Injury Analyses in Rural Children: Comparison of Old-Order Anabaptists and Non-Anabaptists

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Background: Southwestern Ontario largely comprises rural farming districts and is home to numerous Old-Order Anabaptist settlements. Our objective was to describe the injuries sustained by rural children, both Old-Order Anabaptist and non-Anabaptist, to better target injury prevention programs.

Methods: We retrospectively examined injury data of rural children in Southwestern Ontario with injury severity scores ≥12 obtained from hospital and trauma databases (1997–2007).

Results: A total of 422 rural children were included in this study: 7.8% Anabaptist (n = 33) and 92.2% non-Anabaptist (n = 389). The age of injured Anabaptist children (median, 7 years; interquartile range = 10) was younger than non-Anabaptist children (median, 14 years; interquartile range = 7; $p < 0.001$). Anabaptist children were most frequently injured on their property (48.5%; n = 16 of 33; $p < 0.001$). Non-Anabaptist children were mostly injured on roads (56.8%; n = 221 of 389; $p < 0.05$) and by motor vehicle collisions (MVCs; 40.1%; n = 156 of 389; $p = 0.02$). Frequent causes of injury among Anabaptist children were falls (24.2%; n = 8 of 33; $p = 0.02$), animals (15.2%; n = 5 of 33; $p = 0.004$), and buggies (9.1%; n = 3 of 33). Approximately half of both groups injured in MVCs did not use seat belts. There were no significant differences between cohorts in sex, injury severity scores, hospitalization days, rates of complications, interventions, comorbidities, or mortality rates.

Conclusions: Injuries to Anabaptist children occur at a young age, primarily on their property, and exhibit a unique spectrum of mechanisms. In contrast, injuries to non-Anabaptist children occur at an older age, primarily on roads, and in MVCs. The use of protective devices was low among all rural children. Development of collaborative injury prevention programs targeted to distinct rural communities, including Anabaptist and non-Anabaptist, are needed for reducing injuries among rural children.

Key Words: Rural populations, Trauma, Injury prevention, Adolescent, Child.

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Southwestern Ontario primarily comprises rural farming districts, with a relatively large concentration of Old-Order Anabaptist settlements. Anabaptist Old-Order Mennonites and Amish migrated to North America from Europe during the 1800s to escape persecution and to preserve their culture, practices, and beliefs.[1] Anabaptist individuals possess a strong sense of social obligation, assist one another in times of need, and oppose the need for conventional health insurance.[2] In Canada, Anabaptists are eligible for medical insurance; however, they have negotiated with the government to gain exemption, and most choose to pay for medical services out of pocket. Anabaptist individuals abstain from the use of modern technology, dress conservatively, and engage in traditional farming practices akin to those used in the 1700s.[3]

Farming can be a dangerous industry, particularly for children among whom agricultural injury has been recognized as an important public health concern.[4,5] Common farming hazards for children include animals, farming equipment, and falls.[4,6–10] Head and musculoskeletal injuries are commonly reported.[4,8,11] Previous studies have shown that children and adults living in rural areas are at higher risk of injury requiring medical treatment,[12,13] perhaps because of limited access to definitive health care, longer travel distances, different living environments, and different behavioral norms.[12] For Anabaptist families, the availability of health care may be further impaired by limited access to automobiles and telephones, the cost of care, and an unconventional perception of illness severity. Anabaptist individuals frequently perceived themselves as "ill" only when they are unable to complete routine farming tasks.[2]

The objective of this study was to analyze the epidemiology and spectrum of severe injuries occurring in rural children, both Anabaptist and non-Anabaptist, residing locally in the same rural region. Injury analyses of distinct communities, such as the Anabaptist population, are essential for the development of targeted injury prevention programs.

PATIENTS AND METHODS

The University of Western Ontario Ethics Review Board approved this study. The referral region of Southwestern Ontario consists of 10 counties (Gray, Bruce, Huron, Perth, Middlesex, Elgin, Oxford, Essex, Kent, and Lambton) and has a geographical area of ~19,000 km^2, with a pediatric population of ~500,000. The hospital databases and provin-

cial trauma registries of two Southwestern Ontario Trauma Centres (London Health Sciences Centre, London, ON, and Hotel Dieu Grace Hospital, Windsor, ON) were used to identify rural children (younger than 18 years) who presented with an injury severity score (ISS) ≥12 between 1997 and 2007. Anabaptists were recognized in the database through religious identification as "Mennonite" or "Amish" and through the absence of a provincial health insurance number. Rural localization of subjects was determined by mapping their home addresses or postal codes or both within a geographic information system (ArcGIS 9.2; Environmental Systems Research Institute, Redlands, CA) and comparing the locations against 2006 Canadian census data (Statistics Canada).[14] All data were checked for geographic accuracy. Rural areas were defined as areas with a minimum population concentration of <1,000 persons and a population density of <400 persons/km^2.

The data collected in the provincial trauma registries comprise the Comprehensive Data Set and is collected on all severely injured patients (ISS ≥12). The Comprehensive Data Set contains >400 data elements including patient demographics, prehospital care, hospital treatment, injury data, and patient outcomes. Dedicated injury data specialists with training in injury scoring analyze and enter all data. Data were verified upon entry and in subsequent data quality checks at each institution and provincially to ensure accuracy and completeness. Information extracted from the trauma databases for this study included demographics, address, postal code, use and misuse of protective gear or devices (i.e., seat belt, car seat, and helmet), injury information (mechanism, time, date, severity, and injury profile), and hospitalization data (i.e., length of stay, need for intensive care unit admission, and operative procedures). Data on complications and outcomes were also recorded. The Maximum Abbreviated Injury Scale score and ISS were calculated by trained trauma data analysts.[15–18]

The locations where injuries occurred were grouped into four categories: property (home or farm), road, recreation facility, and other locations (industry, public building, residential institution, and other unspecified locations). Causes of injury included the following: falls, animals, machinery, motor vehicle collisions (MVCs), pedestrian or bikes, buggy, other (including abuse, burns, drowning, assault, and sports), and recreational motorized vehicles (RMVs; including snowmobiles, all-terrain vehicles [ATVs], and dirt bikes).

Data were analyzed with Excel 12.1.0 (Microsoft, Redmond, WA) and SigmaStat 3.5 (Systat Software, Richmond, CA). All data sets were prescreened for normality. Data are presented as median values with an interquartile range (IQR), and direct comparisons were made with Mann-Whitney rank-sum tests. Percentages were used to describe categorical outcomes, and distributions of categorical data were compared with either a Pearson's χ^2 test or a Fisher's exact test. p values < 0.05 were considered statistically significant. An Institutional Statistician reviewed all analyses for appropriateness of selected tests and accuracy.

TABLE 1. Demographic Characteristics of Rural Children, Both Anabaptist and Non-Anabaptist (Matched for Location With Geographical Mapping)

	Anabaptist Children (n = 33)	Non-Anabaptist Children (n = 389)	p
Male:female	21 (63.6):12 (36.4)	284 (73.0):105 (27.0)	0.25
Age (yr)			
0–1	3 (9.1)	13 (3.3)	0.24
1–4	9 (27.3)	9 (9.3)	**<0.001**
5–9	8 (24.2)	59 (15.2)	0.26
10–15	11 (33.3)	147 (37.8)	0.75
16–17	2 (6.1)	134 (34.4)	**0.02**
Site of Injury			
Property	16 (48.5)	84 (21.6)	**<0.001**
Road	9 (27.3)	221 (56.8)	**0.002**
Other/unknown	7 (21.2)	59 (15.2)	0.50
Recreation facility	1 (3.0)	25 (6.4)	0.69
Season of injury			
Summer	14 (42.4)	136 (35.3)	0.50
Fall	9 (27.3)	92 (23.9)	0.80
Winter	6 (18.2)	79 (20.5)	0.95
Spring	4 (12.1)	78 (20.3)	0.38

Data presented as n (%).

RESULTS

A total of 422 children injured during a 10-year period in rural Southwestern Ontario met the inclusion criteria for this study. Demographic features of injured children are shown in Table 1. Anabaptist children comprised 7.8% of this injured rural population. The ratio of males to females was similar between Anabaptist and non-Anabaptist cohorts, with more males in both groups. Anabaptist children were significantly younger at the time of injury (median, 7 years; IQR = 10) when compared with non-Anabaptist children (median, 14 years; IQR = 7; $p < 0.001$).

The most common injury location for Anabaptist children was on their property (48.5%; $p < 0.001$) when compared with non-Anabaptist children who were more often injured on roads (56.8%; $p = 0.02$; Table 1). In subgroup analysis of injury location stratified by age, Anabaptist children aged 5 years to 15 years were more likely to be injured on farms than non-Anabaptist children ($p = 0.02$). The peak months for injuries were June and August for all rural children. The peak times of injuries were similar at 6 PM to 8 PM for Anabaptist children (29.6%) and 4 PM to 6 PM for non-Anabaptist children (19.7%). No injuries occurred in the Anabaptist group between midnight and 6 AM.

Injury mechanism data are shown in Table 2. The most common causes of injury among Anabaptist children were falls (24.2%; $p = 0.02$). When stratified by age, more 5-year to 15-year-old Anabaptist children were injured by falls than non-Anabaptists children (15.2% vs. 5.6%; $p = 0.04$). Other notable causes of injuries in Anabaptist children included MVCs (18.2%; $p = 0.02$), animals (15.2%; $p < 0.001$), and buggies (9.1%). No injuries in the Anabaptist population were caused by abuse, suicide, or assault. Among non-

TABLE 2. Mechanism of Injury

	Anabaptist Children	Non-Anabaptist Children	*p*
Falls	8 (24.2)	37 (9.5)	**0.02**
MVC	6 (18.2)	156 (40.1)	**0.02**
Other	5 (15.2)	57 (14.7)	1.00
Animals	5 (15.2)	10 (2.6)	**0.04**
Buggy	3 (9.1)	0 (0)	NA
Pedestrian/bike	3 (9.1)	44 (11.3)	NA
Machinery	2 (6.1)	11 (2.8)	NA
RMV	1 (3.0)	74 (19.0)	NA

NA, not assayed.
Data presented as n (%).

TABLE 3. Injury Severity Scores for Rural Children, Both Anabaptist and Non-Anabaptist (Matched for Location With Geographical Mapping)

	Anabaptist Children (n = 33)	Non-Anabaptist Children (n = 389)	*p*
ISS			
Median (IQR)	17 (11)	22 (13)	0.39
MAIS head/neck			
Number (%) injured	26 (78.8)	277 (71.2)	0.47
Median (IQR)	4 (1)	4 (2)	0.40
MAIS face			
Number (%) injured	6 (18.2)	82 (21.1)	0.87
Median (IQR)	2 (1)	2 (1)	0.24
MAIS chest			
Number (%) injured	6 (18.2)	170 (43.7)	**0.01**
Median (IQR)	4 (1)	3 (1)	0.16
MAIS abdomen			
Number (%) injured	5 (15.2)	147 (37.8)	**0.02**
Median (IQR)	4 (1.25)	3 (2)	0.65
MAIS extremity			
Number (%) injured	10 (30.3)	147 (37.8)	0.51
Median (IQR)	2 (1)	3 (1)	0.11
MAIS external			
Number (%) injured	16 (4.1)	202 (51.9)	0.10
Median (IQR)	1 (0)	1 (0)	**0.04**
≥1 Body area injured			
Number (%)	12 (36.4)	80 (20.6)	**0.047**

MAIS, Maximum Abbreviated Injury Score.
MAIS external includes burns, lacerations, abrasions, and contusions.

Anabaptist children, the most common causes of injury were MVCs (40.1%; $p = 0.015$). When stratified by age, MVC injuries among 16-year to 17-year olds were more prevalent among non-Anabaptist youth (n = 83 of 156, 53.2%) than Anabaptist youth (n = 1 of 6; 16.7%; $p = 0.18$); however, the difference was not statistically significant. Furthermore, the age-stratified analysis comparing the groups was limited by small sample size or did not reveal significant differences.

The injury profiles and severity of injury to each body region, as represented by the median Maximum Abbreviated Injury Scale scores, are listed in Table 3. Compared with the Anabaptist children, significantly more non-Anabaptist children sustained injuries to the chest (43.7%; $p = 0.01$) and abdomen (37.8%; $p = 0.02$). Significantly, more Anabaptist sustained trauma to multiple systems ($p = 0.047$). No statistically significant differences were noted between cohorts in ISS.

TABLE 4. Analyses of Protective Devices Used or Misused by Rural Children, Both Anabaptist and Non-Anabaptist (Matched for Location With Geographical Mapping)

	Anabaptist Children	Non-Anabaptist Children	*p*
MVC			
Seatbelt used	3 (50.0)	87 (55.8)	1.00
No seatbelt used	3 (50.0)	61 (39.1)	0.68
Incorrect car seat use	0 (0)	2 (1.3)	NA
Unreported	0 (0)	6 (3.8)	NA
Bicycle injury			
Helmet	0 (0)	3 (12.0)	NA
No helmet	2 (100)	18 (72.0)	NA
Unreported	0 (0)	4 (16.0)	NA
Overall protective device use			
Incidence—correct use	3 (37.5)	90 (52.6)	0.48
Incidence—incorrect/not used	5 (62.5)	81 (47.4)	0.48

NA, not assayed.
Data presented as n (%).

A summary of protective device data are shown in Table 4. Injuries were classified as potentially preventable through the correct use of seat belts or bike helmets in 46.5% of non-Anabaptist children and in 24.2% of Anabaptist children. Seat belts were unused or incorrectly used in 50.0% of MVCs involving Anabaptist children and 40.4% of non-Anabaptist children. Seventy-four non-Anabaptist children were injured using RMVs (i.e., ATVs, snowmobiles, motorcycles, and dirt bikes). Of these, 68.9% reported using a helmet, 5.4% wore helmets that fell off, and 23% did not use a helmet. Data were unavailable on two individuals. One Anabaptist was injured using a RMV without a helmet.

Analyses of admission and hospitalization data are shown in Table 5. Deaths in the emergency trauma room occurred in six (1.5%) non-Anabaptist children and two (6%) Anabaptist children. Intensive care unit admissions and lengths of stay were comparable among Anabaptist and non-Anabaptist children. Lengths of stay data were unavailable for five non-Anabaptist children and one Anabaptist child. More non-Anabaptist children (41.4%) underwent surgical interventions than Anabaptist children (21.2%; $p = 0.04$). The proportions of complications, comorbidities, and mortalities did not differ statistically between Anabaptist and non-Anabaptist children.

DISCUSSION

In this study, we analyzed injury data for rural children in Southwestern Ontario in comparison with Anabaptist and non-Anabaptist populations. Our data show that Anabaptist children are more likely to suffer severe injuries at a young age, occurring primarily on their property, and exhibit a unique spectrum of injury mechanisms. Given that injuries in this population generally occur at home or farm, injury

TABLE 5. Analysis of Hospitalization Data and Mortality for Rural Children, Both Anabaptist and Non-Anabaptist (Matched for Location With Geographical Mapping)

	Anabaptist Children	Non-Anabaptist Children	*p*
Hospital admission			
Number admitted (%)	31 (93.9)	383 (98.5)	0.25
Days: median (IQR)*	6 (6.5)	8 (10)	0.10
Intensive care unit admission			
Number admitted	24 (72.7)	272 (70.0)	0.89
Days: median (IQR)*	2 (3.25)	3 (5)	0.41
Operative procedures			
No. patients (%)	7 (21.2)	161 (41.4)	**0.04**
Procedure: median (IQR)	1 (0)	1 (0)	0.49
Complications			
Number (%)	9 (27.2)	111 (28.5)	0.96
Comorbidities			
Number (%)	14 (42.4)	174 (45.0)	0.94
Mortality			
No. deaths (%)	5 (15.2)	34 (8.7)	0.36

* Individuals who died were not included in the length of hospitalization calculations.

prevention at home should be emphasized. In contrast, non-Anabaptists are more likely to suffer injuries in adolescence, primarily on roads and in MVCs. This study reveals important data for developing targeted injury prevention programs and supports the need for injury prevention in the rural population given the relatively low use, and correct use, of protective devices.

Previous studies relating injuries to developmental age identify younger children as being at high risk for injury with their tendency to fall, place objects in their mouth, and explore independently.[19] Among Anabaptist children, there was a significantly younger median age at the time of injury compared with non-Anabaptist children with one-third of injuries occurring in children younger than 5 years. Injuries in this age group are often preventable (i.e., burns, falls, and animal-related injuries), suggesting that future injury prevention strategies in the Anabaptist population should emphasize safety to children in this age group, in addition to their parents and caregivers. Adolescent injuries in the Anabaptist population were remarkably low, with a significantly lower rate of MVC, the most common mechanism of injury in adolescence, and no intentional injuries caused by abuse, suicide, or assault.

In pediatric populations, it is typically the late adolescent age group that accounts for the majority of severe injuries.[20] Indeed, youth aged 10 years and older made up the majority of the non-Anabaptist injured population (72.2%), and older children were more likely to be injured in MVCs events largely associated with rapid deceleration and blunt trauma. This mechanism of injury could explain their significantly higher rates of chest and abdominal trauma and significantly greater rates of operative procedures.

Common injury mechanisms noted in our Anabaptist population were similar to mechanisms described in the literature.[3,6,7,21] Unique to the Anabaptist population, the horse and buggy is an important method of transportation, which contributed to 9.1% of injuries in this study. Motorized vehicles are important causes of buggy-related trauma, reinforcing that slow-moving vehicle signs, reflective tape for buggies and horses, and construction of wider rural roads might reduce the risk of collision.[21] In contrast, RMVs, such as ATVs, snowmobiles, and two-wheeled dirt bikes, were a cause of significant morbidity among non-Anabaptist children. ATVs, in particular, have been recognized as significant causes of severe injury,[22,23] especially in the rural population where these vehicles are used for both recreation and service. In Ontario, beyond legislation, which governs the use of ATVs, many stakeholders including the Canadian Pediatrics Society and the Consumer Product Safety Commission recommend that children younger than 16 years should not drive recreational vehicles because of the significant strength, coordination, and judgment required for their safe operation.[24–28] A recent position article from the Ontario Medical Association more conservatively states that children younger than 14 years are not allowed to operate ATVs.[28]

Anabaptist children were more frequently injured on their property, either house or farm, than any other location. Farms are known to be inherently dangerous because there are many opportunities for injury by machinery, animals, and through falls.[4,5,11] The North American Guidelines for Children's Agricultural Tasks have been developed to decrease childhood farming-related injuries by outlining appropriate farming tasks for a child's developmental stage.[29–31] The guidelines are developed for the population-at-large; however, it do not account for the cultural sensitivities of the Anabaptist population, their involvement in farm work at a young age, and their wish to preserve a traditional way of life. Farming injury prevention initiatives should be developed and introduced with the input of community elders.

In farming families, parental supervision of children can sometimes be difficult while concurrently attending to farming tasks.[32] However, previous research suggests that for young children, decreasing environmental risk may be more effective than increasing parental supervision.[33] Suggestions to minimize risk and reduce injury have included the introduction of passive barriers (i.e., fences) to contain play areas and separate children from potential hazards (i.e., hay stacks, water, barns, and animals).[9,32] The introduction of passive barriers may be an intervention that would not infringe on the Anabaptist way of life while reducing children's exposure to hazards.[9,32,34]

The use of protective devices is paramount for injury prevention in the entire rural population. MVCs were an important cause of trauma in both cohorts. Seat belt use in motor vehicles is mandatory by Ontario law. In a recent survey examining seat belt use in rural areas, seat belt usage rate in Ontario was 88.3%.[35] Despite these reported compliance rates, seat belts were not worn by approximately half of injured rural children in both cohorts, making unbelted children more likely to be severely injured when a crash occurs. There remains a need for further injury prevention programs targeting seat belt use among rural adolescents.

Numerous studies support the efficacy of helmet use to reduce the severity of injuries; however, helmet use among cyclists in the rural population as a whole was low. In a recent Cochrane systemic review, bicycle helmet use in children conferred an 88% and 65% risk reduction for head and facial injuries, respectively.[36] A statistically significant protective effect of helmets for head, brain, facial, and fatal injury was recently quantified in a meta-analysis providing clear evidence on the benefits of helmets for cyclists.[37] Multidisciplinary community campaigns may be effective in promoting bike helmet use and bike safety, particularly in those who resist helmet use.[38]

In the Southwestern Ontario, to our knowledge, there are no campaigns that focus directly on the Anabaptist population and take into consideration their unique culture and beliefs. Designated play areas for children, animal or machinery training, and correct use of protective equipment such as seat belts or helmets may significantly reduce injuries to Anabaptist children.[6,7,11] Future research is needed to analyze what Anabaptist-specific safety measures (i.e., seat belts in buggies) may be effective in reducing injuries while being amenable to Anabaptist community members. The development of successful injury prevention programs for Anabaptist children requires collaboration with the Anabaptist community and elders to ensure that all initiatives respect their culture and lifestyle.

This study has potential limitations. First, it is possible that some children, despite the severity of their injuries (ISS $\geq$12), were not brought to hospital out of concern of treatment cost, and we were unable to include these patients. Second, the provincial coroner's data do not identify religion, cultural affiliation, or provincial health insurance status in their database, and hence we could not identify Anabaptist children that died before arrival to hospital. Third, the small sample size in some subgroup analyses may have limited our power to detect a difference between our two cohorts. Fourth, the non-Anabaptist cohort is likely quite heterogeneous relative to the Anabaptist population; however, we were unable to reliably identify other culturally distinct groups in our rural area for comparison. Fifth, the Anabaptist population is culturally distinct from other rural populations; thus, conclusions drawn from the injury analyses of the Anabaptist group cannot be applicable to rural populations at large. Finally, we are unable to analyze the incidence of injuries within the Anabaptist cohort as the provincial consensus data do not report total Anabaptist population. These limitations highlight the need for methodological enhancements to administrative health databases to facilitate the study of unique populations. Despite these limitations, this study emphasizes the importance of understanding the injury epidemiology of distinct groups and is applicable to other Old-Order Anabaptist populations found in the United States (Indiana, Ohio, Kansas, Pennsylvania, and Virginia). It also provides important injury analyses on the general rural population.

CONCLUSIONS

Our data suggest significant differences in injuries between two rural cohorts that could help target injury prevention programs. Injury prevention targeted to younger Anabaptist children and adolescent non-Anabaptist youth may help to reduce severe injuries in these populations. Furthermore, the low use of protective devices among all rural children reinforces the need for focused initiatives to increase their use among rural children. Collaboration with the Anabaptist community is needed to best address injury prevention in this distinct community and create solutions that increase safety without infringing upon their culture and way of life.

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ERRATA

Elderly Hip Fracture Patients Admitted to the Trauma Service: Does it Impact Patient Outcome?: Erratum

In the article that appeared on pages 1348–1352 in volume 63, number 6, an author's name was listed without a middle initial. The author has requested his middle initial be added. The corrected list of authors is as follows: Melvin E. Stone Jr., MD, FACS, Casey Barbaro, BS, Castigliano M. Bhamidipati, MD, Janet Cucuzzo, RN, MSN, and Ronald Simon, MD, FACS.

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Stone Jr. ME, Barbaro C, Bhamidipati C, Cucuzzo J, Simon R. Elderly Hip Fracture Patients Admitted to the Trauma Service: Does it Impact Patient Outcome? *J Trauma.* 2007;63:1348–1352.

Injury Patterns and Psychological Traits of Patients With Self-Inflicted Wounds Produced by Punching Glass: Erratum

In an article that appeared on pages 691–693 in volume 69, number 3, the authors' names were listed in transposed order. The authors should have been listed as: Ahmet Sönmez, MD, Kaan Kora, MD, Nurdan Öztürk, MD, Burak Ersoy, MD, Memduha Aydın, MD and Ayhan Numanoğlu, MD.

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