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# Emergency Department Visits for Pediatric Trampoline-related Injuries: An Update

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## Abstract

**Objectives:** To describe the epidemiology of emergency department (ED) visits for trampoline-related injuries among U.S. children from January 1, 2000, to December 31, 2005, using the National Electronic Injury Surveillance System (NEISS) and to compare recent trampoline injury demographics and injury characteristics with those previously published for 1990–1995 using the same data source.

**Methods:** A stratified probability sample of U.S. hospitals providing emergency services in NEISS was utilized for 2000–2005. Nonfatal trampoline-related injury visits to the ED were analyzed for patients from 0 to 18 years of age.

**Results:** In 2000–2005, there was a mean of 88,563 ED visits per year for trampoline-related injuries among 0–18-year-olds, 95% of which occurred at home. This represents a significantly increased number of visits compared with 1990–1995, when there was an average of 41,600 visits per year. Primary diagnosis and principal body part affected remained similar between the two study periods.

**Conclusions:** ED visits for trampoline-related injuries in 2000–2005 increased in frequency by 113% over the number of visits for 1990–1995. Trampoline use at home continues to be a significant source of childhood injury morbidity.

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**Keywords:** injury prevention, trampoline, child

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In 1977, the American Academy of Pediatrics (AAP) published a policy statement recommending that trampolines “be banned from use as part of the physical education programs in grammar schools, high schools, colleges, and also be abolished as a competitive sport.”<sup>1</sup> Subsequently, in 1981, in a revision to the Academy’s position, the AAP released a second policy statement allowing for “a trial period of limited and controlled use” of trampolines in schools.<sup>2</sup> However, this policy statement (Trampolines II) noted that the trampoline is a potentially dangerous apparatus and recommended continued assessment of the incidence and severity of injury. Among the recommendations made in that statement was that “the trampoline should *never* be used in

home or recreational settings.” Despite this warning, home trampolines have become increasingly popular. Since the release of Trampolines II, a number of reports in the pediatric and orthopedic literature have documented the hazards associated with recreational trampoline use.<sup>3–8</sup>

In 1998, Smith reported an estimated average of 41,600 emergency department (ED) visits for trampoline injuries nationally per year between 1990 and 1995, based on data from the National Electronic Injury Surveillance System (NEISS).<sup>6</sup> NEISS is operated by the Consumer Product Safety Commission and is a national probability sample of hospitals in the United States and its territories. Furthermore, Smith noted that the number of ED visits for trampoline-related injuries increased by 98% over the six years examined in the study. Based on this and other studies,<sup>3–6,9–14</sup> the AAP Committee on Injury and Poison Prevention and the AAP Committee on Sports Medicine and Fitness released a joint statement in 1999 reemphasizing the dangers of trampolines. The primary recommendations were that trampolines should not be used in the home environment, that the trampoline should not be part of routine physical education classes in schools, and that it should never be regarded as play equipment. The statement further recommended that

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“during anticipatory guidance, pediatricians should advise parents never to purchase a home trampoline or allow children to use home trampolines.”<sup>15</sup>

In the present study, we similarly reviewed the number of ED visits for injuries associated with trampoline use in children 0–18 years of age for 2000–2005 using the NEISS database. Specifically, our goals were to determine whether the number of ED visits for trampoline injuries in children has continued to increase or has decreased as compared with the numbers for 1990–1995, as would be predicted based on compliance with AAP recommendations, and to determine whether the demographic and injury characteristics of trampoline-related injuries among U.S. children in 2000–2005 have changed in relation to those described for 1990–1995.

## METHODS

### Study Design

This was a retrospective study using data from NEISS for patients treated from January 1, 2000, to December 31, 2005. Demographics and injury characteristics from this period were compared with corresponding results for 1990–1995 as reported by Smith.<sup>6</sup> The study protocol was approved by the hospital’s Committee on the Protection of Human Subjects.

### Study Setting and Population

Data were obtained from NEISS, which is a national probability sample of hospitals conducted by the U.S. Consumer Product Safety Commission. Data on injury-related visits were obtained from a national sample of 100 NEISS hospitals, which were selected as a stratified probability sample of hospitals in the United States and its territories with a minimum of six beds and a 24-hour ED. NEISS collects data on visits for consumer product-related injuries treated in U.S. EDs and provides data on nearly 350,000 injury-related ED visits annually. It is intended to provide national incidence estimates of all categories and external causes of nonfatal injuries and poisonings treated in U.S. hospital EDs. For the purposes of the present study, all ED visits resulting from a trampoline-associated injury were included.

### Study Protocol

The NEISS collects information on the date of treatment, patient age, diagnosis, body part injured, patient disposition, locale in which the injury occurred, and type of product associated with the injury. Incident locale is coded by NEISS as home, farm or ranch, street or highway, other public property (includes store, office building, restaurant, church, hotel, motel, hospital or other medical facility, nightclub, theater, or other public property), mobile home, industrial place, school, place of recreation or sports, or not recorded. Because deaths are not fully captured by NEISS, patients who were dead on arrival or died in the ED are excluded. Similarly, patient outcome subsequent to leaving the ED is not included in the NEISS data. The following age groupings were used for analysis: 0–4, 5–12, and 13–18 years. NEISS diagnosis was recoded as soft tissue injury (including the NEISS categories of contusions, crushing injuries, hematomas, strains, and sprains), fracture/dislocation

(NEISS categories combined), lacerations (including the NEISS categories of lacerations, punctures, and avulsions), traumatic brain injury (TBI), and other. The diagnosis category TBI included NEISS diagnosis codes for concussion and for internal injury in which “head” was the body part affected.<sup>16</sup> Similarly, NEISS body part categories were recoded as head, neck, face, upper extremity, lower extremity, trunk, and other. When more than one injury diagnosis appears on the ED record, NEISS codes only for the injury that appears to be most severe. In the same way, when more than one body part is affected, NEISS codes only the part that appears to be most seriously injured. Injury rates per 100,000 U.S. residents 18 years of age and younger were calculated based on U.S. population projections from the U.S. Census Bureau on July 1 of each respective year, and the population projected mean of the six years was used for injury rates for the overall six-year period.

### Data Analysis

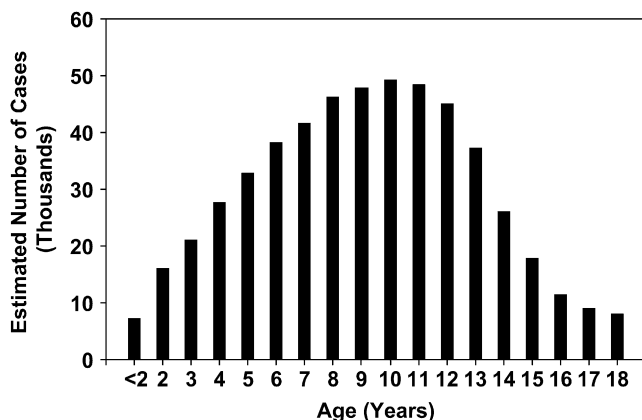
Emergency department visits resulting from injuries involving trampolines were analyzed for patients 18 years of age or younger. Data were analyzed with SAS (version 9.1.2; SAS Institute, Inc., Cary, NC) using the Survey Procedures (PROC SURVEYFREQ) to account for the complex sampling design and the weighting structure utilized by NEISS. Each case was assigned a sample weight by NEISS based on the inverse probability of selection (provided by NEISS). These weights were used to calculate national estimates of nonfatal injuries.

Confidence intervals (CIs) and coefficients of variation were calculated by using a direct variance estimation procedure that accounted for the sample weights. To the extent possible, in order to facilitate comparison, the measures examined (e.g., age categories) were identical to those reported by Smith.<sup>6</sup>

## RESULTS

During 2000–2005, there were an estimated 531,378 (95% CI = 524,250 to 538,506) trampoline-related ED visits by children 18 years of age and younger in the United States (vs. 249,400 in 1990–1995). This represents an average of 88,563 (95% CI = 85,661 to 91,466) visits annually (vs. 41,600 visits annually in 1990–1995) and an injury visit rate of approximately 115 injury visits per 100,000 U.S. children per year (vs. 59.4 per 100,000 in 1990–1995). Overall, trampoline injury visits represented 1.6% of all injury-related ED visits for the 0–18 year age group. Approximately 54% of the trampoline injuries occurred in boys (95% CI = 52.5% to 54.5%; approximately 51% of the age-adjusted estimated census was male), and an estimated 17,917 of the injuries (3.4%) resulted in admission to the hospital or transfer to another hospital.

Figure 1 depicts the age distribution of ED visits for trampoline injuries over the 2000–2005 study period. Approximately 13% (95% CI = 12.8% to 14.2%) of the injuries occurred in children younger than 5 years, 65.8% (95% CI = 64.8% to 66.8%) occurred in 5 to 12 year olds, and 20.7% (95% CI = 19.8% to 21.5%) occurred in 13 to 18 year olds. Soft tissue injuries were the most common injury sustained, followed by fractures or dislocations (Table 1). Table 2 presents the relative distribution



**Figure 1.** Estimated number of ED visits in children for trampoline-related injuries by age, 2000–2005.

of body parts injured. In 2000–2005, extremity injuries were the most frequently reported, accounting for 71% of all injuries. Of these, 49.0% (95% CI = 47.7% to 50.2%) were soft tissue injuries, 43.3% (95% CI = 42.1% to 44.5%) were fractures or dislocations, and 3.3% (95% CI = 2.9% to 3.8%) were lacerations.

When head, neck, and face were taken in composite, this body region accounted for 21% of the injuries. Facial injuries were lacerations in 60.9% of cases (95% CI = 57.7% to 64.1%), soft tissue injuries in 22.2% (95% CI = 19.4% to 24.9%), and fractures or dislocations in 6.2% (95% CI = 4.6% to 7.8%). For head injuries, 40.4% (95% CI = 36.4% to 44.5%) were diagnosed as TBI, 43.2% (95% CI = 39.0% to 47.4%) as lacerations, and 13.8% (95% CI = 10.9% to 16.8%) as soft tissue injuries.

As can be noted in Tables 1 and 2, there was no substantial difference in relative distribution of either diagnosis or body part injured between 1990 to 1995 and 2000 to 2005.

Table 3 depicts two characteristics (diagnosis and body part injured) of trampoline injuries as a function of age group for 2000–2005. Fractures and dislocations accounted for the greatest percentage of injury visits in the 0–4 year age group, whereas soft tissue injuries accounted for the majority of injury visits in both of the

**Table 2**  
Distribution of Body Parts Injured on Trampolines

Body Part Injured	National Estimate*	Percent of Total (95% CI), 2000–2005	Percent of Total (Smith, 1998), 1990–1995
Lower extremity	201,045	37.8 (36.8, 38.8)	41.3
Upper extremity	176,763	33.3 (32.3, 34.2)	29.6
Face	51,870	9.8 (9.2, 10.4)	10.6
Trunk	37,851	7.1 (6.6, 7.7)	7.9
Neck	28,784	5.4 (5.0, 5.9)	10.0 (reported as head and neck)
Head	30,939	5.8 (5.3, 6.3)	
Other	4,125	0.8 (0.6, 1.0)	0.6

\* Based on National Electronic Injury Surveillance System weights.

two older age groups. In regard to primary body part injured, all age groups sustained the majority of injuries to the extremities. However, while both the younger (0–4 years) and older (13–18 years) age groups sustained a significantly higher percentage of injuries to the lower extremities than to the upper extremities, in the middle age group, injuries were approximately evenly divided between the upper and lower extremities. Head injuries represented a decreasing proportion of injuries with increasing age.

More than 60% (95% CI = 59.1% to 62.6%) of injuries to upper extremities were fractures or dislocations, whereas more than 62% (95% CI = 61.1% to 64.4%) of injuries to the lower extremities were soft tissue injuries. As mentioned, for injuries to the head, 40.4% (95% CI = 36.4% to 44.5%) were diagnosed as TBI and 43.2% (95% CI = 39.0% to 47.4%) as lacerations, whereas for neck injuries, more than 88% (95% CI = 85.4% to 91.0%) were soft tissue injuries; other neck diagnoses (including fracture or dislocation) were not of sufficient numbers to make reliable estimates of their values.

The location where the injury occurred was known in 74.4% of cases in 2000–2005. For those cases in which the location was known, 95.1% (95% CI = 94.6% to 95.6%) of the injuries occurred at home, a percentage similar to that reported by Smith for 1990–1995.<sup>6</sup> Injuries from places of recreation or sports accounted for 3.5% of the injuries (95% CI = 3.0% to 3.9%). Lower and upper extremity injuries comprised approximately equivalent proportions of the injuries occurring at home (37% and 34%, respectively), with 10% of the remaining injuries at home involving the face, 7% involving the trunk, and 6% involving the head. Injuries occurring at home were disproportionately soft tissue injuries (48.9%; 95% CI = 47.6% to 50.1%), with fractures or dislocations accounting for 32.0% (95% CI = 30.8% to 33.1%) and lacerations accounting for 11.9% (95% CI = 11.0% to 12.7%).

**Table 1**  
Types of Injuries on Trampolines

Diagnosis	National Estimate, 2000–2005*	Percent of Total (95% CI), 2000–2005	Percent of Total (Smith, 1998)†, 1990–1995
Soft tissue injury	256,509	48.3 (47.2, 49.3)	53.1
Fracture/dislocation	168,402	31.7 (30.7, 32.6)	30.1
Laceration	59,012	11.1 (10.5, 11.8)	13.6
Traumatic brain injury	12,513	2.4 (2.1, 2.7)	0.3 (concussion only)
Other	34,942	6.6 (6.1, 7.1)	2.9

\* Based on National Electronic Injury Surveillance System weights.  
 † Data shown for 2000–2005 represent all patients, regardless of admission status. Data in this Table reported for Smith (1998) represent patients treated and released (approximately 96% of the sample).

**DISCUSSION**

Exercise and play are essential to healthy childhood development and obviously should be encouraged. On

Table 3  
Characteristics of Trampoline Injuries by Age Group, 2000–2005

	0–4 Years		5–12 Years		13–18 Years	
	n*	Percent (95% CI)	n*	Percent (95% CI)	n*	Percent (95% CI)
<b>Diagnosis</b>						
Soft tissue injury	24,540	34.1 (31.5, 36.7)	168,247	48.1 (46.8, 49.4)	63,721	58.0 (55.8, 60.3)
Fracture/dislocation	29,333	40.8 (38.1, 43.5)	112,029	32.0 (30.9, 33.2)	27,040	24.6 (22.7, 26.6)
Laceration	9,350	13.0 (11.1, 14.9)	39,500	11.3 (10.5, 12.1)	10,162	9.3 (7.9, 10.6)
Traumatic brain injury	2,903	4.0 (3.0, 5.1)	7,479	2.1 (1.8, 2.5)	2,131	1.9 (1.4, 2.5)
Other	5,778	8.0 (6.6, 9.5)	22,401	6.4 (5.8, 7.0)	6,763	6.2 (5.1, 7.2)
<b>Body part</b>						
Lower extremity	28,677	39.9 (37.2, 42.6)	120,446	34.4 (33.2, 35.7)	51,922	47.3 (45.0, 49.6)
Upper extremity	23,145	32.2 (29.7, 34.7)	126,307	36.1 (34.9, 37.3)	27,311	24.9 (22.9, 26.8)
Face	9,704	13.5 (11.6, 15.4)	33,393	9.6 (8.8, 10.3)	8,773	8.0 (6.8, 9.2)
Trunk	1,941	2.7 (1.8, 3.6)	25,454	7.3 (6.6, 7.9)	10,456	9.5 (8.2, 0.9)
Neck	2,149	3.0 (2.1, 3.9)	20,281	5.8 (5.2, 6.4)	6,354	5.8 (4.7, 6.9)
Head	5,545	7.7 (6.3, 9.1)	21,118	6.0 (5.4, 6.6)	4,277	3.9 (3.0, 4.8)
Other	744†	1.0 (0.5, 1.6)	2,657	0.8 (0.5, 1.0)	723†	0.7 (0.3, 1.0)

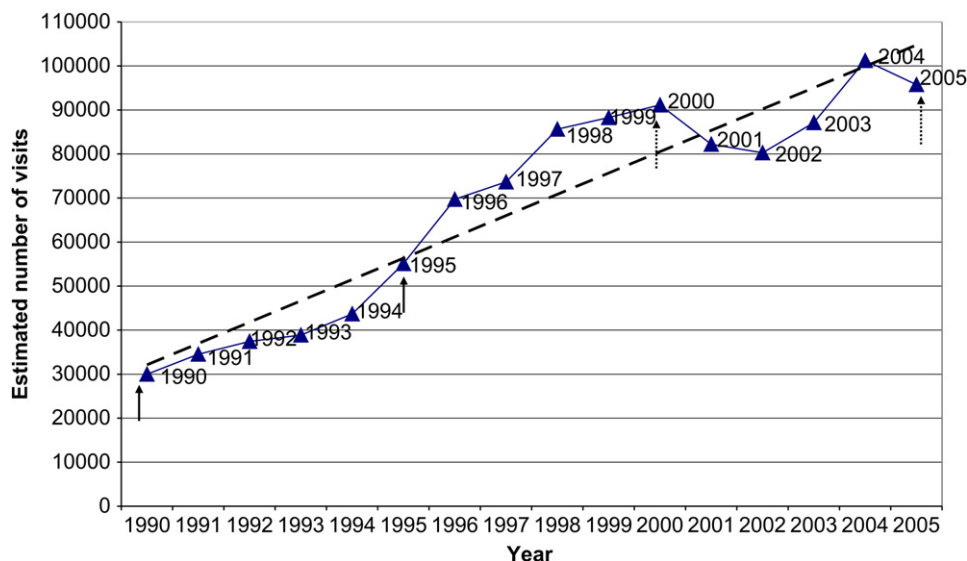
\* Weighted frequencies.  
† Individual national estimates <1,200 are considered unreliable.

the surface, trampoline activities appear to be fun and to satisfy that need. A backyard trampoline can be purchased for approximately \$200, making it affordable for many families. There has been a continued growth in sales of trampolines from 1989 to 2004, with a 15% annual growth from 2001 to 2004 and 1.2 million new trampoline sales in 2004 (personal communication, International Trampoline Industry Association II, Eugene, OR, 2005). Nevertheless, our analysis of NEISS data once again demonstrates that there is significant risk of injury to children associated with the use of trampolines.

According to our analysis of NEISS data for 2000–2005, emergency physicians saw an increase of 281,978 visits

for trampoline injuries in children when compared with NEISS data for 1990–1995.<sup>6</sup> Not surprisingly, the nature of the injuries was largely similar between the two periods. However, it is notable that the vast majority of visits in both studies were the result of injuries that occurred in the home environment. It is also of great concern that very young children, younger than 5 years, accounted for 13% of the trampoline injuries.

It is apparent from Figure 2 that the absolute number of ED visits for trampoline injuries has continued to increase on average from the early 1990s to the present, despite warnings. A best-fit straight line predicting number of ED visits as a function of year had a slope of 4,839



**Figure 2.** Estimated number of ED visits for trampoline-related injuries from 1990 to 2005. Solid arrows depict the time period studied by Smith<sup>6</sup>; dashed arrows depict the time period of the present study. The dashed line represents the best-fit line. (Values for this figure were derived from the National Electronic Injury Surveillance System [NEISS] online query system [<http://www.cpsc.gov/library/neiss.html>]. They may differ marginally from the numbers reported here and by Smith [1998] because Consumer Product Safety Commission analyses may take more factors and information into consideration. Similarly, because NEISS implemented a new sample on January 1, 1997, NEISS adjustment factors were applied for data from years before 1997, as recommended by NEISS.) (Color version of this figure available online at [www.aemj.org](http://www.aemj.org).)

visits per year and accounted for ( $r^2 =$ ) 88.6% of the variability, suggesting a positive linear trend in injury visits over time. However, there were three reductions in yearly visits over the last five years (2000–2001, 2001–2002, and 2004–2005), where there had been none over the preceding ten years. Whether this ultimately reflects a leveling off or random variation is unclear without more years of data, given the year-to-year fluctuations. Yet, despite such signs that could be taken as encouraging, these recent years of reductions have still totaled less than the increases in the interjecting two years (2002–2003 and 2003–2004), such that 2005 still had more trampoline ED visits than 2000 and indeed all years before 2004.

It is difficult to calculate an exact injury rate for trampolines because the exposure rate (amount of trampoline use) is unknown. New trampoline sales are increasing, but it is difficult to consistently get exact yearly sales numbers from industry sources to assist in calculating an exposure rate. Also, additional complexities in establishing an exposure rate include resale of older trampolines and the fact that children utilize trampolines for varying amounts of time and this may vary by age. Thus, while we cannot estimate the injury rate, we can clearly state that the frequency of ED visits for trampoline injuries has dramatically increased. The increase in the number of injuries might be, in part, due to factors such as better reporting by NEISS, but this would likely account for only a minimal amount of the increase. More likely, the increase in trampoline injuries is due to the wider availability of trampolines in homes. As was noted in the early 1990s, the majority of the injuries (95%) occur when trampolines are used at home, a finding that held true in our current data.

Although education has been the predominant injury prevention intervention utilized, further countermeasures should also be considered to address this problem in addition to traditional educational messages. Strategies such as banning the sales of home trampolines, although extreme, have been conducted by the Consumer Product Safety Commission with other unsafe products. Economic interventions have potential as well and could be enacted with home insurers denying insurance or charging a premium to insure homes with trampolines.

The finding that trampoline injuries continue to occur and, indeed, have increased in number despite expert recommendations against the recreational use of trampolines is troubling. With most of these pediatric injuries occurring in residential settings, it appears that more needs to be done to educate the community about the risks associated with home trampoline use. Emergency physicians should join our pediatrician colleagues in their recommendation to parents to “never to purchase a home trampoline or allow children to use home trampolines”<sup>15</sup> and advocate for additional interventions to address this injury problem.

## LIMITATIONS

There are limitations regarding data obtained through NEISS that should be mentioned. The true number of injuries resulting from trampoline use is likely underesti-

mated, because these data are drawn from ED visits at NEISS hospitals and do not include data from injuries treated at other medical facilities (e.g., urgent care facilities, doctors’ offices) or at home. In addition, details regarding the circumstances and characteristics of injuries are limited. For example, information regarding adult supervision at the time of injury is not included, and information such as how many children were on the trampoline simultaneously is not recorded. Similarly, NEISS does not code cause of injury, so it is not possible to determine whether injuries are the result of a fall, a collision, and so on. Location of injury was recorded as unknown or unspecified in a notable percentage of cases. This obviously limits the understanding of the circumstances of the associated injuries. In addition, data regarding the severity of injuries, as well as fatalities, are not available.

Another important limitation of this study is that it does not allow for accurate comparisons of relative risks, because information regarding rates of exposure (i.e., time spent on trampoline activities) are not recorded in NEISS and we could find no comprehensive estimates of participation in trampoline activities. Consequently, while it is possible to note that the 5–12 year age group had the most ED visits nationally for trampoline-related injuries, it is not possible to discern whether that age group spends an equivalent or greater amount of time engaged in trampoline activities when compared with the other age groups.

## CONCLUSIONS

The dramatic increase in the frequency of ED visits for trampoline-related injuries makes it clear that the injury problem related to trampoline use by children has not disappeared and seems to have substantially increased since the early 1990s. The majority of these injuries occur during home trampoline use, with some occurring in very young children. The increased frequency of ED visits for trampoline injuries necessitates further interventions, and emergency physicians should participate in their development and implementation.

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## Erratum

In the print issue of the supplement to the May 2007 issue of *Academic Emergency Medicine*, abstract 432 by Vaillancourt C, Midzic I, Taljaard M, and Chisamore B (Fatigue and Quality of CPR by Older Bystanders Using the New 30:2 Chest Compression to Ventilation Guidelines: A Randomized Cross-over Trial, *Acad Emerg Med* 2007; 14[5, suppl1]:S170) included the wrong abstract text. The correct abstract appears below and in the online issue of the supplement to the May 2007 issue.

### 432 Fatigue and Quality of CPR by Older Bystanders Using the New 30:2 Chest Compression to Ventilation Guidelines: A Randomized Cross-over Trial

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**Introduction:** The 2005 International Consensus on CPR changed the chest compression:ventilation ratio from 15:2 to 30:2 to minimize interruptions and increase the number of compressions. We sought to measure bystander fatigue and CPR quality after 5 minutes of CPR using the new and the old CPR ratios in a population of older lay persons.

**Methods:** This randomized cross-over study took place at a senior's center and a tertiary care hospital. Participants were aged 55 or greater with no significant physical limitation (Frailty score  $\leq 3/7$ ). Participants completed two 5-min CPR sessions (using 30:2 and 15:2 ratios) on a recording manikin, separated by a 5-min rest. We used concealed-blocked randomization to determine the order of ratio. Metronome feedback maintained a compression rate of 100/min. We measured changes in heart rate (HR), mean arterial pressure (MAP), venous lactate (VL), and Borg Exertion Scale (range 6–20). CPR quality measures were number of chest compressions and number of good compressions (fully-released, depth  $\geq 38$ mm). Analyses included Paired t-Test, mixed-effect regression, and descriptive statistics with 95% CIs.

**Results:** The 42 enrolled participants were: mean age 66.0 (range 55–84), female 69.0%, past CPR training 66.7%, and mean initial HR 70.4, MAP 91.3, VL 1.5, and Borg score 9. Bystander fatigue was similar for each CPR ratio: mean difference between groups in increased HR 1.5 (95%CI -1.5–4.5), MAP 1.5 (-1.8–4.8), VL 0.2 (-1.1–1.4), Borg 0.2 (-0.2–0.8). Participants attempted more chest compressions per session using the 30:2 vs the 15:2 ratio (382.2 vs 303.6, mean diff. 78.6;  $p < 0.0001$ ), but completed a similar number of good compressions (128.5 vs 126.6, mean diff. 2.0;  $p = 0.85$ ). The number of good compressions/min declined significantly more rapidly over time for the 30:2 ratio;  $p = 0.02$ .

**Conclusions:** In a population likely to perform CPR, the new 30:2 ratio resulted in significantly more rapid CPR quality decline and no additional benefit over the old ratio.