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Anna M. Girardi * , David N Long , Gavin Austin

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"You Can Be as Vigilant as You Can, Yet They Make Their Way in": A Descriptive Study of Parent and Caregiver Perspectives towards Button Battery Safety

Anna Girardi [1,2,*], David Long [1,2] and Gavin Austin [2]

[1] School of Health and Medical Sciences, University of Southern Queensland, Ipswich, QLD, 4305, Australia
[2] Centre for Health Research, University of Southern Queensland, Toowoomba, QLD, 4350, Australia
* Correspondence: anna.girardi@unisq.edu.au; Tel. +61 7 3812 6421

Abstract: Button batteries pose a significant threat to young children and are found in many household items and children's toys. Along with product manufacturers and retailers, parents and caregivers have a role in button battery ingestion prevention through vigilance regarding items containing button batteries in the home, and knowledge of button battery ingestion symptoms. There is limited information available about parent and caregiver perspectives towards button battery safety. Identifying the areas where increased education is required is important for informing safety campaigns and delivering targeted education. This study aimed to examine parent and caregiver elemental perspectives on button battery safety. One-hundred and seventy-four parents and caregivers of children aged 0 to 5 completed a cross-sectional online survey. Distribution occurred via social media. The survey contained multiple-choice questions pertaining to button battery perspectives, and one open-ended question. Respondents recognized the dangers of button battery ingestion, yet only 37% reported being familiar with button battery ingestion symptoms. While 68% knew of household items containing button batteries, only 21% were aware of product recall information sources. Approximately 64% understood immediate post-ingestion steps and 17% found current safety labels unsatisfactory. In an open-ended question, parents and caregivers provided comments about button battery safety that revealed five broad themes; supervision and education; safe storage of button batteries in the home; ensuring children cannot access button batteries; disposing of button batteries safely; and avoiding purchasing items containing button batteries. This study provides a foundation for ongoing investigation of parent and caregiver perspectives on button battery home safety.

Keywords: caregiver; ingestion injury; children; prevention; button batteries

1. Introduction

Button batteries pose a considerable risk to young children, with the most frequent cases of ingestion-related injuries occurring in those aged 6 and under [1]. Due to their small size, button batteries are widely used in household items and children's toys, making them easily accessible. When ingested, button batteries can become lodged in the esophagus, leading to significant mucosal damage within hours [1]. Injury occurs through generation of hydroxide ions through a chemical reaction known as hydrolysis, which results in breakdown of tissue [1]. This can lead to diffuse injury to the alimentary tract, resulting in long-term issues with swallowing and oral intake [2,3]. Severe complications of button battery ingestion injury may include esophageal perforation, strictures, vocal cord paralysis, spinal erosion, fistula formation, and, in extreme cases, death [4,5].

Button battery exposures are a significant problem in Australia. Approximately one child per month is seriously injured after swallowing a button battery [6], while three Australian children have died from button battery ingestion injury since 2013. Poisons Information Centre data from four Australian states reported 506 calls for pediatric button battery exposure, or suspected exposure, in a 19-month period [7]. Consequently, there have been calls for increased consumer awareness regarding the dangers of button batteries.

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In 2021, 1,023 Australian adults aged 18-70+ were surveyed to understand the general awareness of button battery health risks and current behavior with respect to replacement and disposal of used button batteries [8] . The study found low levels of understanding of safe button battery storage, with just over half reporting they store button batteries in a secure container. Parents, caregivers and health professionals were identified target groups of awareness campaigns arising from the research. Understanding parent and caregiver perspectives on this issue is important so that ongoing awareness can be targeted and relevant. In addition, parents and caregivers have a vested interest in protecting their children, especially as they make consumer decisions about the purchase of household items and toys. In the same vein, over a decade ago, Carr et al. [9] conducted a survey of 557 parents in the United States to measure parental awareness of button battery danger. More than two thirds of parents felt that button batteries pose a high level of danger, and there have been significant efforts to raise awareness and change consumer behavior. In Australia, mandatory standards introduced in June 2022 required warning labels and strict manufacturing guidelines around button battery access, including secure battery compartments [6]. However, there remain products that do not comply with legislation, meaning consumers need to be vigilant against unsafe products, and aware of button battery dangers.

This study aimed to identify Australian parent and caregiver elemental perspectives about button batteries and safety in the home. Identified knowledge gaps can then be used to inform ongoing parent and caregiver-targeted education and awareness campaigns. Importantly, we acknowledge that this study is a foundational beginning to an ongoing enquiry on parent and caregiver perspectives, rather than being a definitive work. Consequently, the findings of this study can be applied as general concepts for future research endeavors to elicit a more granular understanding of button battery safety in the home.

2. Materials and Methods

A survey that contained 20 questions (19 multiple choice questions, and one open-ended question) was developed for this research. The multiple-choice questions had three options: 'No', 'Uncertain', and 'Yes'. Preliminary pilot testing was undertaken by administering the survey to a small representative sample of the target population and revised prior to dissemination. The items were presented in random order, with the open-ended question always appearing last. Parents and caregivers (defined as those who care for a child at least once per week) of children aged 0 to 5 years were invited to complete the survey online anonymously via the University of Southern Queensland Survey Tool. The survey was available from June to August 2023. Recruitment was via social media and online forums. The invitation to participate included the participant information sheet and a survey link. Respondents indicated their informed consent by checking a box prior to commencing the survey. A total of 231 respondents started the survey; of these, 174 completed all questions, and were thus included in the analysis. Ethics approval was provided by the University of Southern Queensland Human Research Ethics Committee (HREC Project ID: ETH2023-0322).

During survey development, we accepted the limitations of our validation processes, particularly with respect to internal consistency and content validity. The survey was designed primarily as a tentative tool to provide insights into parent and caregiver perceptions of button battery safety where a paucity of information exists.

3. Results

Demographic Characteristics

Responses were collected from all Australian states and territories. Respondents were predominantly located in Queensland (n = 88, 51%), followed by Western Australia (n = 24, 14%), Victoria (n = 24, 14%), and New South Wales (n = 19, 11%). They predominantly lived in major/metropolitan areas (n = 116, 67%). Most respondents identified as female (n = 147, 88%). A wide range of ages was represented (range = 21-66 years, M = 37.2, SD = 6.3). Equal numbers of respondents worked full-time, and part-time, with both groups containing 65 individuals (38%). Most respondents

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had completed a bachelor's degree (*n* = 67, 39%) or postgraduate qualification (*n* = 67, 39%), had a family income of $150,000AUD per year or over (*n* = 96, 55%), and had either one child (*n* = 76, 44%) or two children (*n* = 84, 48%).

Multiple-Choice Responses

Most respondents reported knowing that a 'dead' or 'flat' battery can still cause damage if swallowed (*n* = 172, 99%), and that 'swallowing a button battery can be fatal' (*n* = 170, 98%). While only 37% (*n* = 65) of parents and caregivers reported that they were familiar with the symptoms of button battery ingestion, two thirds reported knowing that difficulty eating is a symptom (*n* = 118, 68%), while approximately half reported knowing that coughing (*n* = 95, 55%) and drooling (*n* = 92, 53%) are symptoms. Sixty-eight percent of respondents reported knowing which household products contain button batteries (*n* = 118); however, only 21% (*n* = 37) of respondents reported knowing where to access information about button battery product recalls.

Over two thirds of respondents reported knowing what to do if they suspected their child had swallowed a button battery (*n* = 111, 64%); however, a smaller proportion reported being familiar with first-aid management (*n* = 54, 31%). Over half of respondents reported knowing how to dispose of button batteries safely (*n* = 98, 56%).

Nearly all respondents were of the view that button battery ingestion requires urgent medical attention (*n* = 172, 99%), and that supervision is vital when children are playing with toys containing button batteries (*n* = 166, 95%). A large proportion of respondents reported considering button battery safety when they purchase toys (*n* = 135, 78%). Just over half of respondents reported that a child in their care could not access a button battery (*n* = 100, 57%). When asked if button batteries should be banned in Australia, 55% (*n* = 95) answered 'yes'. Similarly, just over half (*n* = 93, 53%) felt that items containing button batteries should not be purchased by caregivers of children aged five years and below. Almost one in five respondents felt that there is adequate safety labelling on items containing button batteries (*n* = 30, 17%), while 11% (*n* = 20) reported that retailers are doing all they can to prevent children accessing button batteries. See Figure 1.

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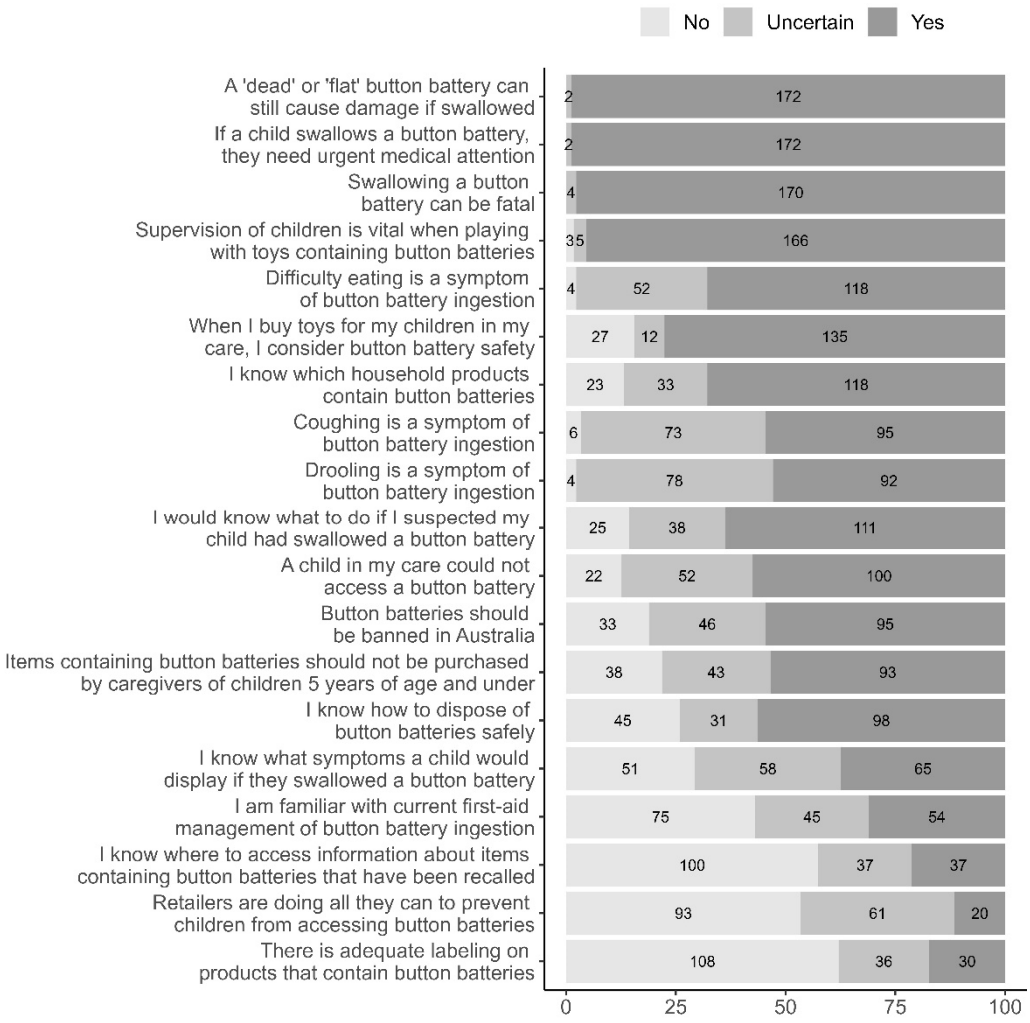

Figure 1. Button battery survey questions and responses (%, n = 174).

Open-Ended Responses

Parents and caregivers' comments included five broad themes: supervision and education; safe storage of button batteries in the home; ensuring children cannot access button batteries; disposing of button batteries safely; and avoiding purchasing items containing button batteries. One parent highlighted the importance of supervision stating directly *"…be proactive in supervision" [Participant R5],* whilst another parent/caregiver advocated for education in preventing button battery ingestions, *"I do not buy any toys that require button batteries either and we have taught our boys not to put anything in their mouth that isn't food or water" [Participant R12].* By extension, other participants called for increased community education for consumers about the dangers of button batteries: *"Increased community education about the health and safety risks button batteries (and products containing them) pose to children (and/or individuals across the lifespan with cognitive differences that result in reduced safety awareness)" [Participant R25].*

The safe storage of button batteries in the home was clearly an issue for some participants, "Ensure button batteries are kept out of reach from little ones, as high as possible and kept in a storage container that needs the pushdown and screw so little ones can't access them" [Participant R10] and perhaps of greater concern, was ensuring children cannot access button batteries, "If any items do [have button batteries] they should only be accessible by a screwdriver" [Participant R14]. Participants were also aware of the importance of disposal, "Flat batteries should be immediately disposed of by wrapping in tape"[Participant R40]. Finally, some respondents recommended simply avoiding purchasing products that contain button batteries. For example, "The best approach is to look for products that do not use button batteries, if you have products that use them, they need to

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be secured well and preferably placed up high out of a child's reach" [Participant R40]. However, another participant qualified their remarks by highlighting the challenge of having to use products that contain button batteries when alternatives are not available, saying, **"**My husband has hearing aids so we have no choice to hold button batteries in our household until he can get the new rechargeable hearing aids**"** [Participant R12].

Discussion

This survey aimed to further our understanding of parent and caregiver perspectives of button battery safety and was designed to be a foundational study that may precede more granular investigation into parent and caregiver perspectives on button battery safety. The results are discussed in themes for clarity.

Button Battery Ingestion Symptomology & Management

Our results indicate that parents and caregivers have a high level of awareness regarding the potential dangers of button batteries, as indicated by their knowledge of the potential symptomology and outcomes post-ingestion. This may be a product of effective Australian button battery awareness campaigns, and media coverage of severe cases, particularly in Queensland where multiple ingestion incidents have occurred that have received significant media attention. Parents and caregivers demonstrated moderate knowledge of button battery ingestion symptoms. A challenge associated with button battery ingestion identification is the ubiquitous nature of the symptoms, and the similarity of button battery ingestion symptoms to those of common aerodigestive conditions [10]. This presents a clinical challenge, as well as makes it difficult for parents and caregivers to identify potential button battery ingestion in their children. It is important to acknowledge the survey asked parents to identify three button battery ingestion symptoms, coughing, drooling or difficulty eating, and to declare whether they feel they would be able to recognize the symptoms of button battery ingestion in their child. There is potential to further explore symptom recognition within this cohort through open-ended questioning. It is also not known how accurate symptom recognition translate to prevention within this population.

Over two thirds of respondents reported knowing what to do if they suspected their child had swallowed a button battery; however, a smaller proportion reported being familiar with first-aid management of button battery ingestion. This aligns with prior research [9], which reported that most parents' and caregivers would take immediate action if they suspected button battery ingestion. An acknowledged limitation of this question is that button battery 'first-aid' may be ambiguous to the respondent. Future iterations should include specific button battery management options in the response options. Albeit, given injury can occur within two hours [1], prompt identification and management of button battery ingestions is paramount.

Product Disposal

While most respondents were aware that a 'dead' or 'flat' button battery could cause damage, only half knew how to dispose of one safely. Safe button battery disposal is important, given that a flat battery can still have sufficient residual charge to generate hydroxide ions and cause severe tissue damage [11]. Prior research has reported that ingestion of loose or discarded batteries accounts for approximately 30% of button battery ingestion cases [1]. Taping of button batteries prior to disposal has been found to be an effective preventative measure [11]. In Australia, the Button Battery Stewardship Council [12] seeks to increase battery collections and recycling, which is an important factor in button battery safety. Ongoing efforts to educate parents and caregivers about appropriate disposal techniques and facilities is an important prevention technique.

Products Containing Button Batteries

Most respondents reported knowing which household products contain button batteries, however of concern is that only a small proportion of respondents knew where to access information

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about button battery device recalls. To date, 179 button battery devices have been recalled in Australia, and 40 of these are from 2023 [13]. In December 2020, the Australian Government made mandatory safety and information standards for button batteries, which dictate that products must have secure battery compartments, undergo compliance testing, have child-resistant packaging, and carry warnings [6]. However, despite product surveillance and enforcement by regulators, products continue to be sold that pose a danger to young children.

Supervision & Purchasing Decisions

Respondents reported that supervision is vital when children are playing with toys containing button batteries, and that they consider button battery safety when they buy toys for their children. Supervision is also highlighted as a major injury prevention strategy used by parents to mitigate the risk of childhood injury [14]. Although, supervision can be subjective and varied, therefore it is not clear what parents perceived supervision to be in this instance.

Heightened vigilance regarding purchasing toys is a promising finding, especially as Cairns et al. [7] reported over a quarter of button battery exposures were from toys. However, toys are not the only source of button batteries in the home. A smaller proportion reported items containing button batteries should not be purchased by parents and caregivers of young children. Button batteries are difficult to avoid in the home, so, until an alternative is available, parent and caregiver awareness is paramount.

Manufacturer and Retailer Responsibility

A small proportion of respondents reported they felt that safety labelling and retailer prevention efforts were adequate. Australia has implemented standards to improve product safety of consumer goods containing button batteries, and button batteries themselves [6]; however, it is apparent parents and caregivers want to see further action from retailers and manufacturers with regards to button battery safety. There is opportunity for retailers and manufacturers to have a more holistic role in product design, and ensuring products containing button batteries have adequate warnings, and restricted access mechanisms.

Open-Ended Responses

The final survey question asked a single open-ended question: "In your opinion, what is the best way to keep children safe from button batteries in the home?". The intent of the question was to generate "sensitizing concepts". Familiar to Charmazian [15] grounded theorists, sensitizing concepts provide researchers with initial concepts about a particular inquiry. Importantly, sensitizing concepts are noted to be tentative tools to assist in development of ideas, rather than producing rigorously derived concepts. As we were interested in developing sensitizing concepts to gather a broad overview of parent and caregiver opinion, an ontologically and epistemologically agnostic thematic analysis approach was undertaken by AG and DL.

5. Conclusions

This study aimed to establish a basic touchstone measure of the perspectives of parents and caregivers towards button battery safety in the home. The survey results suggest that parents and caregivers have an interest in button battery prevention and a desire for education and information in this area, commensurate with the introduction of Australian government mandatory safety standards. Certainly, the severity of button battery injury warrants ongoing research into medical and public health management. Button battery safety is a complex issue, as is the extent to which parent and caregiver perspectives influence safety practices.

Although this is a small study making a limited contribution given the sample size and design, we believe this research has value as a nascent contribution to an area where there is a sparsity of published research. Moreover, the findings of this study can be used to inform future research utilizing a more rigorous methodology, including the use of a validated questionnaire. In future, a

sequential mixed-methods design incorporating open-ended questions or focus groups would likely yield more useful data. Additionally, diverse recruitment channels should be utilized to ensure the data is more accurately representative of the population. Further, the premise that consumer education and awareness can prevent button battery injury overlooks the socioeconomic disparities that exist in access to information and health education. This highlights the importance of manufacturer and retailer compliance with mandatory Australian safety standards.

While the survey results indicate a high level of awareness among parents and caregivers regarding button battery safety, it is important to juxtapose these findings with research that highlights the multifaceted nature of button battery safety. The assumption that increased awareness of parents and caregivers translates directly to effective prevention is not universally accurate. As highlighted by Chao et al., [10] safety considerations beyond parent knowledge and education are needed to prevent button battery injuries.

While there are limited broadly applicable conclusions that can be drawn from this study, these findings augment our understanding of parent and caregiver perspectives towards button battery safety and identify areas that warrant further exploration. While efforts to reduce button battery hazards in the home are likely best targeted at manufacturing and design practices, this study may raise awareness of the parent and caregiver role in button battery safety. Parent and caregiver education, awareness and vigilance are important components of a broader range of safety measures for this issue.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflicts of interest.

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