



■ CHILDREN'S ORTHOPAEDICS

Trampolines injuries are bouncing back

THE EFFECT OF THE COVID-19 UK LOCKDOWN ON THE PAEDIATRIC TRAUMA BURDEN

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Aims

This observational study examines the effect of the COVID-19 pandemic upon the paediatric trauma burden of a district general hospital. We aim to compare the nature and volume of the paediatric trauma during the first 2020 UK lockdown period with the same period in 2019.

Methods

Prospective data was collected from 23 March 2020 to 14 June 2020 and compared with retrospective data collected from 23 March 2019 to 14 June 2019. Patient demographics, mechanism of injury, nature of the injury, and details of any surgery were tabulated and statistically analyzed using the independent-samples *t*-test for normally distributed data and the Mann-Whitney-U test for non-parametric data. Additionally, patients were contacted by telephone to further explore the mechanism of injury where required, to gain some qualitative insight into the risk factors for injury.

Results

The 2020 lockdown resulted in 30% fewer paediatric trauma presentations (441 vs 306), but no significant change in the number of patients requiring surgery (47 vs 51; $p = 0.686$). Trampolining injuries increased in absolute numbers by 168% ($p < 0.001$), almost four times more common when considered as percentage of all injuries observed in 2020 vs 2019. There was a decrease in high energy trauma from road traffic accidents and falls from height (21.5% decrease, $p < 0.001$). Despite a shift towards more conservative treatment options, trampolining injuries continued to require surgery in similar proportions (19.4 vs 20%; $p = 0.708$). Qualitative investigation revealed that the most common risk factor for trampolining injury was concurrent usage, especially with an older child.

Conclusion

COVID-19 lockdown has resulted in a decrease in paediatric orthopaedic presentations and high energy trauma. However, due to a marked increase in home trampolining injuries, and their unchanged requirement for surgery, there has been no change in the requirement for surgery during the lockdown period. As home exercise becomes more prevalent, a duty of public health falls upon clinicians to advise parents against trampoline usage.

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Introduction

The global COVID-19 pandemic has presented several challenges to clinicians, politicians and business owners.¹ Several countries, in an attempt to control the rate of disease spread, have gone through periods of being under lockdown; ceasing international travel and requiring the

population to remain at home. Many countries have already experienced a second wave of this novel coronavirus, and have needed to re-initiate lockdown measures. A second wave has begun in the UK, and a similar lockdown period has been initiated; certainly, it seems that future lockdowns of varying severity are likely. An understanding

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Fig. 1

Examples of typical trampolining presentations observed during the lockdown period. These are high energy injuries in these age groups. a) A 13-year-old female patient with an atypical supracondylar fracture b) This highly unstable fracture required emergent fixation with three Kirschner wires. c) Satisfactory radiological union at four-month follow-up. d) A four-year-old male patient with proximal tibial buckle fracture.

of the effect of a lockdown period is vital in order to guide the decision to re-initiate a lockdown period, and also to better prepare clinicians.

School closure has been demonstrated to be particularly useful in slowing the spread of infectious diseases during previous pandemics.^{2,3} Similar practice has therefore been adopted in many countries during this current pandemic, with all schools in the UK closing by 20 March 2020.⁴ Initiation of UK lockdown has therefore had an enormously deleterious effect upon the activities which children can participate in, with cessation of school and team sports and entire families required to stay indoors. Several studies from around the world have reported significant decreases in paediatric traumatic presentations, and a marked shift away from high energy trauma and road traffic accidents, with a notable increase in home exercise and corresponding injuries as a result, with particular attention paid to home trampoline usage.⁵⁻¹²

Pre-COVID-19, the dangers and economic impact of home exercise and particularly of home trampolines have been investigated by several research groups and recommendations for safe use have been made. However, parents remain largely unaware of this.¹³⁻¹⁸ The force generation from a trampoline is known to cause some fracture patterns that are pathognomonic with this mechanism of injury (e.g. proximal tibia fractures, Figure 1) and disproportionately affect children under six years old.¹⁹⁻²² Concurrent usage by two or more children, particularly when of different sizes, denotes a 14-fold risk of injury to the smaller child.²⁰⁻²⁴ Trampolining injuries should be considered a high

Table I. Selection criteria and justifications for each criterion.

Criteria	Reason
Inclusion	
Age ≤ 16 yrs old	Paediatric cases only
Removal of metalwork due to a complication counted as a second surgery (e.g. due to infection)	This is additional surgery, not expected as part of the initial procedure.
Exclusion	
Hand trauma	Managed by the plastic surgery service at this site
Major polytrauma	Managed at major trauma centre
Planned removal of metalwork did not count as a further procedure (e.g. removal of TENS nails)	These are expected as part of the initial procedure.

TENS, titanium elastic nail system.

energy mechanism of injury, and Figure 1 illustrates common presentations that our hospital encountered during the lockdown period.

Previous studies from metropolitan major trauma centres have highlighted that their studies have been limited by the nature of the hospital within which they are based, questioning whether their findings may have been skewed by any changes occurring within the surrounding district general hospitals.^{5,25} We aim to fill that gap in their data, and to supplement and corroborate these findings. Our study examines the effect of the first UK lockdown and the resultant shift in behaviour upon the paediatric trauma burden upon a single UK district general hospital (Broomfield Hospital, Chelmsford, UK). Our null hypothesis is that there has been no statistically significant change in the paediatric trauma burden during the UK lockdown period.

Methods

Patients seen in the consultant-led paediatric fracture clinic at a district general hospital between 23 March 2020 and 14 June 2020 were compared with those seen between the same dates in 2019. Selection criteria and the justification for each criterion is given in Table I. The study included 306 patients in 2020 and 441 in 2019. Three patients (< 1%) were excluded in 2020 due to insufficient data.

Outcome measures. 2020 data was collected prospectively and 2019 data was collected retrospectively. Both data sets were collected from imaging and electronic health record documentation in the emergency department, orthopaedic trauma clinic, and operating theatre records. Anonymised patient demographics, mechanism of injury, location and type of injury were recorded. Injuries were differentiated into soft tissue injuries and those with identified fractures. Cases that received surgical intervention were stratified into those requiring metalwork (including implant selection; e.g. Kirschner (K)-wires vs intramedullary nailing), and those that did not (e.g. manipulation under anaesthetic and plaster

Table II. Comparison of absolute numbers of injuries between 2019 and 2020.

Variable	2019	2020	p-value*
Overall, n			
Total injuries	441	306	< 0.001
Surgery required	51	47	0.686
Age group (yrs), n			
0 to 5	102	85	0.214
6 to 11	149	129	0.230
12 to 16	190	94	< 0.001
Type of injury, n			
Fractures	279	185	< 0.001
Soft tissue injuries	162	123	0.021
Limb n			
Upper limb	306	191	< 0.001
Lower limb	134	117	0.283

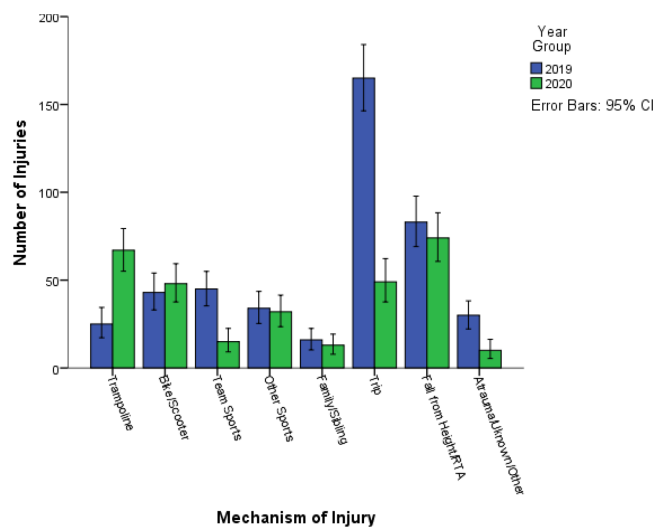
*Chi-squared test.

application). Further detail regarding the mechanism of injury and risk factors surrounding the incident were collected using a patient survey. This was performed by automated text message, or supplemented by individual telephone calls to parents.

Follow-up. No patients were lost to follow-up. All fractures achieved clinical and radiological union. Extraphyseal fractures were all discharged successfully; however, there were 11 physeal injuries which continue to be followed up by the paediatric orthopaedic team, to ensure that there are no longer term sequelae including growth arrest and deformity.

Statistical analysis. Continuous data was tabulated and analyzed. 2020 and 2019 data were compared and statistically tested using the independent-samples *t*-test for normally distributed data and the Mann-Whitney-U test for non-parametric data. Data normality was determined through a combination of visual inspection of histograms and Q-Q plots and inspection of skewness values in relation to their standard error values. Categorical data was compared using chi-squared test or Fisher's exact test where expected values were < 5 for > 25% of cells or < 1 for any cell if appropriate. All statistical analyses were performed using SPSS v. 21.0 (IBM, Armonk, New York, USA). All comparative tests were two-tailed with significant initially set at $p < 0.05$. Bonferroni corrections were applied to this significance value in instances where contingency tables were larger than 2×2 in order to avoid a type 1 error.

This project was registered with the local research and audit department, and was deemed to be a service evaluation project and therefore ethical approval and informed consent were not required. In order to confirm this, we used the National Research and Ethics Service decision making tool (www.hra-decisiontools.org.uk).

**Fig. 2**

Graph comparing injuries by mechanism of injury in 2019 and 2020.

Results

The 2020 UK lockdown has resulted in several statistically significant changes and allows us to reject our null hypothesis. Table II gives a brief overview of some of our findings in terms of absolute numbers, in order to provide some context.

In 2020, patients were significantly younger (median age 10 years (interquartile range (IQR) 6 to 12) vs 8 years (IQR 5 to 11); $p = 0.001$, Mann-Whitney U test), which was mainly due to a decrease in presentations from children over 11 years old (190 vs 94; $p < 0.001$, chi-squared test).

A 30% decrease in the number of cases in total was observed (441 vs 306; $p < 0.001$, chi-squared test), however there was no significant difference in the number of cases that required surgery (51 vs 47; $p = 0.686$, chi-squared test). There was a decrease in fracture presentations (279 vs 185; $p < 0.001$, chi-squared test) and an increase in soft tissue injuries (162 vs 123; $p = 0.021$, chi-squared test). Significantly fewer upper limb injuries were seen in 2020 (306 vs 191; $p < 0.001$, chi-squared test).

The decrease in presentations was largely accounted for by a decrease in injuries sustained doing team sports (45 vs 15; $p < 0.001$, chi-squared test) and accidental trips (165 vs 49; $p < 0.001$, chi-squared test). Conversely, there was a significant increase in trampolining injuries (25 vs 67; $p < 0.001$, chi-squared test), which made up a larger proportion of surgical cases in 2020 (28% vs 8%; $p = 0.010$, chi-squared test). As a percentage of injuries presenting, there was a 400% increase in those from trampolines compared to 2019. A summary of the change in mechanism of injury is presented in Figure 2.

Table III. Comparisons of injury characteristics as a proportion of all injuries each year.

Variable	2019 (n = 441)	2020 (n = 306)	p-value*
Age group (yrs), %			
0 to 5	23.1	27.6	0.165
6 to 11	34.8	41.9	0.021†
12 to 16	43.1	30.5	< 0.001‡
Type of injury, %			
Fractures	63.3	60.1	
Soft tissue injuries	36.7	39.9	
Limb, %			
Upper limb	69.5	62.0	0.032§
Lower limb	30.5	38.0	
Mechanism, %			
Trampolining	5.7	21.8	< 0.001‡
Bike/scooter	9.8	15.6	0.016†
Team sports	10.2	4.9	0.008†
Other sports	18.8	24.0	0.085
Fall from height/RTA	37.4	15.9	< 0.001‡
Trip	3.6	4.2	0.681
Sibling/family	7.7	10.4	0.204
Atraumatic/other/unknown	6.8	3.3	0.033†

*Chi-squared test.

†Not significant after Bonferroni correction applied.

‡Significant after Bonferroni correction applied.

§Significant without Bonferroni correction needed.

RTA, road traffic accident.

Table IV. Proportional comparison of surgical cases between 2019 and 2020.

Variable	2019 (n = 51)	2020 (n = 47)	p-value
Age group (yrs), %			
0 to 5	23.5	34.0	0.25*
6 to 11	49.0	40.4	0.395*
12 to 16	27.5	25.5	0.834*
Type of injury, %			
Fractures	92.2	91.5	< 0.999†
Limb, %			
Upper limb	66.7	74.5	0.938*
Lower limb	33.3	25.5	
Mechanism, %			
Trampolining	7.8	27.7	0.010*‡
Bike/scooter	9.8	17.2	0.294*
Fall from height/RTA	33.3	29.8	0.704*
Trip	23.5	8.5	0.444*

*Chi-squared test.

†Fisher's exact test.

‡Significant without Bonferroni correction needed.

RTA, road traffic accident.

Table III makes proportional comparisons between the 2019 and 2020 cohorts, revealing that a higher proportion of lower limb injuries were seen in 2020 (30.5% vs 38.0%; $p = 0.032$, chi-squared test). There was a marked increase in trampolining injuries in 2020 (21.8% vs 5.7% of all injuries in 2019; $p < 0.001$, chi-squared test). A similar, but insignificant trend was also

Table V. Trampolining injuries subanalysis, comparing numbers of trampoline-related injuries between 2019 and 2020 as a proportion of the total number of injuries that year.

Variable	2019 (n = 25)	2020 (n = 67)	p-value*
Age group (yrs), %			
0 to 5	32.0	25.4	0.525
6 to 11	60.0	50.7	0.429
12 to 16	8.0	23.9	0.088
Sex, %			
Male	40.0	50.7	0.359
Female	60.0	49.3	
Type of injury, %			
Fractures	64.0	59.7	0.707
Soft tissue injuries	36.0	40.3	
Limb, %			
Upper Limb	60.0	46.3	0.241
Lower Limb	40.0	53.7	
Area/bone injured, %			
Distal radius/ulna/carpus	12.0	10.4	0.831
Radius/ulna shaft	12.0	10.4	0.831
Supracondylar	24.0	19.4	0.628
Humerus shaft	4.0	3.0	0.807
Clavicle	8.0	3.0	0.294
Distal femur/proximal tibia	8.0	1.5	0.118
Tibia/fibula shaft	4.0	7.5	0.550
Ankle	20.0	35.8	0.146
Foot	8.0	9.0	0.885
Surgery required			
Total cases, %	20.0	19.4	0.708
MUA, n	2	6	
MUA + K-wire, n	1	4	
IM nail, n	2	2	
ORIF, n	0	1	

*Chi-squared test.

IM nail, intramedullary nail; K-wire, Kirschner wire; MUA, manipulation under anaesthesia; ORIF, open reduction, internal fixation.

seen in the portion of injuries attributed to bicycles and scooters (9.8% vs 15.6%; $p = 0.016$, chi-squared test). Conversely, a lower proportion of injuries in 2020 were due to higher energy trauma such as road traffic accidents (RTAs) and falls from height (37.4% vs 15.9%; $p < 0.001$, chi-squared test).

Table IV compares the numbers of cases requiring surgery in more detail. In 2020, trampolining injuries required more surgery (4 vs 13; $p = 0.029$, chi-squared test) and also made up a higher proportion of surgical cases (7.8% vs 27.7%; $p = 0.010$, chi-squared test).

Table V displays a subanalysis of trampolining injuries between 2019 and 2020 periods. The injuries between both groups presented similarly, with no statistical difference in the patient demographics, injury, nor the intervention required. Although more abundant, trampolining injuries in 2020 were just as severe as in 2019, and there was no proportional change in the requirement for surgical intervention (20% vs 19.4%; p

= 0.708, chi-squared test), despite a more conservative approach to management.

Discussion

The combination of the closure of schools, family confinement, and the unavailability of team sports has steered families towards the use of inexpensive forms of home exercise such as bicycles, scooters, and trampolines.^{5,26} Studies from several countries have investigated the local effect of COVID-19 lockdown periods upon the paediatric trauma in their individual hospitals; however, the type of hospital does seem to be a factor in determining the nature of their experience. Studies from major trauma centres in more metropolitan areas including London (UK) and Montreal (Canada), demonstrated no significant increase in trampolining injuries.^{12,25,27} One study group in rural South Australia found no change in paediatric orthopaedic admissions, although no explanation was offered for this.²⁸ The hospital included in our study is a rural district general hospital, with an affluent surrounding population.

Trampoline home usage is a relatively new phenomenon, originally invented as a training tool for gymnasts and acrobats in the 1940's.²⁰ Several studies have highlighted the dangers of trampolines, and have compared usage at home and in trampoline parks.¹³⁻¹⁹ These studies have consistently shown that home trampolines are more dangerous, with resultant injuries financially costing more to treat because of several factors (including difference in trampoline design, force transmission, supervision, concomitant use by two or more participants, requirement for surgery).²⁹ The consensus from the currently available literature is that trampolines pose a significant danger to the public, with a high requirement for surgery, and their usage has been discouraged.^{19-22,27}

However, trampoline purchases are increasing and are projected to continue doing so, particularly in the event of further lockdown periods. Market reports from several prominent groups have provided detailed market analyses of toy sales in 2019 and 2020; investigating the relevance of several factors, including global geography (e.g. Asia-Pacific, Europe, North/South America, Europe, Middle East, and Africa), mode of sale (i.e. online vs offline), type of trampoline (e.g. size, shape, type) and end user (e.g. commercial vs individual).³⁰⁻³² The NPD group documented an increase in toy sales of USD 256 million in the first financial quarter of 2020, which represents a 7.6% increase as compared with the same period in 2019.³⁰ This report found that increased trampoline sales were a key observable trend.³⁰ The Technavio group found that “the global trampoline market has the potential to grow by USD 691 million during 2020 to 2024, and the market’s growth momentum will accelerate throughout the forecast period”.³¹ The advent of smart trampolines with Bluetooth connectivity is

expected to provide a further boost to trampoline sales in the future, with outdoor toys such as this described as a “supercategory” that may emerge if lockdown measures continue.³⁰⁻³² Trampolining is demonstrably dangerous, and these market reports should be cause for alarm.

During the lockdown period, orthopaedic departments across the UK adopted a more conservative and pragmatic approach to fracture management as published in COVID-19-specific British Orthopaedic Association Standards for Trauma and Orthopaedics and British Society for Children's Orthopaedic Surgery guidelines.^{33,34} Several adult studies have explored the impact of lockdown on the management of adult trauma, including neck of femur and spinal fractures.^{35,36} In our department, we adopted a consultant-led service, with the increased use of intranasal diamorphine and Entonox in the emergent setting for manipulation of acute fractures as described in work from Nottingham, UK.³⁷ In cases where surgery was necessary, metalwork was avoided as much as possible.^{33,34,38,39} This temporary change in practice helped reduce the footfall within the hospital, achieving the aim of minimizing the risk of COVID transmission to children and their families. Despite this conservative shift in management strategy, trampolining injuries continued to require surgery in similar proportions (Table V).

Telephone consultations provided insight into risk factors for injury that were statistically significant and congruent with previous studies. Many of the contacted parents reported concurrent usage with another child, which has been often cited as a specific risk factor for injury in those under six years old; previous literature has stated as it denoting a 14-fold increased chance of injury to the smaller child due to the “double-bounce” effect.⁴⁰ Injuries described to be pathognomonic with trampolining, including proximal tibial fractures, atlanto-axial subluxations, vertebral artery dissections, manubriosternal dislocations were not found to be significant within this cohort.

A recent study from a USA major trauma centre raised some questions regarding the relationship between district general hospitals and their local MTC during this period.⁵ They hypothesized that district general hospitals may have foregone referral to larger paediatric centres and chosen to manage patients locally. During our UK study, no paediatric patients were referred to our regional major trauma centre. The Philadelphia group also hypothesized that patient behaviour may have shifted; and that parents may have chosen to minimize travel and present to smaller major trauma centres that were close to them geographically, rather than travel further to a larger hospital.⁵ In our UK study, we did not experience an increase in patients presenting to the hospital, suggesting that we were not taking over some of the patient load from our regional major trauma centre.

Government mandated lockdown periods are likely to continue until widespread vaccination is carried out. As a result, the nature of exercise, recreation, and work for children and adults will be increasingly moving into the domestic setting. This paper highlights the importance of informing and educating parents and regulators of the potential risk of injury associated with home trampoline usage, as is done with other high risk sporting activities.

This study only involved one hospital; the socio-economic and geographical factors at play have not been taken into account and the surrounding area is fairly rural and affluent. A multiregional approach may have mitigated this; however, this was a challenge which we failed to co-ordinate at such a chaotic time across the nation.

In a temperate climate such as the UK, the weather can play a big part in deciding what kind of exercise or activities one is likely to participate in. Hotter weather is known to have a demonstrable increase in fracture presentations and an increase in the workload of orthopaedic practitioners.⁴¹ This is a difficult factor to include within this study; however the observed dates of this study were notably hotter and drier during 2020, as compared with the same period of time in 2019.^{26,42}

The threshold for a parent to decide to bring their child to the emergency department may also have played a part in reducing the number of presentations during 2020. It is difficult to ascertain whether there has been an effect, but it is likely that many parents were sensibly disinclined to present to the emergency department. Our study is not the only one to demonstrate that COVID-19 has had an effect upon the number of paediatric presentations to the emergency department.^{12,25-27}

We have provided statistically significant evidence supporting our test hypothesis and reject our null hypothesis. The COVID-19 UK lockdown has had a significant and demonstrable effect upon the paediatric trauma burden within our district general hospital.

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