

Impact of errors in age estimates on the classification of proper child occupant restraint use: an observational survey

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ABSTRACT

Background Proper classification of child occupant restraint use is dependent on the age of the child occupant. Observations of vehicle restraint use involve estimating child age. If estimates of age are incorrect, then a potential for misclassification of restraint use exists.

Objective To compare estimated and confirmed child occupant age and calculate the impact of errors in age estimates on the proportion of children classified as properly restrained.

Methods Observations of restraint use were completed for occupants 0–8 years of age at two health clinics. After initial observation, we approached the driver to confirm the child's age. Each child's restraint use was classified as either compliant or not compliant with state law, based on type of restraint used and based on the child's estimated and confirmed ages.

Results Classification of age categories for child occupants (n=218) was correct in 86.3% of observations. For 48.6%, the confirmed and estimated age matched exactly, and for 98.1%, age matched within ± 1 year. Overall, compliant restraint use based on estimated age was 39.4%, and based on confirmed age was 38.5%. In paired comparisons, restraint use based on estimated age versus confirmed age was concordant for more than 95% of children.

Conclusions The level of accuracy for age estimates was sufficient for making estimates of compliant restraint use. Errors in estimated age resulted in a less than 1 percentage point difference in overall proper restraint use calculations. The results suggest that such observations can be a reliable measure of proper child occupant restraint use.

BACKGROUND

Observational surveys are an accepted and practical approach to measure the prevalence of child occupant restraint use and the impact of efforts to increase restraint use.^{1–5} Such surveys are often done using observer estimates of child age. The assignment of proper occupant restraint is dependent upon the age of the child. For example, a 3-year-old child should ordinarily be restrained in a child safety seat with a five-point harness, but a 5-year-old child may be properly restrained in a booster seat. Therefore, an incorrect estimate of child age may result in a misclassification of proper occupant restraint.^{5–7} Some studies have tried to assess the accuracy of child age estimates in observational surveys,^{5–7} but to our knowledge, none have calculated the impact of errors in age assignment on the classification of proper or compliant restraint use.

For the purposes of this study, compliant restraint use was based on the 2009 Texas Child Passenger Safety law.

The objective of this study was to compare an observer's estimate of child age to the driver's report of the child's age and then to calculate the impact of errors in age estimates on the proportion of children who were classified as properly restrained, using three different models of compliant restraint classification.

METHODS

Observations of child occupant restraint use were made for vehicle occupants who were estimated to be 0–8 years of age at two community-based primary care clinics associated with a large public hospital in Dallas, Texas. Both clinics served a predominately Hispanic population (83% and 74%) and had similar rates of poverty (15% and 13%) (Brad Walsh, Parkland Health & Hospital system, Population Medicine, March 2012).

One observer with more than 13 years of experience in child occupant restraint observations conducted the observation using a standard observation survey form based on a long-standing Texas Transportation Institute survey.^{6–8} In addition to being a parent to four children, the observer's training included 6 years as a certified child passenger safety technician including 4 years as a certified child passenger safety instructor. The observer also received the Texas A&M Transportation Institute training on performing observational surveys via a train-the-trainer model. The training involved classroom instruction on vehicle identification and child passenger safety laws, as well as, a year-long quality assurance process to ensure consistency in observing and coding restraint use. The observer collected information at both community health clinics on the child's estimated age/race/gender, and also seat position, vehicle type and restraint type, as each vehicle entered or exited the parking lot of the clinic. Vehicle occupants and restraint use were observed while the vehicle was stopped in the parking lot. After the initial observation of age/race/gender was recorded, the observer approached the vehicle driver to record the confirmed (driver-reported) child age/race/gender. Once the observer completed the validation, she offered the driver a fitting station flyer that included information on free local fitting stations. There was no interaction with the child occupant and therefore we did not attempt to weigh or measure the height of the child. Observations were conducted at various

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times during clinic hours from 11 June 2010 to 23 February 2011.

This study was deemed to have exempt status from the University of Texas Southwestern Medical Center Institutional Review Board; verbal consent was obtained and documented. Data were analysed using Epi Info 2000. Confidence limits were calculated using mid-p exact limits.

The 2009 Texas Child Passenger Safety Law states that all children under 8 years old or less than 4 feet 9 inches (144.78 cm) must be restrained in a child safety seat in accordance with manufacturer instructions.⁹ The law does not specify compliance with rear-facing versus forward-facing child restraint use. In order to classify each child's restraint use as either compliant or not compliant with Texas state law, we developed three different definitions (models) of compliant restraint use, based on child's age and type of restraint used (table 1). While all three definitions are compliant with state law, each has a slightly different level of restrictiveness that tests the sensitivity of the definition, especially around age category 'break points'. We then made a calculation as to whether each child would have been assigned as 'compliant' or 'non-compliant,' with regard to restraint use, based on the child's estimated age and the child's confirmed age. In other words, each child has two classifications of compliance: one based on estimated age and one based on confirmed age. Concordant assignment was determined as the same classification (compliant or non-compliant) for estimated and confirmed age. Discordant assignment was determined as a different classification (compliant and non-compliant) for estimated and confirmed age.

In model 1, the least restrictive definition, children age 0–3 years were classified as compliant if they were observed to have been restrained in a child safety seat; children were classified as not compliant if they were restrained in a booster seat, seat belt or had no restraint. Children aged 4–7 years were classified as compliant if they were observed to be restrained in a child safety seat or booster seat; children were classified as not compliant if they were restrained in a seat belt or had no restraint. Children 8 years of age and older were classified as compliant if they were observed as restrained in a booster seat or safety belt; children were not compliant if they were restrained in a child safety seat or had no restraint.

In model 2, the most restrictive definition, children aged 0–4 years were classified as compliant if they were observed to have been restrained in a child safety seat; children were classified as not compliant if they were restrained in a booster seat, seat belt or had no restraint. Children aged 5–8 years were

classified as compliant if they were observed to be restrained in a booster seat; children were classified as not compliant if they were restrained in a child safety seat, seat belt or had no restraint. Children 9 years of age and older were classified as compliant if they were observed as restrained in a booster seat or safety belt; children were not compliant if they were restrained in a child safety seat or had no restraint.

In model 3, children aged 0–3 years were classified as compliant if they were observed to have been restrained in a child safety seat; children were classified as not compliant if they were restrained in a booster seat, seat belt or had no restraint. Children aged 4–7 years were classified as compliant if they were observed to be restrained in a booster seat; children were classified as not compliant if they were restrained in a child safety seat, seat belt or had no restraint. Children 8 years of age and older were classified as compliant if they were observed as restrained in a booster seat or safety belt; children were not compliant if they were restrained in a child safety seat or had no restraint.

RESULTS

Observations were completed for 218 child occupants, 101 (46.3%) at the first clinic and 117 (53.7%) at the second clinic. There were no refusals by vehicle drivers.

Overall, the confirmed data for age, race and gender was very similar to the estimated data for age, race and gender. Confirmed data showed that child occupants were mostly boys (52.3%, n=114), Hispanic (93.1%, n=203) and had a mean age of 2.6 years (range: 0–11 years). Estimated data showed child occupants as being equally boys or girls (46.8% each, n=102), with 6.4% (n=14) of child occupants having an unknown gender, 93.1% being Hispanic (n=203) and having a mean age of 2.7 years (range: 0–8 years).

Age estimates

For each child, we compared the observer's estimated age to the child's confirmed age. In nearly half of the observations (48.6%, n=106), the estimated age and confirmed age matched exactly and for nearly all the observations (98.2%, n=214), the estimated and confirmed age matched within ± 1 year. In four children, the estimated age was more than 1 year different from the confirmed age.

We then compared age groupings, (<1 year of age, 1–4 years of age, 5–8 years of age) in a manner similar to a table designed by Moeller *et al.*⁵ Age groupings based on estimated age were correctly assigned for 188 (86.2%) of the 218 children. Table 2 shows the number of incorrect age assignments by age category and whether the confirmed age was younger or older than the estimated age. Children in the 5–8-year-old category were more likely than children in the <1-year-old category or 1–4-year-old category to have their age inaccurately estimated (n=14, 28.6% vs n=8, 12.5% and n=8, 7.6% respectively) ($p < 0.002$, by χ^2).

Restraint use

For each child observed, a calculation was made as to whether the child's restraint use was in compliance with state law according to each of the three model definitions (table 1), based on the child's estimated age, and also based on the child's confirmed age.

Model 1

In the paired comparison (table 3), the classification of compliant child restraint use, for model 1, based on estimated age, was concordant with the classification of compliant child

Table 1 Definitions of compliant* restraint for three models, based on child age and type of child safety seat or seat belt

Age, years	Model 1	Model 2	Model 3
0	CS	CS	CS
1	CS	CS	CS
2	CS	CS	CS
3	CS	CS	CS
4	CS, B	CS	B
5	CS, B	B	B
6	CS, B	B	B
7	CS, B	B	B
8	B, SB	B	B, SB
9	B, SB	B, SB	B, SB

*Based on the 2009 Texas Child Passenger Safety Law.
B, booster seat; CS, car seat; SB, seat belt.

Table 2 Incorrect age assignment by estimated age category

Estimated age category	Total in estimated age category	Number with incorrect age estimate			Confirmed age was older than estimated age	Confirmed age was younger than estimated age
		No.	%	95% CI		
<1 year	64	8	12.5	6.0 to 22.4	8	NA
1–4 years	105	8	7.6	3.3 to 14.5	5	3
5–8 years	49	14	28.6	17.3 to 42.3	5	9
Total	218	30	13.7	9.7 to 18.8	18	12

NA, not applicable.

restraint use based on confirmed child age in 97.2% of the observations (212/218) and discordant in 2.7% (6/218) of the observations. Among the six discordant cases, we classified four children as compliant based on estimated age, but they were actually not in compliance based on their confirmed age. Additionally, we classified two children as non-compliant based on estimated age, but they were actually compliant based on confirmed age.

Model 2

Restraint use based on model 2 showed similar results; compliant child restraint use based on estimated age was concordant with the classification of compliant child restraint use based on the confirmed child age in 97.7% of the observations (213/218) and discordant in 2.3% (5/218) of the observations. Among the five discordant cases, we classified three children as compliant based on estimated age but they were actually not in compliance based on their confirmed age; also, we classified two children as non-compliant based on estimated age, but they were actually compliant based on confirmed age.

Model 3

The paired comparison in model 3 showed that the classification of compliant child restraint use based on estimated age was concordant with the classification of compliant child restraint use based on confirmed child age in 96.3% of the observations (210/218) and discordant in 4.3% (8/218) of the observations. Among the eight discordant cases, we classified five children as compliant based on estimated age but they were actually not in compliance based on their confirmed age; and we classified three children as non-compliant based on estimated age, but they were actually compliant based on confirmed age.

Prevalence of compliant restraint use

Table 4 displays the overall compliant restraint use for estimated and confirmed child occupant age based on the three

different models. In each model, the difference between compliant restraint use based on age versus based on confirmed age was less than 1%.

DISCUSSION

This study assessed the accuracy of an observer's estimates of child age compared to the driver's report of the child's age and measured the impact of errors in age estimates on the proportion of children who were classified as properly restrained, using three different definitions (models) of proper (or compliant) restraint. Overall, we found that the classification of age categories for child occupants was correct in 86.3% of observations, which was similar to results found by Moeller et al (87.1%).⁵ However, we had fewer errors in assigning age for infants and toddlers, and Moeller and colleagues had fewer errors in assigning age for school-age children.⁵

We then measured the impact of errors in estimated child age on the classification of compliant restraint use, which to our knowledge has not been previously done. Overall there was little impact in the calculation of compliant restraint use. For each of the three models, errors in estimated age resulted in less than 1 percentage point difference in overall proper restraint use calculations. Further, in the paired comparisons, restraint use based on estimated age was concordant with restraint use based on confirmed age for more than 95% of children.

There are a number of limitations in this study. First, observations were done by one observer with many years of observational survey experience, and may not be applicable to surveys with multiple observers. However previous studies have documented a high concordance and accuracy of observations between observers.^{5,6} We also did not have the ability to assess whether the number of years of experience was a determining factor for the accuracy of our observations. Other studies have confirmed that trained observers and car seat technicians are better at determining the appropriateness of child restraints than community observers.³ It may be helpful to further study

Table 3 Assignment of compliant child restraint use based on estimated and confirmed age by three models of restraint use (n=218)

		Estimated child age					
		Restrained			Not restrained		
		N	%	95% CI	N	%	95% CI
Confirmed child age	Restrained	Model 1*					
		82	37.6	31.4 to 44.2	2	0.9	0.2 to 3.0
	Not restrained	Model 2*					
		4	1.8	0.6 to 4.4	130	59.6	53.0 to 66.0
	Restrained	Model 3*					
		74	33.9	27.9 to 40.4	2	0.9	0.2 to 3.0
	Not restrained	Model 1*					
		3	1.4	0.4 to 3.7	139	63.8	57.2 to 69.9
	Restrained	Model 2*					
		79	36.2	30.1 to 42.8	3	1.4	0.4 to 3.7
	Not restrained	Model 3*					
		5	2.3	0.8 to 5.0	131	60.1	53.5 to 66.4

*Restrained' denotes restrained and compliant with state law.

*See table 1 for model definitions.

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Table 4 Compliant child restraint use based on estimated versus confirmed age by three models of restraint use (n=218)

	Model 1*			Model 2*			Model 3*		
	N	%	95% CI	N	%	95% CI	N	%	95% CI
Estimated age	86	39.4	33.1 to 46.1	77	35.3	29.2 to 41.8	84	38.5	32.2 to 45.1
Confirmed age	84	38.5	32.2 to 45.1	76	34.9	28.8 to 41.4	82	37.6	31.4 to 44.2

*See table 1 for model definitions.

the length of observer training and develop recommendations for optimal results. In addition, the observer estimated and verified child occupant age/race/gender. Although the observer recorded the estimated age prior to verifying the age, this does introduce potential bias. Second, our study did not look at the issue of forward-facing versus rear-facing car seat usage when determining compliance. Third, this study relied on driver reports of the child occupant's age. There may have been situations where the driver was not the parent or guardian and did not provide correct age information. Fourth, we did not physically check the restraint use or measure the height or weight of the child in order to verify optimal compliance. Rather, we used age in determining classification of proper (compliant) restraint use for each of the three models. Fifth, the population that was observed was largely Hispanic and had a low rate of compliant restraint use. With a lower prevalence of restraint use, the inaccuracies in age estimates may have had less impact than if the population had had higher restraint use. Sixth, a majority of children observed in the survey were younger than (≤ 4 years), a group for which our observer was more accurate in assigning age. If the observed population had been predominately older children (≥ 5 years), the proportion of incorrect classifications likely would have been higher. Seventh, this study did not attempt to track the child occupants leaving the health clinic and, therefore, we do not know if a child occupant was observed more than once during the study period.

In conclusion, the level of accuracy for age estimates in this survey population seems to have been sufficient to provide calculations of proper (compliant) restraint use that are adequate for monitoring trends over time. More studies are needed to determine if these results are consistent among multiple observers and in other populations. The results nevertheless suggest that such observations can be a reliable measure of proper child occupant restraint use.

What is already known on this subject

- ▶ Child restraint observations are an accepted and practical tool for measuring restraint use.
- ▶ Trained observers can make reasonably accurate estimates of child age, but concerns have been raised about the impact of errors in age estimates on the assignment of proper child occupant restraint use.

What this study adds

- ▶ This study calculated the impact of errors in age estimates on classifications of compliant child occupant restraint use.

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