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Temporal trends in the management of metacarpal and phalangeal fractures in the 21st century: an analysis of Australian population-based data

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Abstract

Background: Fractures of the hand, specifically the metacarpals and phalanges, are a common injury. Whilst many of these fractures can be treated non-operatively, a number of advances have led to the increase in popularity of surgical intervention. The aim of this study was to assess and describe trends in management of phalangeal and metacarpal fractures in Australia over the last two decades.

Methods: A review was conducted of the Medicare Benefits Scheme (MBS), specifically querying the item numbers pertaining to the management of metacarpal and phalanx fractures. Data was recorded as the incidence per 100 000 patients.

Results: Overall, there was a statistically significant decrease in the incidence of closed reduction of metacarpal and phalanx fractures, with a converse statistically significant increase in open reduction internal fixation.

Conclusion: This study demonstrates that over the last 20 years, there has been a decrease in closed reduction of intra- and extra-articular phalangeal and metacarpal fractures, with a converse but smaller increase in open reduction and fixation. These trends are likely multifactorial in aetiology, and should be monitored to guide resource allocation and health provision in the future.

Introduction

Hand fractures are common injuries, accounting for up to one third of all fractures presenting to emergency departments.[1,2] The vast majority (more than 90 %) of these injuries involve the metacarpals and phalanges, posing a significant financial and health burden to both the individual and the community[2,3] Thus, appropriate and timely management is key.

Although many of these fractures can be treated non-operatively, factors such as patient characteristics, the mechanism of injury and fracture configuration may mandate surgical intervention. There have been a number of surgical advances in the management of metacarpal and phalangeal fractures since the turn of the century, including minimally invasive approaches that aim to diminish soft tissue disruption, the development of lower profile plating systems and a focus on immediate postoperative mobilization.[4–7] However, little information is available on the changes in outcome and practice rendered by these developments.

The aim of this study is to assess and describe trends in management of phalangeal and metacarpal fractures in Australia over the last two decades.

Methods

This epidemiological study was performed utilizing data obtained from the Australian Government Department of Health Medicare Benefits Schedule (MBS) registry. The MBS comprises a list of services from which eligible patients can receive publicly funded subsidies toward the cost of medical services, under which the vast majority of surgical procedures are performed.

In January of 2021, the number of services claimed per calendar year over the 20 year period from January 2000 to October 2020

was calculated by querying the MBS item reports for all item numbers related to the management of metacarpal and phalangeal fractures. The MBS schedule underwent changes to the item numbers following a review in 2015. To incorporate this change, data was assessed for a combined cohort of metacarpals and phalanges, and grouped into either closed or open management of intra- or extra-articular fractures respectively. To allow cohesion and simplicity, mallet fractures were incorporated into the intra-articular group as opposed to being assessed as a separate disease entity; similarly, closed reduction with percutaneous pinning was included in the closed reduction group.

Data was calculated as rates of service per 100 000 people to allow for changes in population. Trends were assessed using all-age national averages, as well as stratified by age and sex. These longitudinal service utilization patterns were correlated and quantified using Spearman's rho (r), with alpha set at 0.05. Least squares analysis was used to identify the coefficient of linear regression. All statistical analysis was performed on MiniTab Express (Pennsylvania, USA). Institutional ethics approval was not required given that the collected data is publicly available, with no direct participant involvement.

Results

Population adjusted MBS data revealed a statistically significant decrease in the rates of closed reduction of extra-articular phalangeal and metacarpal fractures during the 20 year period of interest (refer Fig. 1; male: b (coefficient) $= -4.8$ (cases per 100 000 people), $r = -0.99$, $p < 0.0001$/female: b (coefficient) $= -1.7$ (cases per 100 000 people), $r = -0.97$, $p < 0.0001$). A similar decrease was seen in the rates of closed reduction of intra-articular phalangeal and metacarpal fractures (refer Fig. 2; male: b (coefficient) $= -0.44$ (cases per 100 000 people), $r = -0.96$, $p < 0.0001$/female: b (coefficient) $= -0.2$ (cases per 100 000 people), $r = -0.76$, $p < 0.0001$). This trend was consistent across both sexes and all age groups (refer Table 1).

A converse statistically significant increase in open reduction of intra-articular (male: b (coefficient) $= 0.14$ (cases per 100 000 people), $r = 0.66$, $p = 0.0001$/female: b (coefficient) $= 0.15$ (cases per 100 000 people), $r = 0.90$, $p < 0.0001$) and extra-articular (male: b (coefficient) $= 0.14$ (cases per 100 000 people), $r = 0.61$, $p = 0.0004$/female: b (coefficient) $= 0.07$ (cases per 100 000 people), $r = 0.72$, $p < 0.0001$) metacarpal and phalangeal fractures was seen (refer Figs. 3 and 4). Again, this trend was consistent across both sexes and all age groups (refer Table 1). Service provision for males was generally higher than for females across all age groups, until the age of 65 and over.

Discussion

Phalangeal and metacarpal fractures are common, accounting for between 10% and 30 % of all fractures presenting to emergency departments[12] Van Onselen reported that 19% of fracture presentations to the largest level one trauma centre in The Netherlands involved the hand, with metacarpal and phalangeal injuries comprising greater than 90 % of these.[2] This distribution is similar to other contemporary epidemiological reports from around the world.[3,8,9] All studies agree that the majority of the injuries occur in young males, with Van Onselen reporting that the incidence for men was higher than that of women until the sixth decade of life.[2] Economic analyses indicate that that these injuries pose a significant burden to both the individual and society.[3] de Putter assessed all patients treated through emergency departments in The Netherlands in 2007, and found that hand and wrist injuries incurred a greater financial burden due to lost productivity and health care costs than any other ($740 million).[3] Within the umbrella of hand and wrist injuries, hand and finger fractures were the most expensive sub-group and contributed to almost half of lost productivity, due to lengthier rehabilitation required when compared to more frequent injuries (such as lacerations) and the high proportion manifested in the working population.[3] Thus, appropriate management and early return to function are vital.

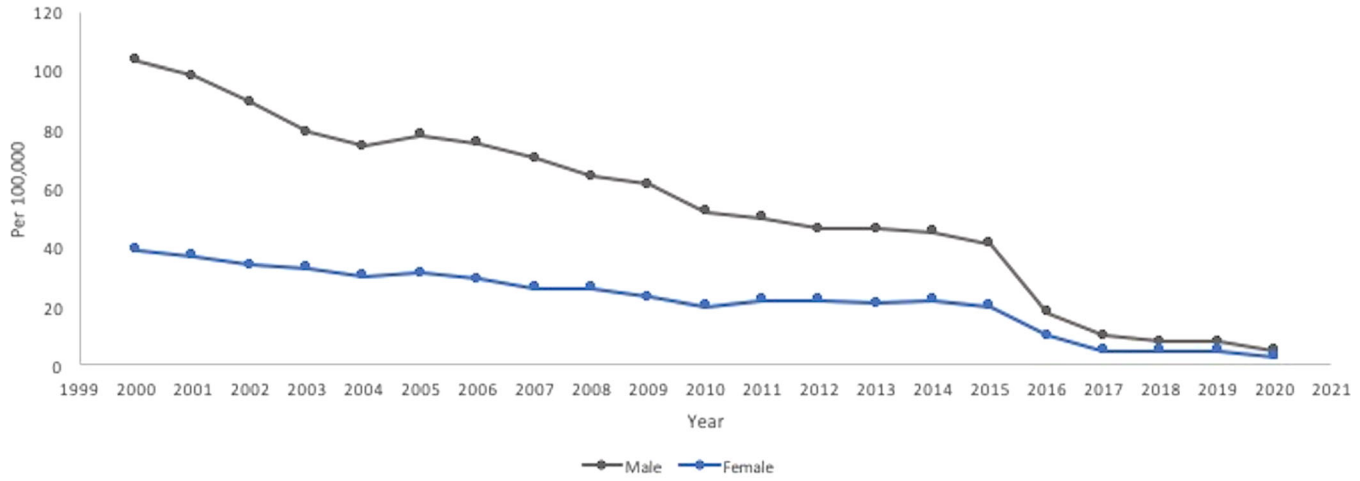

Fig. 1. Rate of closed reduction of extra-articular metacarpal and phalangeal fractures per 100 000 population.

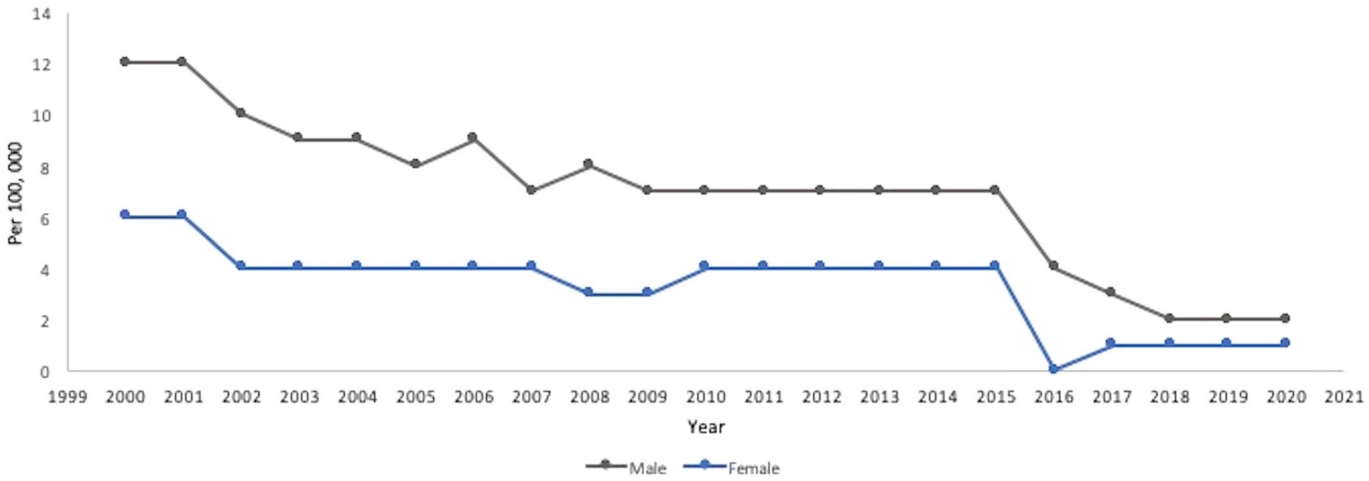

Fig. 2. Rate of closed reduction of intra-articular phalangeal and metacarpal fractures per 100 000 population.

It has long been recognized that early mobilization following phalangeal and metacarpal fractures is important in minimizing permanent stiffness, recovering strength and facilitating an earlier return to function.[10] This must be balanced against the risks of overly aggressive attempts of internal fixation, potentially resulting in soft tissue damage, tendon adhesions, infection and the need for future implant removal. Although stable fractures may be managed non-operatively, instability or patient preference may dictate intervention with a view to early mobilization. Reports from the late twentieth century detailed the increasing popularity of operative fixation of hand fractures, which may be due to due to improved implants and instrumentation, greater understanding of the biomechanical principles of internal fixation, more demanding public expectations, advancements in imaging and anaesthetic modalities, and the advent of specialized hand therapists and surgeons.[10]

Attitudes toward operative fixation of metacarpal and phalangeal fractures have changed further since the turn of the twentieth century, following greater biomechanical and outcome analysis, the evolution of hand fracture fixation systems, and renewed interest in alternate surgical approaches. It is now well accepted that rigid fixation constructs confer significantly improved outcomes when compared to non-rigid constructs, as they facilitate precise alignment and earlier mobilization.[4,11,12] Biomechanical and clinical studies utilizing comminuted phalangeal models indicate that open reduction with plate fixation affords superior stability when compared to closed reduction and k-wire stabilization.[13–15] Lower profile and variable angle locking plates (which preserve periosteal vascularity whilst evenly distributing load across all screws) have further improved outcomes.[16] Alternative surgical approaches (such as the dorsolateral and mid-axial approaches) with lateral or dorsolateral plate positioning, as well as novel fixation concepts (including the use of intramedullary compression screw fixation for a range of fracture configurations), aim to minimize the soft tissue disruption that increases post-operative scarring and reduces range of motion and satisfaction.[4,5,17,18]

There is little evidence on the temporal changes in management of phalangeal and metacarpal fractures in the last two decades. This study provides a contemporary analysis of surgical preference for these injuries in Australia, adjusted for population, and finds a significant decrease in the rate of closed reduction (without or without percutaneous fixation), with a reciprocal but milder increase in open reduction and internal fixation. It concurs with the previous literature in that the majority of service provisions for these injuries occurred in young males. This may be due to the risk of injury conferred through manual labour—the vast majority of which is performed by males—as well as the male predilection for violent social and sporting endeavours. The increase in service provision for females following the fifth decade of life may be contributed to by greater bone fragility post-menopause.

Despite the advances in approach and hardware, it is important to remember that the majority of these fractures are stable and can be managed non-operatively.[10,19] It is interesting to note the reduction in closed reduction of extra-articular phalangeal and metacarpal fractures by 95% in males and 92% in females over the 20 year period——a change which was not offset by the increase in open reduction of these injuries in the same timeframe. This reduction may be due to changes in patient presentation (with improving safety practices and knowledge decreasing rates of injury); alterations in surgical preference (as a generation of surgeons train with widespread access to locking plate technology); and greater acceptance that mild radiographic deformity does not necessarily correspond to impaired patient outcomes or function, particularly in the metacarpal. An abrupt decrease in closed reduction of both intra- and extra-articular fractures was noted from 2015 onward. This may be due to the aforementioned coding changes; an increase in closed reduction of these fractures in an outpatient setting (although there is no evidence to suggest this); or an acceleration of the established trend.

This study has limitations. MBS data is reflective only of operations performed on private patients (either in the public or private systems), as public operations are funded in Australia by the state governments, with block reimbursement from the federal government based of historical activity levels. Thus, public operations and those covered by alternate insurance schemes (worker's compensation, *etc*.) are not captured. However, the proportion of the Australian population with private health insurance has remained

Table 1 Percent change in service provision stratified by sex and age

CR-extra-articular					CR-intra-articular				ORIF-extra-articular				ORIF-intra-articular			
FEMALE		% Change compared to last 5 year period	MALE	% Change compared to last 5 year period	FEMALE	% Change compared to last 5 year period	MALE	% Change compared to last 5 year period	FEMALE	% Change compared to last 5 year period	MALE	% Change compared to last 5 year period	FEMALE	% Change compared to last 5 year period	MALE	% Change compared to last 5 year period
2000	39		2000 103		2000	6	2000	12	2000	2	2000	5	2000	1	2000	6
2001	37		2001	98	2001	6	2001	12	2001	2	2001	7	2001	1	2001	6
2002	34		2002	89	2002	4	2002	10	2002	1	2002	6	2002	1	2002	6
2003	33		2003	79	2003	4	2003	9	2003	2	2003	4	2003	1	2003	6
2004	30	-	2004	74 -	2004	4	- 2004	9 -	2004	2	- 2004	6 -	2004	1	- 2004	6 -
2005	31		2005	78	2005	4	2005	8	2005	2	2005	7	2005	1	2005	7
2006	29		2006	75	2006	4	2006	9	2006	2	2006	6	2006	1	2006	6
2007	26		2007	70	2007	4	2007	7	2007	2	2007	7	2007	1	2007	8
2008	26		2008	64	2008	3	2008	8	2008	2	2008	8	2008	1	2008	8
2009	23	−22%	2009	61 −21%	2009	3	−25% 2009	7 −25%	2009	2	11% 2009	9 32%	2009	2	20% 2009	9 27%
2010	20		2010	52	2010	4	2010	7	2010	2	2010	9	2010	2	2010	7
2011	22		2011	50	2011	4	2011	7	2011	2	2011	7	2011	1	2011	9
2012	22		2012	46	2012	4	2012	7	2012	2	2012	8	2012	2	2012	8
2013	21		2013	46	2013	4	2013	7	2013	2	2013	9	2013	2	2013	8
2014	22	−21%	2014	45 −31%	2014	4	11% 2014	7 −10%	2014	2	0% 2014	8 11%	2014	2	50% 2014	9 8%
2015	20		2015	41	2015	4	2015	7	2015	2	2015	6	2015	2	2015	8
2016	10		2016	18	2016	0	2016	4	2016	3	2016	7	2016	3	2016	8
2017	5		2017	10	2017	1	2017	3	2017	3	2017	8	2017	3	2017	9
2018	5		2018	8	2018	1	2018	2	2018	3	2018	8	2018	4	2018	10
2019	5	−58%	2019	8 −64%	2019	1	−65% 2019	2 −49%	2019	4	50% 2019	9 −7%	2019	5	89% 2019	9 7%
2020	3	-	2020	5 -	2020	1	- 2020	2 -	2		-	-	2020	3	- 2020	6 -

Abbreviations: CR, closed reduction; ORIF, open reduction internal fixation.

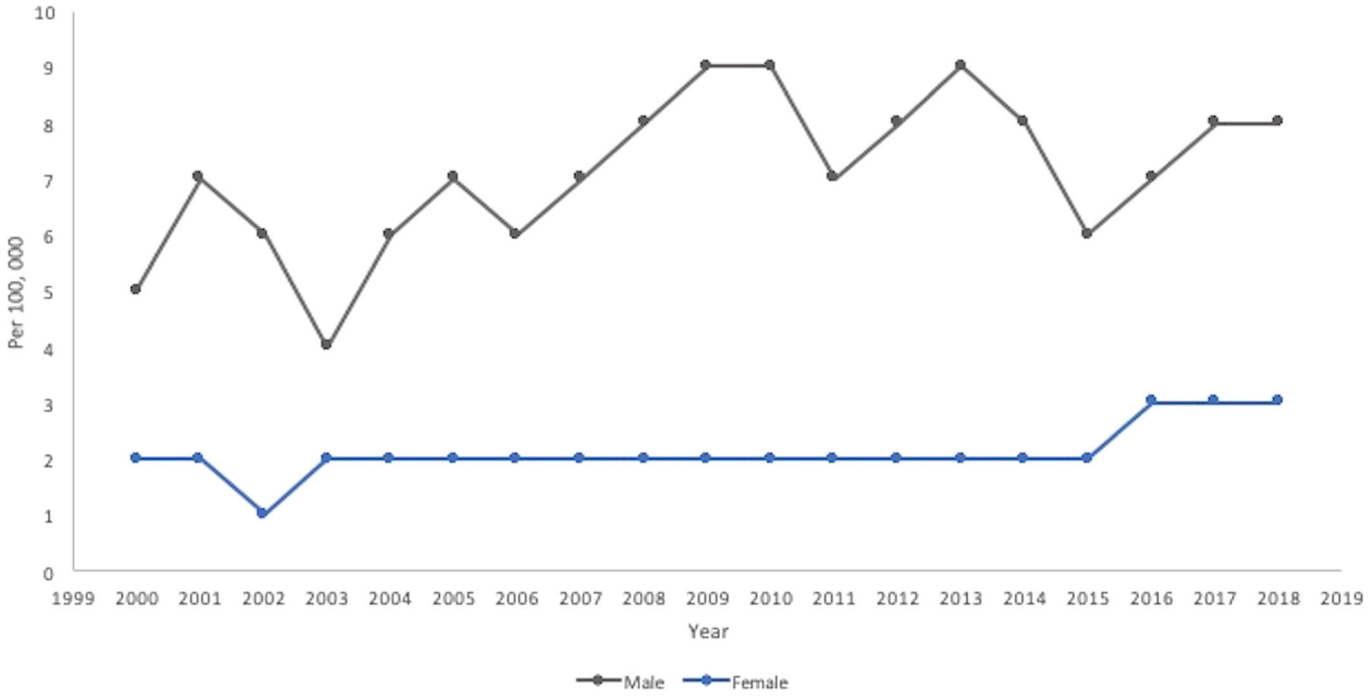

Fig. 3. Rate of open reduction of extra-articular metacarpal and phalangeal fractures per 100 000 population.

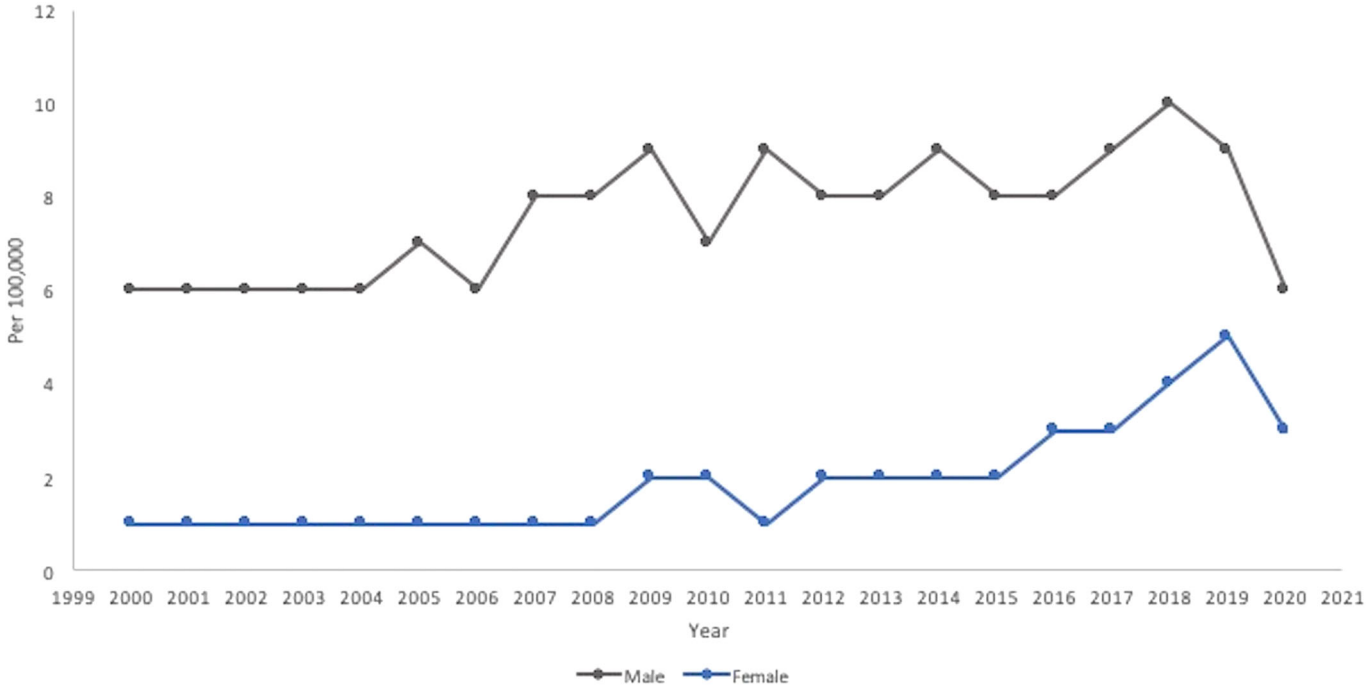

Fig. 4. Rate of open reduction of intra-articular metacarpal and phalangeal fractures per 100 000 population.

largely stable over the last two decades (at roughly 45%), and thus these trends may be extrapolated to the entire population.[20] Further, the organization of item numbers in the MBS does not allow for comprehensive sub-analysis—for example, there is no delineation between adult and paediatric fractures of the hand. The data is not provided in a manner permitting multiple regression analysis to determine the strength of the relationship between time and change in item numbers. However, simple regressional analysis was able to be performed to approximate the changes over time in management. Alterations in the MBS schedule in 2015 also resulted in changes

to item numbers. Certain new techniques (such as intramedullary screw fixation) are not adequately captured within the schedule. Additionally, it is possible that trends in billed item numbers do not reflect changes in operative management, but provide a snapshot into unethical billing practices, with surgeons utilizing inappropriate item numbers which yield greater renumeration.

Despite these limitations, the trends witnessed are significant, and noted regardless of age or sex. Further evaluation of hand fracture prevalence and distribution in an Australian population, to assess injury incidence and rates of operative intervention, would be useful, as would comparison to trends from other nations.

Conclusion

This study demonstrates that over the last 20 years, there has been an increase in open reduction and fixation of phalanx and metacarpal fractures, with a converse decrease in closed reduction. Although the data in this study is limited due to inherent limitations of the MBS registry itself, as well as changes in the MBS schedule, the trends noted provide information that can be used to guide resource allocation and health provision in the future. A comparison to similar data from other nations would be useful.

Conflicts of interest

None declared.

Informed consent

As this study was a registry study, there was no requirement for informed consent, or human or animal rights considerations. No funding was obtained for this study.

Author contributions

Brahman S. Sivakumar: Conceptualization; investigation; methodology; project administration; resources; supervision; writing – original draft; writing – review and editing. **Vincent VG An:** Data curation; formal analysis; investigation; writing – review and editing. **Michael Symes:** Conceptualization; investigation; methodology; writing – original draft; writing – review and editing. **David Graham:** Investigation; supervision; writing – review and editing. **Richard Lawson:** Investigation; resources; supervision; writing – review and editing. **Elizabeth Clarke:** Investigation; project administration; supervision; writing – review and editing.

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