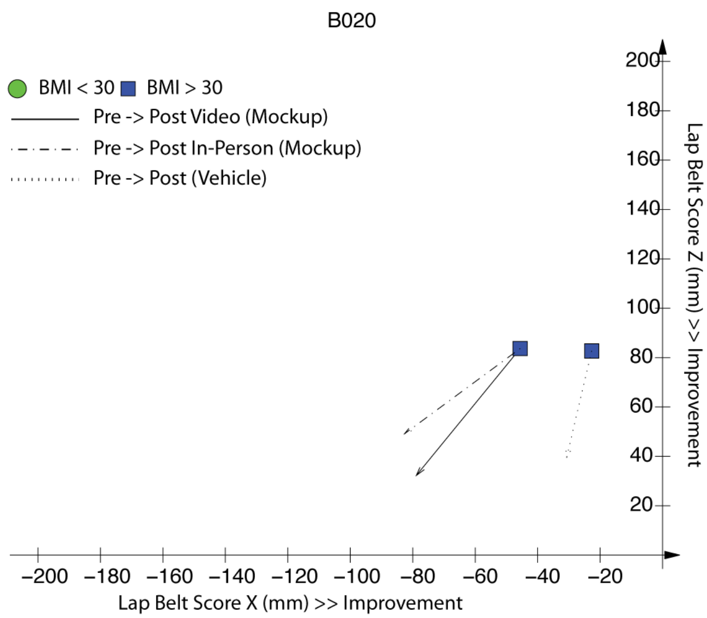
Pre Interventions



Post Video

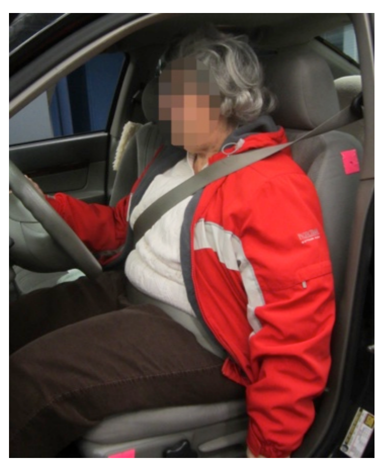


Post In-Person



In-Vehicle

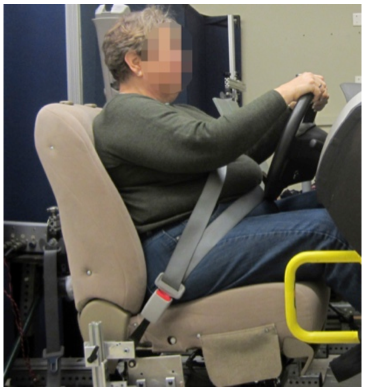
Pre Interventions



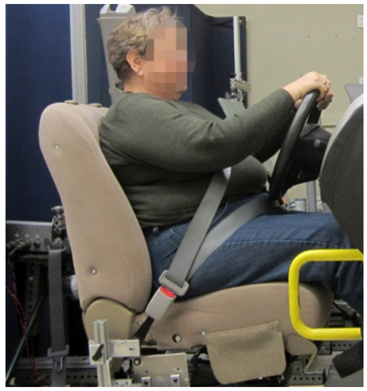
Post Interventions

B021

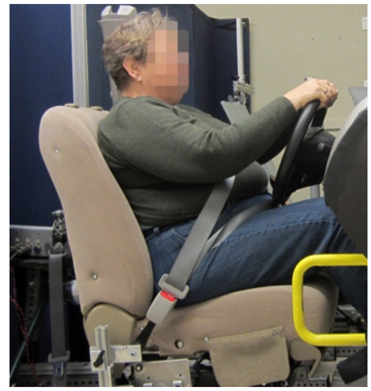
Mockup



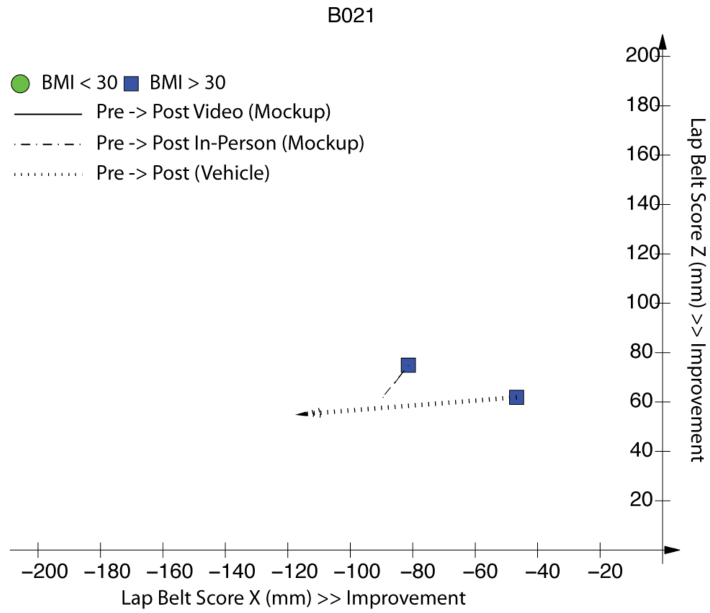
Pre Interventions



Post Video



Post In-Person



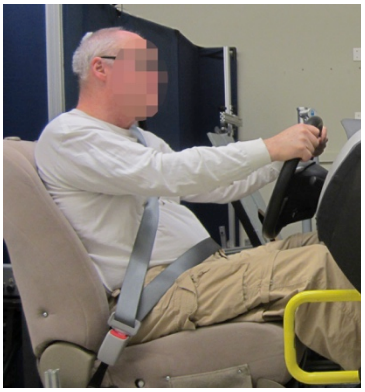
In-Vehicle

Pre Interventions

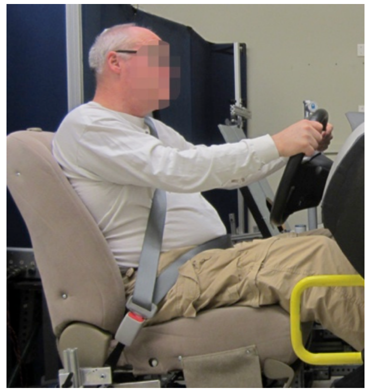
Post Interventions

B022

Mockup



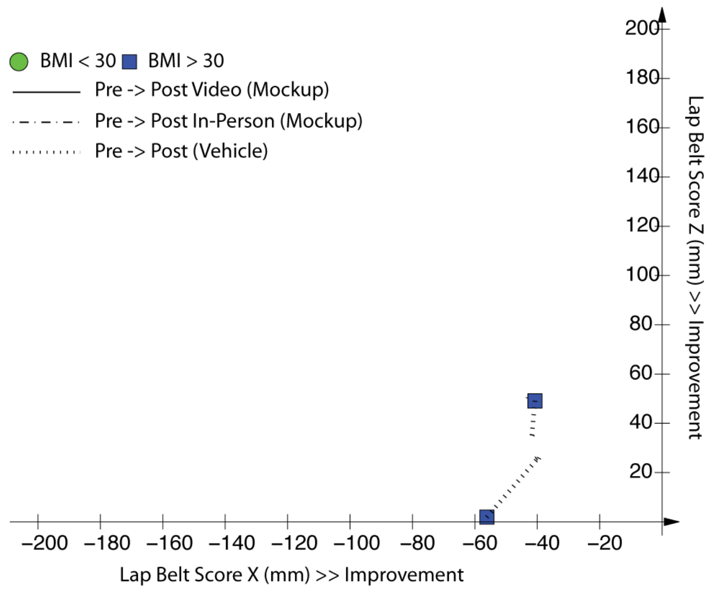
Pre Interventions



Post Video

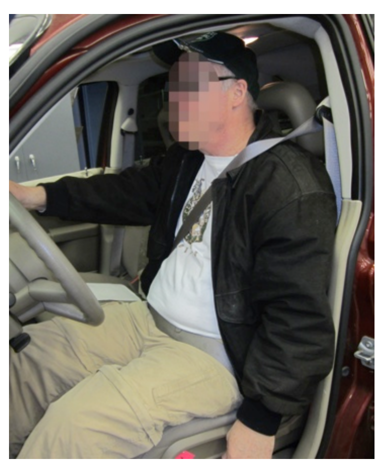
Post In-Person

B022



In-Vehicle

Pre Interventions

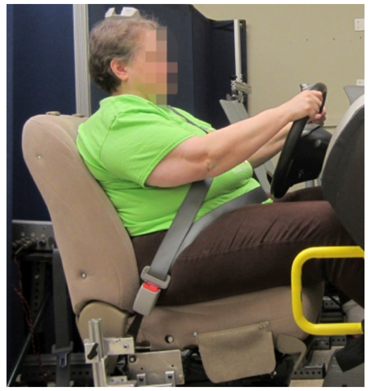


Post Interventions

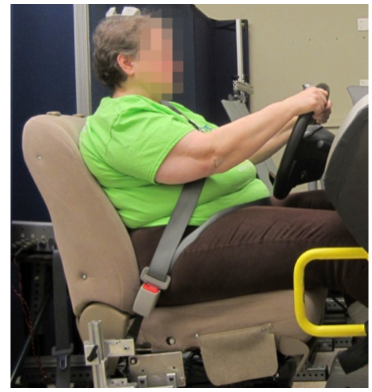
B023

Mockup

Pre Interventions

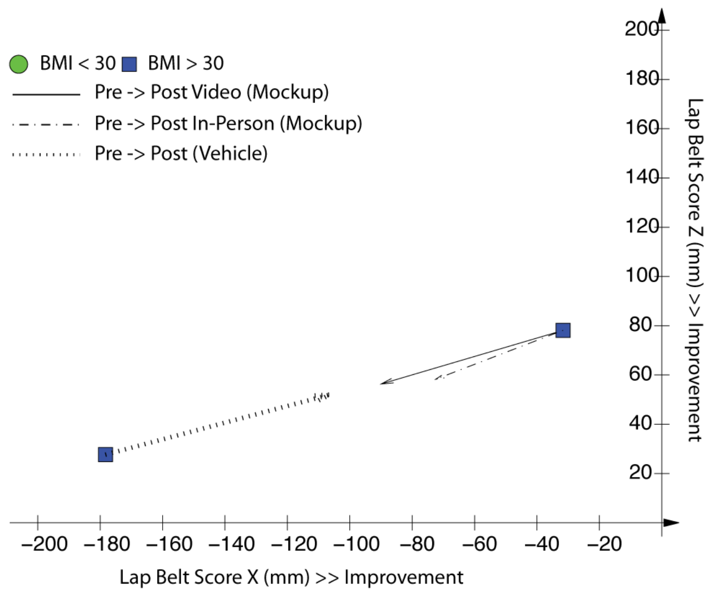


Post Video

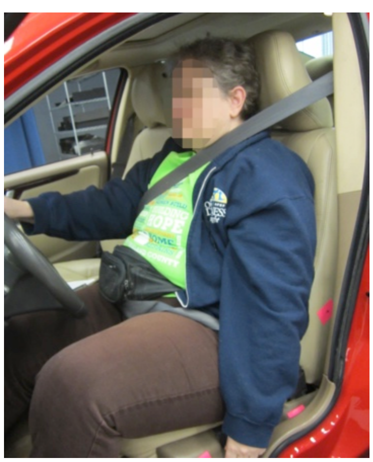


Post In-Person

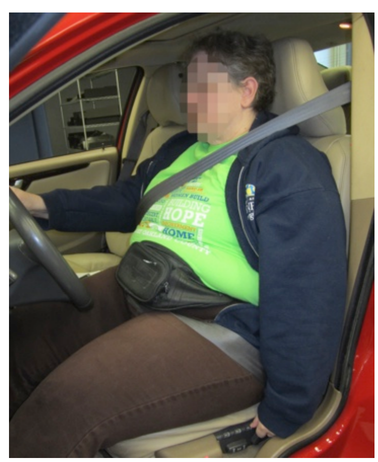
B023



In-Vehicle



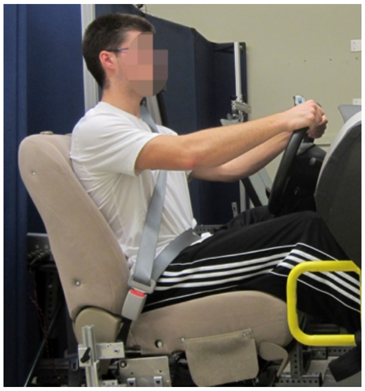
Pre Interventions

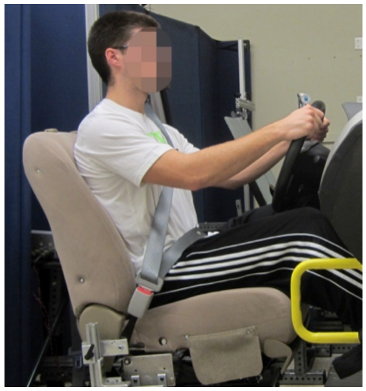


Post Interventions

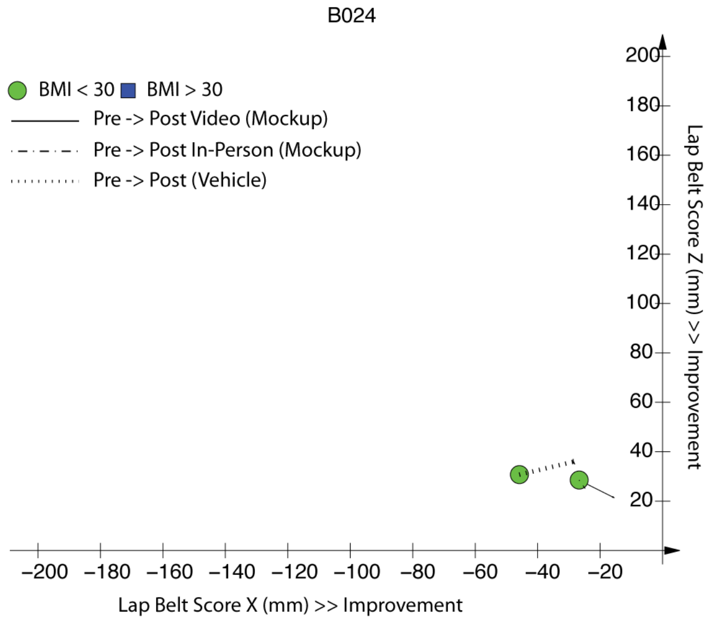
B024

Mockup





Pre Interventions | Post Video | Post In-Person

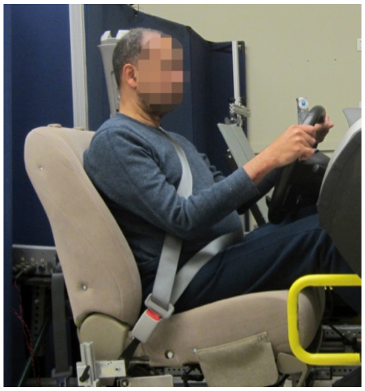


In-Vehicle

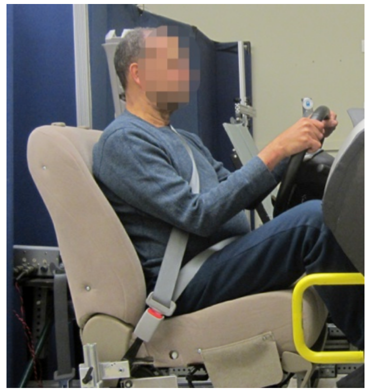
Pre Interventions | Post Interventions

B025

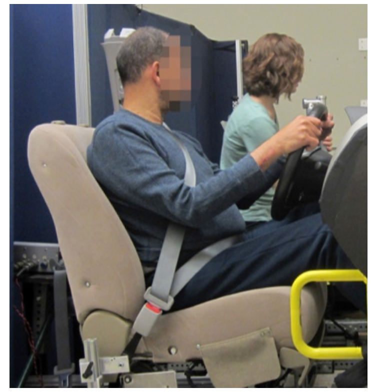
Mockup



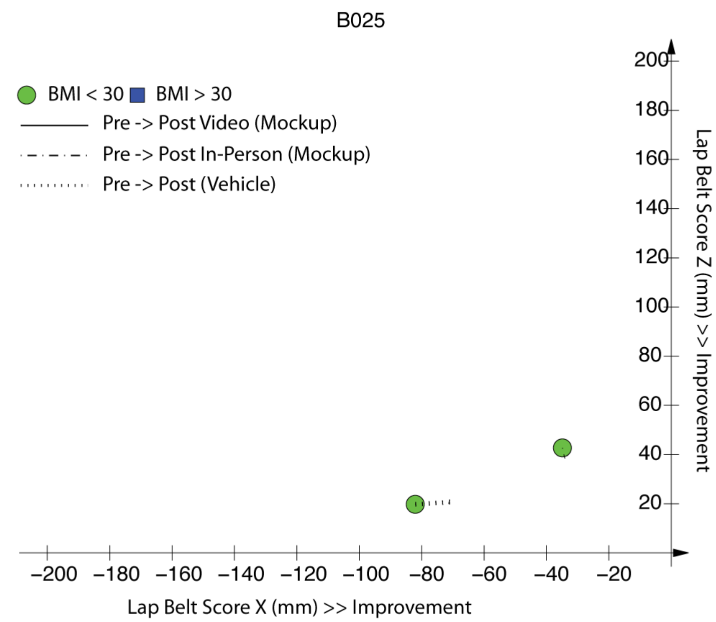
Pre Interventions



Post Video

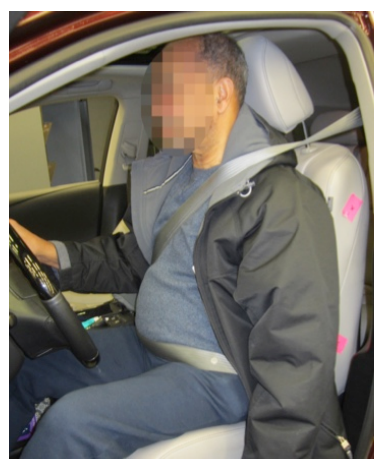


Post In-Person



In-Vehicle

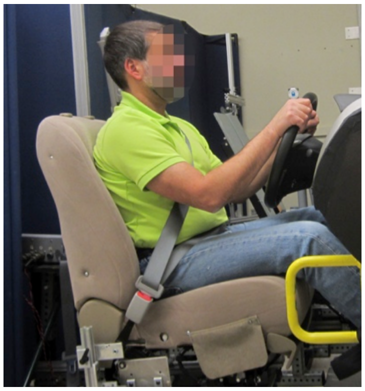
Pre Interventions



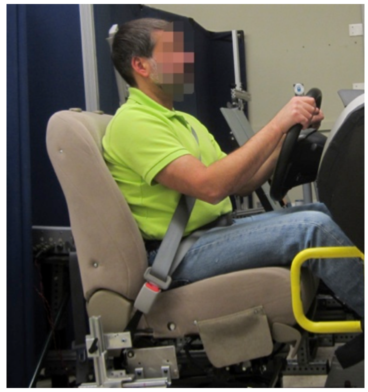
Post Interventions

B026

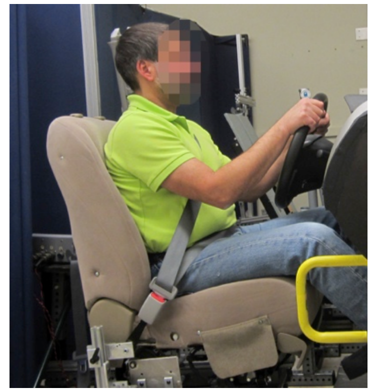
Mockup



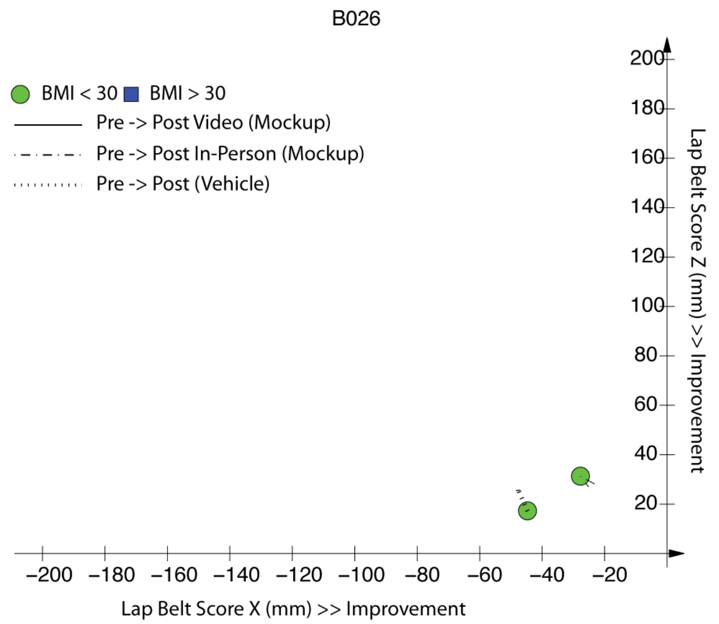
Pre Interventions



Post Video



Post In-Person



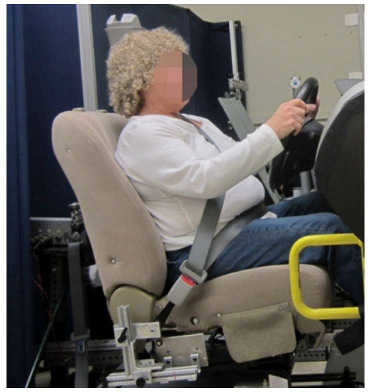
In-Vehicle

Pre Interventions

Post Interventions

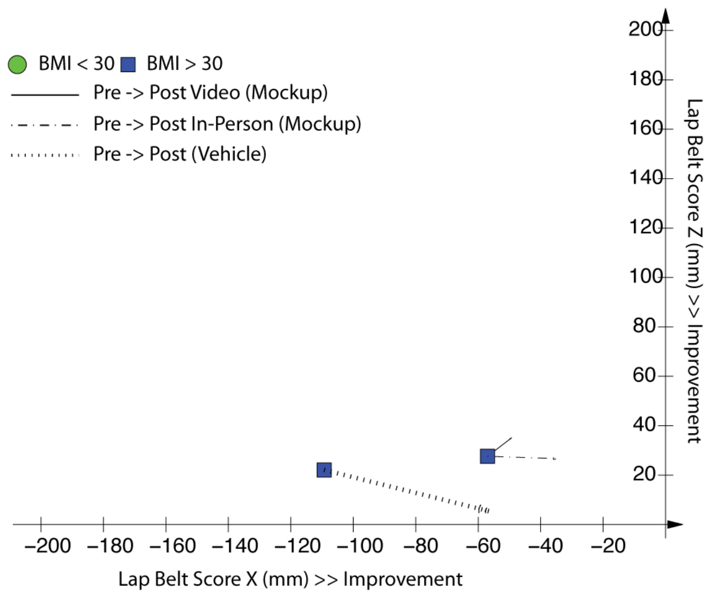
B027

Mockup



Pre Interventions | Post Video | Post In-Person

B027

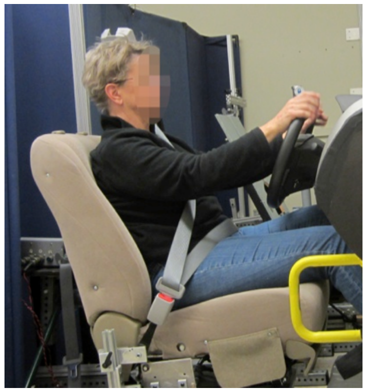


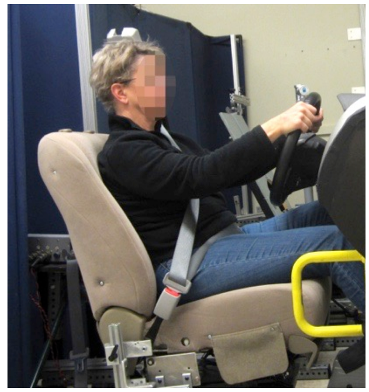
In-Vehicle

Pre Interventions | Post Interventions

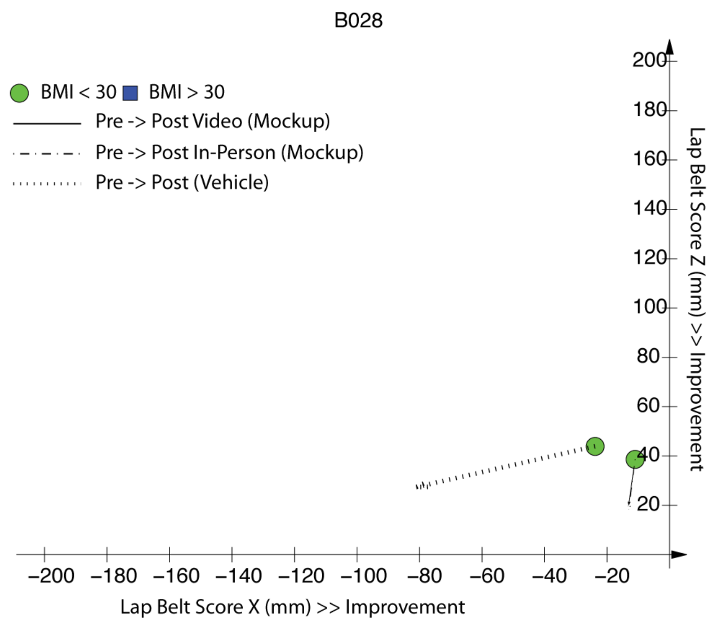
B028

Mockup



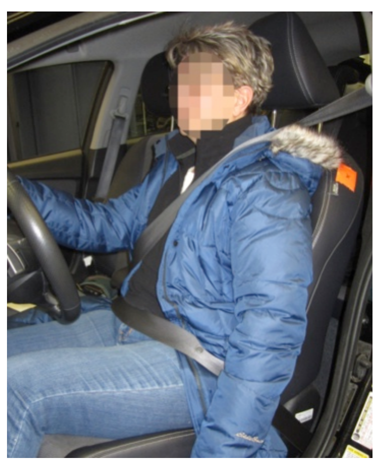


Pre Interventions | Post Video | Post In-Person



In-Vehicle

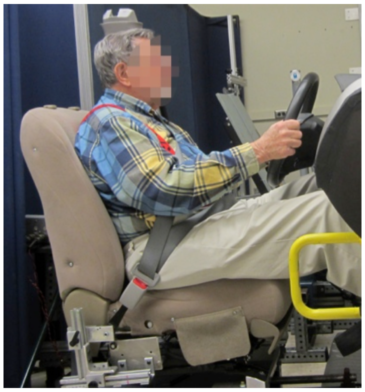
Pre Interventions

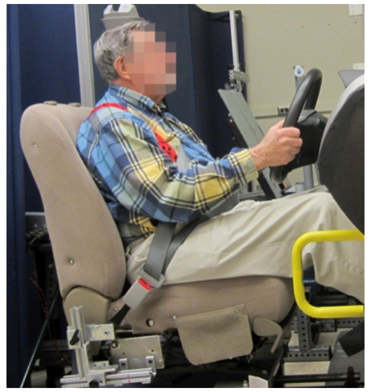


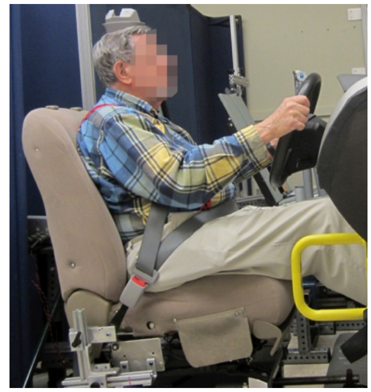
Post Interventions

B029

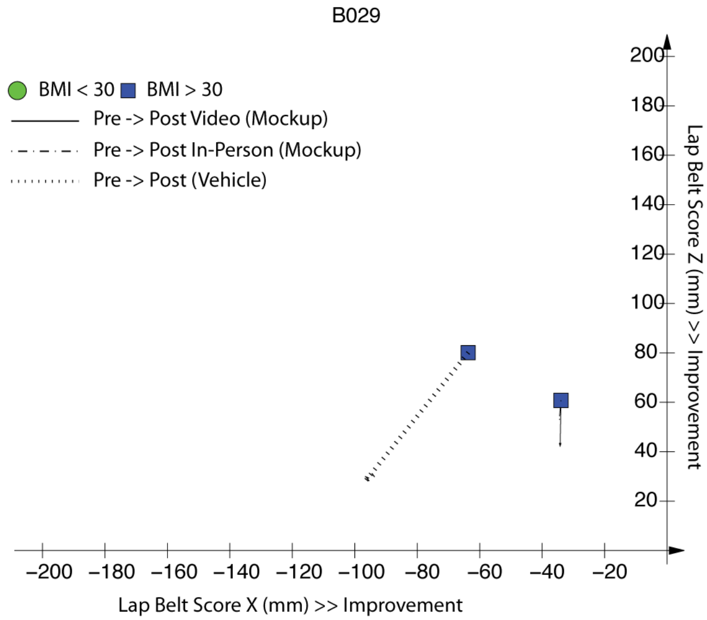
Mockup







Pre Interventions | Post Video | Post In-Person



In-Vehicle

Pre Interventions | Post Interventions