# Does motivation matter? A systematic review and meta-analysis of outcomes following intentional foreign object ingestion.

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## Introduction

### *Rationale*

The global displacement crisis has reached unprecedented levels, with over 100 million forcibly displaced individuals reported by the United Nations High Commissioner for Refugees (UNHCR) as of May 2024 [1]. Refugees and asylum seekers often endure severe hardship—including violence, persecution, and perilous journeys—compounding their vulnerability upon arrival in host countries [2, 3]. This population is at heightened risk of mental health challenges due to trauma, detention, and insecure legal status [4–7].

Self-harm is a particularly concerning manifestation of psychological distress among asylum seekers, with rates significantly exceeding those in the general population—up to 216 times higher in offshore detention settings [8–10]. Common methods include cutting, blunt trauma, hanging, self immolation, poisoning, and intentional ingestion of foreign objects (IIFO) [9, 11], influenced by access to means, cultural norms, and underlying motivations [12].

IIFO is defined as the non-accidental ingestion of non-nutritive foreign bodies [13]. While 80–90% of cases resolve spontaneously, 10–20% require endoscopic intervention and up to 1% require surgery [14, 15]. Timely access to care is essential, but often constrained in refugee contexts by geographic isolation and limited medical infrastructure, increasing the risk of complications [16].

Global rates of IIFO appear to be rising. In the United States, incidence doubled in 2017, with 14% of cases classified as intentional [17]. One review found up to 92% of adult ingestions were intentional among individuals from lower socioeconomic backgrounds, suggesting even higher prevalence in displaced populations [18].

The management of IIFO has evolved significantly since the 17$^{th}$ century, from open gastrotomy to rigid esophagoscopy and, more recently, endoscopic techniques [19–23]. Historical case reports illustrate the extremes of this behaviour—including one psychiatric patient who ingested over 2,500 objects weighing 21 kilograms [24], and another who swallowed an item 28 cm in length [25].

Clinical outcomes depend on multiple factors: age, comorbidities, object size and characteristics, location, and time to presentation. Current guidelines recommend intervention strategies based on these variables [14]. However, most literature to date focuses on IIFO in prisons or psychiatric populations, with limited data from refugee or asylum-seeking groups.

In detention settings, ingestion may be used as a protest or distress signal when other forms of communication are blocked [26]. In psychiatric contexts, motivations may include psychosis, personality disorders, pica, malingering, or affective dysregulation [27–32]. Malingering is especially reported in prisons, often as a means to access hospital care [27, 33]. Conversely, in borderline personality disorder, ingestion may serve as an emotional regulation strategy rather than an indication of suicidal intent [27, 32]. In rare cases, repeated IIFO has led to discussions around palliative care approaches, recognising the futility of repeated surgical intervention in treatment-resistant psychiatric illness [34].

Despite increasing prevalence, the heterogeneous motivations behind IIFO—and their potential impact on clinical decision-making—remain poorly understood [35–37]. Motivation likely influences management strategies and outcomes. For instance, protest-driven ingestion may avoid high-risk behaviours, lowering the threshold for conservative management [38, 39].

This systematic review aims to address these gaps by exploring how motivation for IIFO affects clinical outcomes. Specifically, it examines associations between motivation and rates of endoscopic and surgical intervention, conservative management, complications, and mortality—toward informing more responsive and appropriate healthcare strategies for vulnerable populations.

### *Objectives*

The primary object of this systematic review was to quantify the rates of endoscopy, surgery, death, complication and conservative management following intentional ingestion of foreign objects in human populations. The systematic review sought to examine how individual factors such as demographic/population characteristics, object characteristics and motivations for ingestion influence the likelihood of these outcomes.

## Methods

This study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [40]. Ethical approval was not required as all analysis was based on published data. Eligibility criteria were structured using the PICOS (Population, Intervention, Comparator, Outcome, Studies) framework.

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*Eligibility Criteria*

| Category | Details |
|---|---|
| Population | Any human; any age group. |
| Interventions or exposures | Non-accidental ingestion of a true foreign body (non-nutritive items). |
| Comparators / Control group | Demographics:<br>Gender, age, detained person, psychiatric inpatient, displaced person, under influence of alcohol, psychiatric history, severely disabled, previous ingestion.<br>Motivation:<br>Intent to harm, psychiatric, psychosocial, protest, other.<br>Object characteristics:<br>Button battery, magnet, long (>5 cm), large diameter (>2.5 cm), multiple, blunt objects, sharp-pointed objects. |
| Outcomes of interest | Endoscopic intervention, surgical intervention, conservative management, complication rates, mortality. |
| Setting | Any setting. |
| Study designs | Any design. |

TABLE I: Inclusion criteria structured using the PICOS framework.

This review included studies involving human participants of any age who had non-accidental ingestion of a true foreign body (non-nutritive items). Studies were only included if they reported on all of the following data: demographic/population data; motivations for ingestion; object characteristics; and outcomes (whether conservative, endoscopic, or surgical treatment was used). All settings were eligible, and a wide range of study designs were accepted.

Studies were excluded if the full text was not available in English, as this would limit the ability to assess methodology and extract reliable data. Accidental ingestions, non-human studies, and ingestions undertaken in controlled research settings were excluded to ensure that the review focused solely on real-world, intentional ingestion events relevant to clinical practice.

Ingestions that were not explicitly intentional, or where intent could not be confidently inferred (e.g., young children with no relevant history or psychiatric comorbidities), were excluded to maintain a clear focus on non-accidental ingestion as the exposure of interest. Studies involving the ingestion or co-ingestion of substances such as drugs or poisons were also excluded to avoid confounding physiological effects and to ensure consistency with the review's focus on physical foreign bodies. Similarly, studies in which the primary cause of death was unrelated to the ingestion event—such as concurrent suicide by other means—were excluded to avoid misattributing outcomes to foreign body ingestion.

Studies published before the advent of endoscopy (1906) were excluded to reduce historical bias and to avoid skewing the intervention data toward surgical outcomes, given that endoscopy was not available as a clinical management option at that time. Finally, studies were excluded if they lacked original empirical data (e.g., reviews, editorials, or commentaries), involved duplicate or overlapping datasets (with only the most comprehensive or recent version retained), or failed to report on key variables such as outcomes, motivations, or object characteristics—essential for subgroup analyses and interpretation of results.

A full list of eligibility criteria is shown in Table I. This is reproduced in a larger format for clarity in Appendix A-A. A full list of exclusion criteria is available in Appendix A-B.

*Information Sources*

Relevant articles were identified through a systematic search of PubMed, Web of Science, Embase, Scopus, PsycINFO, CENTRAL and Google Scholar during January 2025, with the assistance of a librarian. Included articles then had their bibliography's searched by the primary author (JGE) on 14th May 2025 to identify any potentional additional literature not uncovered in the primary search.

*Search Strategy*

The search was conducted using keywords and MeSH terms based on the concepts underpinning this review. The keywords and MeSH terms used can be found in Appendix B.

*Selection Process*

All identified articles were collated and duplicate articles were identified and removed. Remaining articles underwent independent title and abstract screening conducted by the first author (JGE). To ensure consistency, a randomly selected 10% sample of these articles underwent independent screening by a second author (MS). Any discrepancies identified between these two reviewers were resolved by a third reviewer (GC). Inter-reviewer agreement was calculated using Cohen's Kappa [41]. Remaining articles proceeded to full text review, where the same independent screening process was repeated on full text articles.

*Data Collection Process*

Data were initially extracted by a single reviewer (JGE) into *Microsoft Excel* [42]. Variables for extraction were developed iteratively through engagement with the literature and analysis of consistent reporting patterns. A preliminary review of the first 30 case reports informed the development of additional data categories, which were subsequently applied to the remaining reports.

Following initial extraction, data were imported into *Python* [43] for further processing and analysis. The Python-based pipeline included data cleaning, validation, and transformation to ensure consistency across heterogeneous study formats. These structured data were then used to guide the extraction of aggregate data from case series. Studies were grouped for extraction based on their classification as case reports or case series. Where case series contained sufficiently granular data, cases were extracted individually and treated as case reports; otherwise, data were extracted at the aggregate level. Case grouping for analysis followed the criteria for inclusion as individual case reports or case series, as defined above. Relevant data from reviews and other literature types were recorded under the case report category.

*Data Items*

Outcome data were extracted for rates of endoscopy, surgery, conservative management, mortality, and complications. For the purposes of this study, *surgery* was defined as "any operative intervention performed in a sterile operating theatre under general or regional anaesthesia, involving incision or surgical access to

body cavities (including laparotomy, laparoscopy, thoracotomy, or cervical exploration) for the purpose of removing an ingested object or managing complications of ingestion". Procedures performed "solely via flexible or rigid endoscopy through natural orifices" were categorised as *endoscopy* and not considered surgical interventions.

Predictor variables were grouped in five subgroups: *Age Group*, *Gender*, *Demographic*, *Motivation*, *Object*. Motivations are elaborated on here as they are key variables in this review. Intent to harm was defined as ingestion carried out with the purpose of self-harm, self-injury, or suicide. If the ingestion was for another reason, it was recorded as 'N'. If the intent was unclear, it was marked as 'UK'. Protest-related ingestion was defined as an act of ingestion carried out as a form of protest, demonstration, or manipulation—for example, in response to detention conditions. If the ingestion was not motivated by protest, it was marked as 'N'; if unclear, as 'UK'. Psychosocial motivation included ingestion motivated by social or interpersonal dynamics—such as imitative behaviour, a desire to shock, body-image concerns, or the use of ingestion for safekeeping objects. If these factors were not involved, the case was marked as 'N'; if unclear, as 'UK'. Unknown motivation was recorded when no clear motivation was identifiable in the documentation. If a specific motive was documented, this was marked as 'N'. If the available information was ambiguous, it was recorded as 'UK'.

Full definitions of all variables are provided in Appendix C. The full dataset of extracted case-level and series-level data (including bias assesments), is available on Github.

### *Risk of Bias Assessment*

Risk of bias was assessed manually for all included studies by a single reviewer (JGE), using the *Joanna Briggs Institute (JBI) Critical Appraisal Checklists for Case Reports and Case Series* [44]. Studies were first classified as either case reports or case series based on the level of granularity in the data. Each study was then evaluated using the corresponding JBI tool.

### *Effects Measures Analysis (Summary)*

Univariate associations between binary predictors (e.g., motivation, object type) and binary outcomes (e.g., endoscopy, surgery, complications) were assessed using odds ratios (ORs) with 95% confidence intervals (CIs), via chi-square or Fisher's exact tests [41]. Multivariate logistic regression was used to identify independent predictors, with models adjusted for age, gender, motivation, and object characteristics, and fitted using *statsmodels* in Python [45]. For case series, meta-analyses of proportions and univariate meta-regression explored outcome frequencies and associated factors using random-effects models and inverse-variance weighted regression. Full methodology is detailed in Appendix C.

## RESULTS

### *Study Selection*

A total of 808 records were identified through initial database searches: PubMed (317), Web of Science (277), Google Scholar (135), Embase (25), SCOPUS (24), PsycINFO (16), and Cochrane (14). 316 duplicates were identified and removed.

Title and abstract screening was undertaken, with JGE reviewing all 492 records. A random sample of 50 records was generated for independent screening MS. Cohen's Kappa was calculated for inter-reviewer agreement between JGE and MS, yielding a value of 0.38, indicating fair agreement. Where JGE and MS disagreed, 16 records were reviewed by GC. In total, 176 records were excluded, leaving 316 for full text review.

During full text review, JGE reviewed all 316 records. A random sample of 32 records was generated for independent review by MS. Inter-reviewer agreement was again calculated using Cohen's Kappa, yielding a value of 0.21, indicating fair agreement. Where JGE and MS disagreed, 5 records were reviewed by GC. In total, 276 records were excluded during full text review. 40 records were included and proceeded to bibliography search.

The bibliographies of the 40 included papers were searched by manually JGE. Relevant bibliography items were identified, collated, and evaluated against the eligibility criteria, yielding 194 results. These 194 results were reviewed by JGE. 164 bibliography search records were excluded, leaving 30 for inclusion.

Therefore, a total of 70 records were included in this study and proceeded to bias assessment. This process is illustrated in Figure 1.

### *Risk of Bias*

*Case Reports:* 75 cases from 67 studies [33, 38, 46–108, 112, 113] were evaluated using the *JBI Checklist for Case Reports* [44]. 3 cases were excluded. Cases were excluded at this stage if they failed to describe the following domains: patient history and timeline (1 case) [112], current patient condition (2 cases) [112], interventions and treatments (1 case) [113], patient post-intervention condition (2 cases) [112], harms (2 cases) [112], and takeaway lessons (2 cases) [112]. The excluded cases came from the following studies: [112, 113]. Of the remaining 72 cases, all reported interventions and treatments (72 cases, 100%) [33, 38, 46–108]. Most clearly described patient history and timeline (71 cases, 99%) [33, 38, 46–55, 57–108], patient post-intervention condition (70 cases, 97%) [33, 38, 46–66, 69–108], takeaway lessons (70 cases, 97%) [33, 38, 46–55, 57–88, 90–108], patient demographic (69 cases, 96%) [38, 46–52, 54–105, 107, 108], and current patient condition (69 cases, 96%) [33, 38, 46–91, 93–108]. Reporting was also strong for diagnostic assessments (66 cases, 92%) [33, 38, 46–55, 57–61, 63–91, 93–108], and harms (38 cases, 90%) [49, 53–55, 58, 60, 61, 65, 66, 68, 69, 71, 75–80, 84–88, 90, 95, 96, 99, 100, 103, 105–108].

*Case Series:* Seperately, 3 studies [109–111] were evaluated using the *JBI Checklist for Case Series* [44]. Reporting quality was generally high across all JBI domains. All included case series fully reported clear inclusion criteria, standard condition measurements, valid patient identification methods, complete inclusion, clear demographic information, clear clinical information, clear outcome and follow-up, and approprate statistical analysis [109–111]. However, fewer studies (2) reported consecutive inclusion, and clear site demographic information [109, 111].

### *Study Characteristics*

A total of 68 studies were included in the synthesis. 65 studies were case reports, yielding 72 cases [33, 38, 46–108]. A full list of group summary case-level characteristics and outcomes is available in Table II.

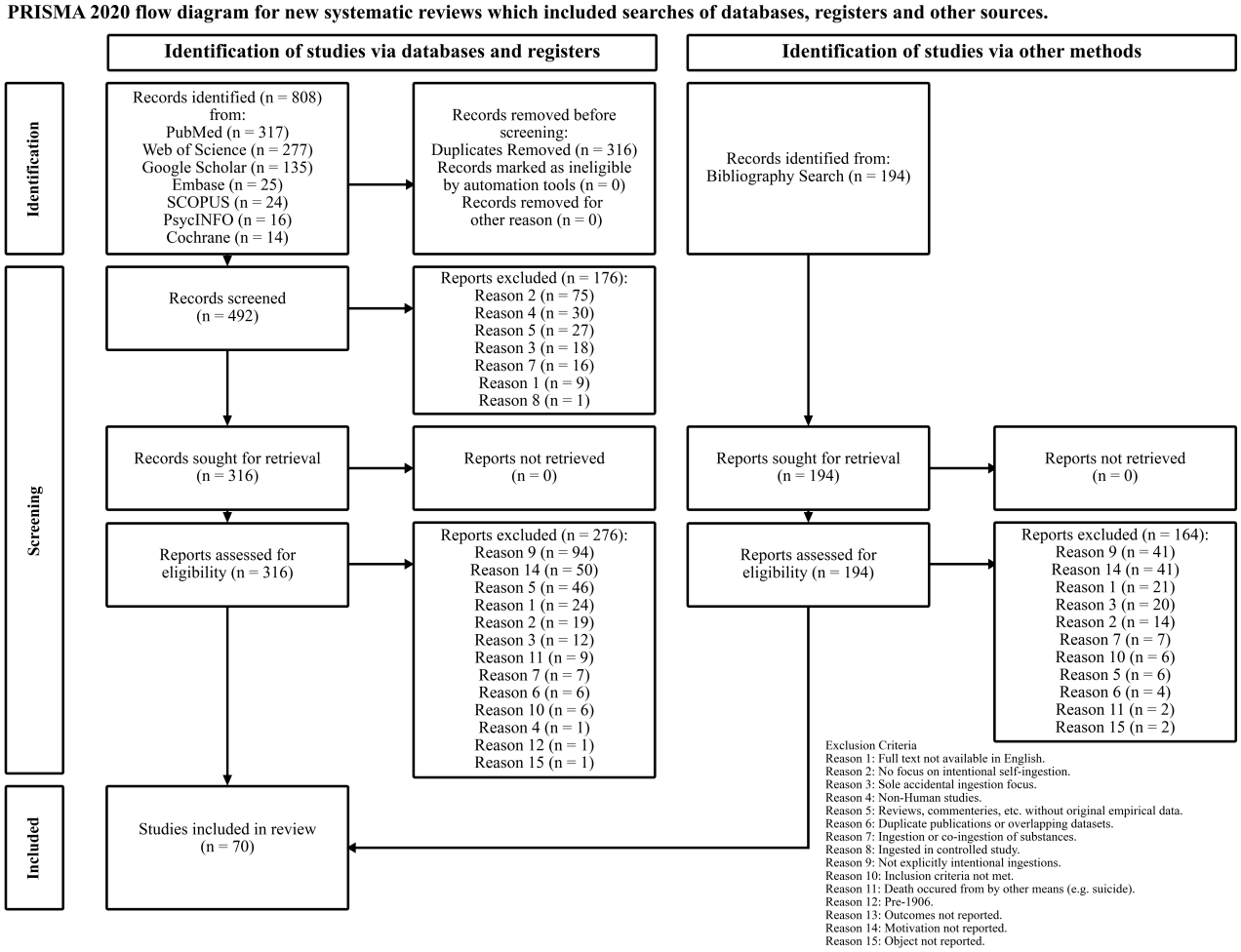


Fig. 1: PRISMA flow diagram summarising the study selection process.

3 studies were case series, yielding 90 cases [109–111]. A full list of grouped series-level characteristics and outcomes is available in Table III.

*Synthesis*

Across 72 single-patient case reports and three case series (total $n = 162$) we extracted uniform data on patient motive, object features, treatment approach and outcome.

Random–effects pooling of the three case series yielded a conservative–management rate of 40.6 % (95 % CI 29.2–52.8; $I^2 \approx 75$), an endoscopy rate of 41.6 % (29.5–54.7; $I^2 \approx 95$) and a surgical rate of 17.8 % (12.0–25.8; $I^2 \approx 17$). Overall complications occurred in 7.3 % of patients (2.9–17.3) and there were three reported deaths.

*Motivation:* Series-level meta-regression confirmed motivation as the dominant predictor of management.

- **Intentional self-harm** lowered the probability of conservative care by 17 % (aOR 0.83, 95 % CI 0.79–0.86, $p = 0.012$) and raised surgical use by 11 % (aOR 1.11, 1.05–1.18, $p = 0.015$); endoscopy was unaffected (aOR 0.92, 0.27–3.13, $p = 0.559$). Case-level logistic modelling amplified this signal, showing a 15-fold increase in surgery (aOR 15.97, 1.32–192.40, $p = 0.029$).
- **Psychiatric (non-self-harm)** motivation produced a smaller but significant rise in surgical intervention (aOR 1.07, 1.03–1.11, $p = 0.017$) with no change in other pathways; the effect disappeared in multivariable analyses.
- **Psychosocial** motives behaved similarly, decreasing conservative management (aOR 0.82, 0.70–0.96) and increasing surgery (aOR 1.12, 1.01–1.25), both $p = 0.040$.
- **Protest** ingestions—almost exclusively in custodial settings—did not alter the odds of any single treatment modality in the series-level model, though case-level analysis linked protest with an extreme rise in complications (aOR 290.44, 1.40–60 043.40).

*Object:*

- **Sharp objects** significantly reduced conservative management by 19 % (aOR 0.81, 0.68–0.98, $p = 0.044$) but had no independent effect on surgery or endoscopy; numbers were too small for stable multivariable estimates.
- **Multiple objects** and **length $>$ 5 cm** were neutral in univariate meta-regression, yet individual-patient models linked long objects to a seven-fold rise in surgery and a twenty-fold rise in complications, while multiple-object ingestion drove an eighteen-fold increase in complications.

*Demographics and setting:* Male sex curtailed conservative treatment by 13 % (OR 0.87, 0.78–0.97, $p = 0.039$) without influencing other modalities. Detention status increased conservative management by 62 % (OR 1.62, 1.11–2.38, $p = 0.039$) and,

TABLE II: Grouped summary of case-level variables and outcomes.

| Variable | Count | Percentage | References |
|---|---|---|---|
| *Gender* | | | |
| Male | 43 | 60% | [33, 46–82] |
| Female | 28 | 39% | [38, 83–107] |
| Unknown | 1 | 1% | [108] |
| *Age Group* | | | |
| <18 | 13 | 18% | [68, 76, 77, 83, 84, 88, 92, 93, 99, 100, 105] |
| 18–25 | 18 | 25% | [33, 46, 49, 52, 57, 65, 69, 70, 74, 81, 87, 95, 96, 101, 104] |
| 26–40 | 25 | 35% | [38, 48, 50, 51, 53, 59–62, 64, 67, 69, 71–73, 75, 79, 86, 89–91, 102, 106–108] |
| 41–60 | 11 | 15% | [47, 55, 56, 58, 63, 66, 78, 80, 82, 94, 103] |
| 60+ | 3 | 4% | [85, 97, 98] |
| Unknown | 2 | 3% | [54] |
| *Population* | | | |
| Detained Person | 12 | 17% | [33, 48, 50, 51, 69, 72, 75, 79] |
| Psychiatric Inpatient | 4 | 6% | [82, 92, 108] |
| Displaced Person | 2 | 3% | [46, 61] |
| Under Influence of Alcohol | 3 | 4% | [53, 57, 78] |
| Psychiatric History | 36 | 50% | [38, 48, 51, 52, 56, 59, 60, 62–68, 70, 71, 75, 76, 82–85, 89, 91, 92, 94, 95, 97, 100–103, 107, 108] |
| Severely Disabled | 7 | 10% | [52, 68, 82, 97, 100, 101, 107] |
| Previous Ingestor | 19 | 26% | [48, 51, 54, 57, 58, 62–64, 68, 76, 78, 82, 87, 92, 102, 107, 108] |
| *Motivation* | | | |
| Intent to harm | 21 | 29% | [33, 47–49, 56, 57, 60, 69, 70, 75, 76, 83, 89, 90, 98, 102, 108] |
| Protest | 9 | 12% | [33, 55, 61, 69, 104] |
| Psychiatric | 34 | 47% | [38, 47, 48, 51, 52, 58, 59, 62–68, 71, 75, 76, 81, 82, 84, 86, 87, 91, 92, 94–98, 100, 102, 103] |
| Psychosocial | 17 | 24% | [46, 53, 65, 72–74, 77, 78, 87, 88, 93, 94, 98, 99, 104–106] |
| Other | 9 | 12% | [50, 58, 62, 79, 80, 84, 101, 102, 107] |
| *Object* | | | |
| Button Battery | 2 | 3% | [54, 55] |
| Magnet | 9 | 12% | [55, 68, 76, 77, 84, 88, 99, 100, 105] |
| Long (>5cm) | 32 | 44% | [47, 49, 50, 52, 56–58, 60, 61, 64, 65, 67, 70–72, 78, 79, 81–83, 86, 89, 90, 92, 96, 97, 100, 102, 103, 107] |
| Large (>2.5cm) Diameter | 51 | 71% | [33, 46–52, 54, 56–58, 61–67, 69–73, 76, 78, 79, 82, 83, 86, 88–90, 92, 96, 97, 99–103, 106–108] |
| Sharp | 34 | 47% | [33, 38, 48, 51, 53, 56–60, 62–65, 67, 69–71, 74, 81–83, 86, 87, 91, 92, 94, 96] |
| Multiple | 44 | 61% | [38, 51, 52, 55, 56, 58–60, 62–71, 74–78, 80–82, 84, 85, 87, 88, 93–96, 98–100, 103, 105, 108] |
| *Outcome* | | | |
| Endoscopy | 31 | 43% | [46, 50–56, 61–63, 68, 72, 73, 75, 76, 79, 80, 82, 86, 89, 91, 94, 96, 98, 100–103, 106] |
| Surgery | 44 | 61% | [33, 47–49, 52, 56, 57, 59–61, 64, 65, 67–71, 74, 76–78, 81, 83–86, 88–92, 96, 97, 99, 104–108] |
| Death | 2 | 3% | [58, 66] |
| Conservative | 7 | 10% | [38, 58, 66, 87, 92, 93, 95] |
| Complication | 48 | 67% | [49, 51–61, 64–71, 74, 76–79, 81, 84–86, 88, 90–93, 96, 97, 99, 100, 102–107] |

in case-level analysis, was associated with a 97 % reduction in recorded complications (aOR 0.03, 0.00–0.59). A binary history of psychiatric illness showed no significant association with any outcome in series-level modelling.

*Certainty and heterogeneity:* All included studies were uncontrolled case reports or case series. High between-study heterogeneity for several endpoints ($I^2$ up to 95 %), shifting definitions of motive and object descriptors, and limited follow-up constrain the certainty of pooled estimates. No GRADE assessment was performed.

*Data availability:* All extraction scripts and raw data are openly hosted at https://github.com/jackgedge/iifo_systematic_review.

*Investigation of Heterogeneity:* Heterogeneity was explored across study results using two complementary approaches.

Firstly, meta-analyses of proportions were conducted for each outcome of interest across included case series. Between-study heterogeneity was quantified using the $I^2$ statistic and $\tau^2$ vari-

TABLE III: Grouped series-level summary.

| Variable | Total | Case Reports | Karp *et al.* [109] | Lee *et al.* [110] | Elghali *et al.* [111] |
|---|---|---|---|---|---|
| *Total Cases* | 162 | 72 | 19 | 52 | 19 |
| *Gender* | 162 | 72 | 19 | 52 | 19 |
| Male | 133 (82) | 43 (60) | 19 (100) | 52 (100) | 19 (100) |
| Female | 28 (17) | 28 (39) | 0 (0) | 0 (0) | 0 (0) |
| Unknown | 1 (1) | 1 (1) | 0 (0) | 0 (0) | 0 (0) |
| *Age* | | | | | |
| Minimum | 7 | 7 | 17 | 25 | 19 |
| Mean | 28 | 30 | 24 | — | 24 |
| Median | 35 | 28 | — | 35 | — |
| Maximum | 100 | 100 | 40 | 50 | 27 |
| *Population* | 204 | 83 | 37 | 61 | 23 |
| Detained Person | 102 (63) | 12 (17) | 19 (100) | 52 (100) | 19 (100) |
| Psychiatric History | 65 (41) | 36 (50) | 18 (95) | 9 (18) | 2 (12) |
| Previous Ingestor | 21 (13) | 19 (26) | — | — | 2 (11) |
| Severely Disabled | 7 (4) | 7 (10) | — | 0 (0) | — |
| Psychiatric Inpatient | 4 (2) | 4 (6) | 0 (0) | 0 (0) | 0 (0) |
| Under Influence of Alcohol | 3 (2) | 3 (4) | — | — | — |
| Displaced Person | 2 (1) | 2 (3) | — | — | — |
| *Motivation* | 178 | 90 | 19 | 50 | 19 |
| Protest | 79 (49) | 9 (12) | 3 (16) | 50 (97) | 17 (89) |
| Psychiatric | 46 (28) | 34 (47) | 12 (63) | 0 (0) | 0 (0) |
| Intent to harm | 27 (17) | 21 (29) | 4 (21) | 0 (0) | 2 (11) |
| Psychosocial | 17 (10) | 17 (24) | 0 (0) | 0 (0) | 0 (0) |
| Other | 9 (6) | 9 (12) | 0 (0) | 0 (0) | 0 (0) |
| *Object* | | | | | |
| Sharp | 102 | 34 | 19 | 33 | 16 |
| Multiple | 69 | 44 | — | 24 | 1 |
| Long (>5cm) | 64 | 32 | — | 32 | 0 |
| Large (>2.5cm) Diameter | 51 | 51 | — | — | — |
| Magnet | 9 | 9 | — | 0 | 0 |
| Button Battery | 2 | 2 | — | 0 | 0 |
| *Outcome* | 230 | 132 | 19 | 58 | 21 |
| Endoscopy | 78 (48) | 31 (43) | — | 46 (88) | 1 (5) |
| Surgery | 59 (36) | 44 (61) | 5 (26) | 6 (12) | 4 (21) |
| Complication | 54 (33) | 48 (67) | — | 6 (12) | — |
| Conservative | 36 (22) | 7 (10) | 14 (74) | 0 (0) | 15 (79) |
| Death | 3 (2) | 2 (3) | 0 (0) | 0 (0) | 1 (5) |

n (%)

ance. The degree of heterogeneity varied substantially across outcomes:

- Substantial heterogeneity ($I^2 = 95\%$) was observed for endoscopy.
- Heterogeneity was moderate for surgery ($I^2 = 17\%$).
- Heterogeneity was low ($I^2 = 0\%$) for conservative management.
- Meta-analyses could not be meaningfully conducted for death and complications due to insufficient data.

Secondly, to investigate potential sources of heterogeneity, univariate meta-regression was performed for each outcome. Given the small number of case series available, series-level data was combined with collapsed aggregate case reports to increase the number of contributing studies. Meta-regressions examined associations between outcome proportions and patient-level predictors including gender, population characteristics, ingestion motivations, and object type.

Significant associations between certain predictors and outcomes were identified, particularly in relation to motivation and surgery or conservative management outcomes. This suggests that clinical heterogeneity in patient characteristics likely contributed to observed between-study differences.

No additional subgroup or sensitivity analyses were performed, given the limited number of studies and inconsistent reporting of potential study-level moderators.

*Sensitivity Analyses:* Formal sensitivity analyses were not performed due to the limited number of included case series and the small number of studies available for several outcomes. Given the small number of eligible series and heterogeneity in reporting, the meta-analyses of proportions and meta-regressions were considered primarily descriptive in nature.

To partially address robustness, aggregate case report data

TABLE IV: Grouped Univariate Association Testing test results.

| Variable | Conservative | Endoscopy | Surgery | Death | Complication |
|---|---|---|---|---|---|
| *Gender* | | | | | |
| Male | 0.23 [0.04, 1.30] (p=0.110) | 1.42 [0.54, 3.72] (p=0.632) | 0.93 [0.36, 2.46] (p=1.000) | — | 1.41 [0.52, 3.81] (p=0.671) |
| Female | 4.57 [0.82, 25.41] (p=0.101) | 0.78 [0.30, 2.03] (p=0.786) | 0.97 [0.37, 2.57] (p=1.000) | — | 0.84 [0.31, 2.28] (p=0.932) |
| Unknown | — | — | — | — | — |
| *Age Group* | | | | | |
| <18 | 1.96 [0.34, 11.45] (p=0.602) | 0.33 [0.08, 1.33] (p=0.194) | 2.45 [0.61, 9.84] (p=0.328) | — | 1.84 [0.46, 7.44] (p=0.522) |
| 18–25 | 1.23 [0.22, 6.94] (p=1.000) | 0.29 [0.08, 0.98] (p=0.074) | 2.80 [0.82, 9.62] (p=0.163) | — | 1.41 [0.44, 4.56] (p=0.773) |
| 26–40 | 0.28 [0.03, 2.51] (p=0.409) | 2.25 [0.84, 6.04] (p=0.171) | 0.93 [0.34, 2.51] (p=1.000) | — | 0.83 [0.30, 2.31] (p=0.930) |
| 41–60 | 2.49 [0.42, 14.83] (p=0.289) | 2.70 [0.71, 10.22] (p=0.188) | 0.18 [0.04, 0.76] (p=0.019)* | — | 0.54 [0.15, 2.00] (p=0.488) |
| 60+ | — | 0.65 [0.06, 7.51] (p=1.000) | 1.29 [0.11, 14.88] (p=1.000) | — | 1.00 [0.09, 11.61] (p=1.000) |
| Unknown | — | — | — | — | 0.49 [0.03, 8.18] (p=1.000) |
| *Population* | | | | | |
| Detained Person | — | 0.99 [0.28, 3.53] (p=1.000) | 0.86 [0.24, 3.08] (p=1.000) | — | 0.63 [0.17, 2.26] (p=0.510) |
| Psychiatric Inpatient | — | 0.44 [0.04, 4.54] (p=0.634) | 2.25 [0.22, 22.99] (p=0.634) | — | 0.15 [0.01, 1.50] (p=0.103) |
| Displaced Person | — | — | 0.67 [0.03, 12.84] (p=1.000) | — | 0.50 [0.03, 9.77] (p=1.000) |
| Under Influence of Alcohol | — | 0.88 [0.07, 10.69] (p=1.000) | 1.00 [0.08, 12.27] (p=1.000) | — | — |
| Psychiatric History | 0.96 [0.20, 4.70] (p=1.000) | 0.80 [0.29, 2.20] (p=0.861) | 1.35 [0.48, 3.74] (p=0.756) | 0.71 [0.04, 11.97] (p=1.000) | 0.70 [0.24, 2.03] (p=0.696) |
| Severely Disabled | — | 4.13 [0.74, 23.06] (p=0.115) | 0.81 [0.17, 3.93] (p=1.000) | — | 1.31 [0.23, 7.35] (p=1.000) |
| Previous Ingestor | 1.69 [0.30, 9.38] (p=0.665) | 0.83 [0.26, 2.65] (p=0.986) | 0.74 [0.23, 2.36] (p=0.832) | 1.61 [0.09, 27.40] (p=1.000) | 0.34 [0.10, 1.23] (p=0.179) |
| *Motivation* | | | | | |
| Intent to harm | — | 0.49 [0.16, 1.55] (p=0.347) | 5.40 [1.36, 21.43] (p=0.024)* | — | 0.84 [0.28, 2.56] (p=0.988) |
| Protest | — | 0.33 [0.06, 1.74] (p=0.279) | 5.50 [0.64, 47.15] (p=0.137) | — | 4.71 [0.55, 40.44] (p=0.251) |
| Psychiatric | 7.07 [0.80, 62.31] (p=0.105) | 1.44 [0.55, 3.77] (p=0.624) | 0.47 [0.17, 1.27] (p=0.212) | — | 0.67 [0.24, 1.85] (p=0.608) |
| Psychosocial | 1.20 [0.21, 6.84] (p=1.000) | 0.89 [0.29, 2.72] (p=1.000) | 0.63 [0.21, 1.93] (p=0.603) | — | 0.94 [0.30, 2.99] (p=1.000) |
| Other | 1.19 [0.13, 11.18] (p=1.000) | 3.04 [0.70, 13.29] (p=0.161) | 0.14 [0.03, 0.75] (p=0.023)* | 7.75 [0.44, 136.41] (p=0.236) | 0.58 [0.14, 2.40] (p=0.469) |
| *Object* | | | | | |
| Button Battery | — | — | — | — | — |
| Magnet | — | 1.07 [0.26, 4.35] (p=1.000) | 2.46 [0.47, 12.80] (p=0.467) | — | — |
| Long (>5cm) | 0.45 [0.08, 2.51] (p=0.446) | 0.80 [0.31, 2.05] (p=0.820) | 2.43 [0.90, 6.56] (p=0.128) | 1.23 [0.07, 20.40] (p=1.000) | 1.88 [0.67, 5.24] (p=0.342) |
| Large (>2.5cm) Diameter | 0.23 [0.05, 1.17] (p=0.081) | 1.41 [0.48, 4.16] (p=0.727) | 1.65 [0.57, 4.80] (p=0.518) | — | 0.92 [0.30, 2.85] (p=1.000) |
| Sharp | 1.56 [0.32, 7.51] (p=0.700) | 0.34 [0.13, 0.90] (p=0.048)* | 2.16 [0.82, 5.72] (p=0.187) | 1.12 [0.07, 18.65] (p=1.000) | 1.09 [0.41, 2.90] (p=1.000) |
| Multiple | 4.26 [0.48, 37.48] (p=0.235) | 0.50 [0.19, 1.30] (p=0.233) | 1.03 [0.39, 2.71] (p=1.000) | — | 2.60 [0.95, 7.13] (p=0.104) |

OR: Odds Ratio. CI: Confidence Interval. p: p-value. * indicates $p < 0.05$. — indicates missing or unreported values.

was incorporated into the meta-regression models to increase the effective number of series contributing to each outcome. This al-

TABLE V: Grouped case-level logistic regression results.

| Variable | Conservative | Endoscopy | Surgery | Death | Complication |
|---|---|---|---|---|---|
| *Age Group* | | | | | |
| <18 | — | — | — | — | 7.58 [0.09, 675.19] (p=0.376) |
| 18–25 | — | — | — | — | 2.19 [0.03, 183.09] (p=0.728) |
| 26–40 | — | — | — | — | 18.50 [0.20, 1679.21] (p=0.205) |
| 41–60 | — | — | — | — | 0.25 [0.00, 19.78] (p=0.532) |
| 60+ | — | — | — | — | 9.60 [0.02, 3831.95] (p=0.459) |
| *Gender* | | | | | |
| Male | — | — | — | — | — |
| Female | — | — | — | — | — |
| *Population* | | | | | |
| Detained Person | — | 1.04 [0.13, 8.51] (p=0.970) | **0.04 [0.00, 0.77] (p=0.033)*** | — | **0.02 [0.00, 0.47] (p=0.015)*** |
| Psychiatric History | — | 0.70 [0.10, 4.95] (p=0.720) | 1.38 [0.11, 17.74] (p=0.805) | — | 0.32 [0.03, 3.28] (p=0.339) |
| Severely Disabled | — | 8.58 [0.70, 104.86] (p=0.092) | 0.58 [0.04, 8.83] (p=0.691) | — | 0.47 [0.02, 12.53] (p=0.655) |
| Previous Ingestor | — | 0.44 [0.07, 2.65] (p=0.371) | 0.97 [0.11, 8.31] (p=0.975) | — | 1.55 [0.21, 11.53] (p=0.671) |
| *Motivation* | | | | | |
| Intent to harm | — | 1.02 [0.18, 5.72] (p=0.982) | 9.56 [0.73, 124.32] (p=0.085) | — | 0.19 [0.02, 1.52] (p=0.116) |
| Protest | — | 0.52 [0.04, 6.49] (p=0.611) | 3.12 [0.10, 95.21] (p=0.514) | — | **231.67 [1.16, 46389.11] (p=0.044)*** |
| Psychiatric | — | 3.67 [0.49, 27.24] (p=0.204) | 0.07 [0.00, 1.28] (p=0.074) | — | 0.34 [0.04, 2.86] (p=0.321) |
| Psychosocial | — | 1.74 [0.20, 15.10] (p=0.613) | 0.16 [0.01, 2.58] (p=0.195) | — | 0.19 [0.01, 2.42] (p=0.199) |
| Other | — | 1.53 [0.22, 10.92] (p=0.669) | 0.09 [0.01, 1.44] (p=0.089) | — | 0.27 [0.03, 2.71] (p=0.264) |
| *Object* | | | | | |
| Large (>2.5cm) Diameter | — | 1.91 [0.33, 10.91] (p=0.469) | 1.44 [0.21, 9.90] (p=0.714) | — | 1.24 [0.13, 11.96] (p=0.854) |
| Sharp | — | 0.27 [0.06, 1.35] (p=0.111) | 2.54 [0.34, 19.22] (p=0.366) | — | 0.31 [0.05, 2.06] (p=0.225) |
| Multiple | — | 0.62 [0.11, 3.49] (p=0.585) | 1.59 [0.25, 10.35] (p=0.626) | — | **27.80 [3.18, 242.85] (p=0.003)*** |
| Long (>5cm) | — | 0.28 [0.05, 1.56] (p=0.146) | 5.06 [0.68, 37.76] (p=0.114) | — | **13.74 [1.27, 148.57] (p=0.031)*** |

aOR: Adjusted Odds Ratio. CI: Confidence Interval. p: p-value. * indicates $p < 0.05$. Boldface indicates statistical significance. — indicates missing or u

lowed exploratory assessment of predictor-outcome relationships across a larger pooled dataset. However, no additional sensitivity analyses (e.g. leave-one-out analyses, exclusion of small studies, or alternative meta-analytic models) were conducted, as such analyses would not have been statistically meaningful in the context of the available data.

*Investigation of Heterogeneity:* Heterogeneity was explored across study results using two complementary approaches.

Firstly, meta-analyses of proportions were conducted for each outcome of interest across included case series. Between-study heterogeneity was quantified using the $I^2$ statistic and $\tau^2$ variance. The degree of heterogeneity varied substantially across outcomes:

- Substantial heterogeneity ($I^2 = 95\%$) was observed for endoscopy.
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- Meta-analyses could not be meaningfully conducted for death and complications due to insufficient data.

Secondly, to investigate potential sources of heterogeneity, univariate meta-regression was performed for each outcome. Given the small number of case series available, series-level

TABLE VI: Grouped univariate meta-regression results for series-level data.

| Variable | Conservative | Endoscopy | Surgery | Death | Complication |
|---|---|---|---|---|---|
| *Gender* | | | | | |
| Unknown | **0.03 [0.00, 0.49] (p=0.039)*** | 0.21 [0.00, 45880999868.65] (p=0.585) | **7.37 [1.25, 43.52] (p=0.040)*** | — | — |
| Female | **0.89 [0.81, 0.97] (p=0.039)*** | 0.95 [0.37, 2.40] (p=0.585) | **1.07 [1.01, 1.14] (p=0.040)*** | — | — |
| Male | **0.87 [0.78, 0.97] (p=0.039)*** | 1.18 [0.52, 2.71] (p=0.235) | 1.01 [0.78, 1.32] (p=0.856) | — | — |
| *Age* | | | | | |
| Minimum | **1.36 [1.04, 1.78] (p=0.044)*** | 1.11 [0.29, 4.20] (p=0.492) | **0.87 [0.85, 0.88] (p=0.001)*** | — | — |
| Mean | **0.59 [0.39, 0.89] (p=0.039)*** | — | 1.29 [0.91, 1.81] (p=0.068) | — | — |
| Maximum | 0.95 [0.90, 1.00] (p=0.050) | 0.98 [0.57, 1.68] (p=0.698) | 1.03 [0.99, 1.08] (p=0.100) | — | — |
| Median | — | — | — | — | — |
| *Population* | | | | | |
| Detained Person | **1.62 [1.11, 2.38] (p=0.039)*** | 1.06 [0.67, 1.67] (p=0.346) | 0.94 [0.85, 1.04] (p=0.129) | — | — |
| Psychiatric Inpatient | **0.43 [0.22, 0.83] (p=0.039)*** | 0.68 [0.00, 462.82] (p=0.585) | **1.65 [1.06, 2.57] (p=0.040)*** | — | — |
| Psychiatric History | 0.89 [0.52, 1.54] (p=0.228) | 0.95 [0.35, 2.62] (p=0.653) | 1.08 [1.00, 1.16] (p=0.052) | — | — |
| Displaced Person | — | — | — | — | — |
| Under Influence of Alcohol | — | — | — | — | — |
| Severely Disabled | — | — | — | — | — |
| Previous Ingestor | — | — | — | — | — |
| *Motivation* | | | | | |
| Intent to harm | **0.83 [0.79, 0.86] (p=0.012)*** | 0.92 [0.27, 3.13] (p=0.559) | **1.11 [1.05, 1.18] (p=0.015)*** | — | — |
| Psychiatric | 0.89 [0.62, 1.28] (p=0.154) | 0.95 [0.44, 2.06] (p=0.585) | **1.07 [1.03, 1.11] (p=0.017)*** | — | — |
| Other | **0.69 [0.51, 0.92] (p=0.039)*** | 0.84 [0.05, 15.30] (p=0.585) | **1.25 [1.02, 1.52] (p=0.040)*** | — | — |
| Psychosocial | **0.82 [0.70, 0.96] (p=0.039)*** | 0.91 [0.20, 4.24] (p=0.585) | **1.12 [1.01, 1.25] (p=0.040)*** | — | — |
| Protest | 1.04 [0.01, 73.36] (p=0.931) | 1.06 [0.68, 1.65] (p=0.352) | 0.95 [0.84, 1.08] (p=0.233) | — | — |
| *Object* | | | | | |
| Sharp | **0.81 [0.68, 0.98] (p=0.044)*** | 1.15 [0.03, 47.73] (p=0.712) | 1.07 [0.72, 1.60] (p=0.523) | — | — |
| Button Battery | — | 0.46 [0.00, 214198.51] (p=0.585) | 3.04 [0.21, 44.58] (p=0.120) | — | — |
| Magnet | — | 0.84 [0.05, 15.30] (p=0.585) | 1.28 [0.70, 2.33] (p=0.120) | — | — |
| Multiple | — | 0.97 [0.28, 3.40] (p=0.832) | 1.06 [0.62, 1.81] (p=0.402) | — | — |
| Long (>5cm) | — | 1.10 [0.16, 7.73] (p=0.637) | 1.04 [0.31, 3.43] (p=0.762) | — | — |
| Large (>2.5cm) Diameter | — | — | — | — | — |

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Significant associations between certain predictors and outcomes were identified, particularly in relation to motivation and surgery or conservative management outcomes. This suggests that clinical heterogeneity in patient characteristics likely contributed to observed between-study differences.

No additional subgroup or sensitivity analyses were performed, given the limited number of studies and inconsistent reporting of potential study-level moderators.

*Sensitivity Analyses:* Formal sensitivity analyses were not performed due to the limited number of included case series and the small number of studies available for several outcomes. Given the small number of eligible series and heterogeneity in reporting, the meta-analyses of proportions and meta-regressions were considered primarily descriptive in nature.

To partially address robustness, aggregate case report data was incorporated into the meta-regression models to increase the effective number of series contributing to each outcome. This allowed exploratory assessment of predictor-outcome relationships across a larger pooled dataset. However, no additional sensitivity analyses (e.g. leave-one-out analyses, exclusion of small studies, or alternative meta-analytic models) were conducted, as such analyses would not have been statistically meaningful in the context of the available data.

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Secondly, to investigate potential sources of heterogeneity, univariate meta-regression was performed for each outcome. Given the small number of case series available, series-level data was combined with collapsed aggregate case reports to increase the number of contributing studies. Meta-regressions examined associations between outcome proportions and patient-level predictors including gender, population characteristics, ingestion motivations, and object type.

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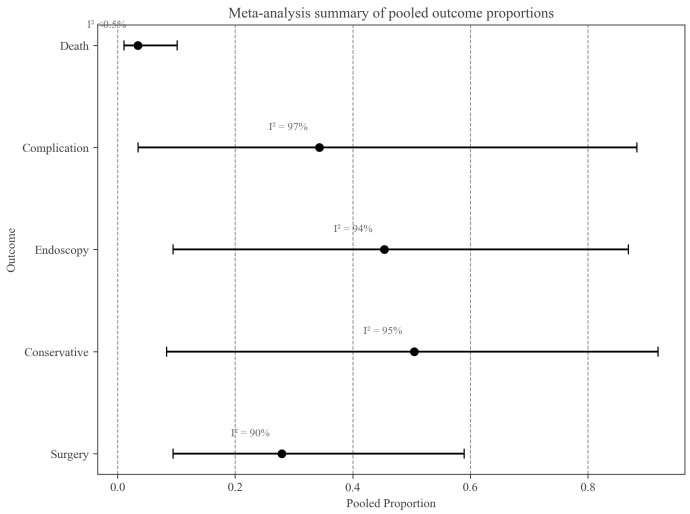


Fig. 2: Case series meta-analysis of pooled outcome proportions.

### *Assessment of Reporting Bias*

Risk of bias due to missing results (arising from reporting biases) was not formally assessed through funnel plot inspection or quantitative methods such as Egger's test, as the number of included case series per outcome was too small to support these analyses (fewer than 10 series per outcome). Furthermore, case series are prone to selective reporting and variable outcome definitions, which may contribute to reporting bias; however, the heterogeneity in reporting precluded a more formal assessment.

For the meta-regressions, the inclusion of aggregate case report data partially mitigated the risk of missing results at the series level but could not address potential reporting biases within the individual case reports or across studies. Overall, the potential for reporting bias remains a limitation of the syntheses presented in this review and should be considered when interpreting results.

### *Certainty of Evidence*

A formal assessment of certainty in the body of evidence (e.g. using the GRADE approach) was not performed, as the included evidence was primarily derived from case reports and case series, which are inherently subject to a high risk of bias and lack of control groups. Additionally, heterogeneity across studies was substantial for several outcomes, and reporting was inconsistent across series.

The small number of available case series per outcome, the inclusion of aggregate case report data, and the observational nature of the data all limit the certainty of the synthesised results. As such, the findings of this review should be interpreted as exploratory and hypothesis-generating, rather than providing high-confidence estimates of effect.

## DISCUSSION

### *Interpretation of Results*

The present review represents, to the author's knowledge, the largest synthesis of intentional ingestion of foreign objects (IIFO)

cases published to date, aggregating evidence from 72 case reports (*n*=72 individuals) and three case series (*n*=90 individuals). Several clinically salient patterns emerged.

*Patient motivation is a key driver of management and outcomes:* Across aggregated case-level data, an explicit intent to self-harm was strongly and independently associated with a greater likelihood of surgical intervention (adjusted odds ratio [aOR] 15.97, 95% CI 1.32–192.40). In the series-level meta-regression, the same motivation increased the pooled probability of surgery by 11% and simultaneously reduced the probability of conservative management by 17%. These findings suggest that self-harm intention may correlate with the ingestion of more dangerous objects (e.g., longer, multiple, or sharp items) or with more limited cooperation during endoscopic retrieval, thereby lowering the threshold for operative management.

By contrast, protest-related ingestions-almost exclusively reported in detained populations—were associated with a markedly elevated risk of complications (aOR 290.44, 95% CI 1.40–60,043.40) despite being less frequently managed surgically. This paradox may reflect the ingestion of less inherently hazardous objects (e.g., multiple coins or cutlery, perhaps based on availability of objects) but delayed disclosure, refusal of treatment, and prolonged mucosal contact before medical assessment. Psychiatric and psychosocial motivations were intermediate, modestly increasing surgical rates while decreasing conservative approaches in the series-level analyses, perhaps reflecting the diversity of motivations that are presented in these motivation categories.

*Object characteristics modulate both procedural choice and adverse events:* Long objects (>5 cm) increased the odds of surgery seven-fold and complications twenty-fold, underscoring existing guideline thresholds that recommend operative removal when length exceeds 5–6 cm. Multiple objects behaved similarly, multiplying the adjusted odds of complications by 18, whereas sharp objects paradoxically reduced the likelihood of endoscopic retrieval (OR 0.34, 95% CI 0.13–0.90). The latter may reflect pre-emptive surgical management of sharp items or technical constraints that prompt a conservative waiting period until spontaneous passage or localisation stabilises for operative extraction.

*Demographic and setting factors exert more modest effects:* Age between 41 and 60 years was independently linked to a lower probability of surgery in univariate testing, but this effect did not persist after multivariable adjustment, suggesting confounding by motivation or object type. Male sex—over-represented in both the case series (100%) and the aggregated cohort (60%)—reduced the pooled probability of conservative management by 13%. Detention status, while associated with protest motivation, surprisingly correlated with fewer complications in multivariable models (aOR 0.03, 95% CI 0.00–0.59). One plausible explanation is the heightened clinical vigilance and rapid escalation pathways available in custodial healthcare settings. Another explanation, as seen in some cases [38, 39], could be that when ingesting as a form of protest, ingestors may modify seemingly radiographically high risk looking objects (e.g. metal razorblades) with radiolucent protection (e.g. tape, paper, or chewing gum). Objects would appear high risk on imaging, but the physical mucosal risks from sharp edges (and perhaps thus complications) would be abutted.

*Treatment patterns are heterogeneous.:* Meta-analysis of case series demonstrated wide variation in endoscopic use (pooled proportion 41.6%, $I^2 = 94.9\%$), whereas surgical (17.8%, $I^2 = 17.4$

*Implications for practice and research.:* These findings highlight the importance of systematically documenting the psychosocial context of ingestion alongside detailed object metrics. Future prospective registries should integrate standardised motivation coding and time-to-presentation metrics to refine predictive models. Clinicians should maintain a high index of suspicion for complications in detained or protest-motivated ingestions even when initial imaging appears favourable.

### *Limitations of the Evidence Base*

The certainty of the above interpretations is tempered by several inherent weaknesses in the available literature.

*Predominance of uncontrolled designs:* All included studies were descriptive case reports or case series lacking comparator groups. This precludes causal inference and amplifies susceptibility to selection bias, as more severe or dramatic presentations are preferentially published.

*Small sample sizes and sparse data:* Even after pooling, outcome events such as death (*n*=3) were rare, limiting statistical power and inflating confidence intervals—most notably in the multivariable models where some estimates span several orders of magnitude.

*Heterogeneous—and sometimes opaque—variable definitions:* Motivation categories were author-defined and variably applied, raising the risk of misclassification. Object descriptors ("long", "sharp", "large diameter") were inconsistently measured, and key parameters such as exact dimensions or material composition were often omitted.

*Incomplete outcome ascertainment and follow-up:* Many reports truncated follow-up at hospital discharge, obscuring delayed complications such as stricture formation or psychiatric relapse. Without uniform longitudinal data, outcome proportions may underestimate true morbidity.

*Publication and reporting biases:* Funnel-plot assessment was infeasible, but the over-representation of male detainees and dramatic surgical cases suggests selective reporting. Negative or conservatively managed cases, particularly in community psychiatry settings, are likely under-published.

*Limited generalisability:* The aggregated series drew heavily from custodial environments in North America and Europe. Cultural, legal, and healthcare-system differences mean that motivation profiles, object availability, and management pathways may diverge in other regions.

*Temporal changes in clinical practice:* The study period spans nearly three decades, during which endoscopic technology, retrieval devices, and guideline recommendations have evolved. Earlier cases may not reflect contemporary management capabilities.

*Missing motivation data and unclear intentionality:* Fifty otherwise eligible papers did not specify patient motivation and were therefore excluded from quantitative synthesis; as motivation strongly influences management decisions, this omission likely biases effect estimates toward cohorts with better-documented psychosocial backgrounds. An additional 94 papers failed to confirm whether the ingestion was intentional, leading to their exclusion. These gaps constrain the representativeness of our sample and may under- or over-estimate the frequency of self-harm or protest-driven ingestions.

*Absence of anatomical location data:* Although many primary reports specified the site of lodgement (e.g., oesophagus, stomach, small bowel), systematic extract or coding this variable was not undertaken. Failure to adjust for location—particularly oesophageal impaction, which is linked to higher perforation risk and lower endoscopic success[14, 15]—may confound the observed associations between motivation, object characteristics, and outcomes.

*Undifferentiated psychiatric history:* Psychiatric history was extracted only as a binary yes/no field, with no breakdown by diagnostic category, severity, or treatment status. Collapsing diverse conditions—such as borderline personality disorder, intellectual disability, or psychosis—into one umbrella variable likely diluted diagnosis-specific risk signals and limited our ability to model nuanced links between mental-health phenotypes, motivation, and outcomes. Prospective studies should capture granular psychiatric diagnoses and therapeutic engagement to refine risk stratification.

*Case-series dominance by male detainees:* All three pooled series described exclusively male prison inmates—most with protest or self-harm motives and sharp objects such as razor blades [109–111]. Their homogeneous demographic and custodial context disproportionately increased the weight of detained-person, male-gender, and protest-motivation categories in the series-level models, likely amplifying the observed association between protest motivation and complications and contributing to the extreme heterogeneity seen for endoscopic rates. Consequently, pooled proportions may not extrapolate to civilian, paediatric settings.

*Recommendation for future reporting:* Given the prognostic importance of motivation, this review strongly encourage authors and clinicians to document explicitly whether an ingestion is intentional or accidental and to record the underlying motive when known. Such standardised reporting would enhance the comparability of studies and improve risk-stratified care.

Taken together, these limitations necessitate cautious interpretation of effect sizes and underscore the need for prospective, multi-centre registries with standardised data dictionaries and longer follow-up horizons.

### *Limitations of the Review Process*

Several limitations of the review process should be acknowledged. Firstly, although a comprehensive search strategy was implemented, it is possible that relevant studies were missed, particularly unpublished case series or reports not indexed in major databases. Secondly, screening and data extraction were conducted by a single reviewer, which may introduce the risk of human error or subjective bias in study selection and coding. To mitigate this, detailed protocols and reproducible scripts were used, and key results were cross-checked. Thirdly, reporting of outcomes and predictor variables varied substantially across included studies, particularly in case reports, which limited the completeness and consistency of data synthesis. Finally, no formal assessment of study-level risk of bias was performed, as the majority of included studies were descriptive case series and reports without comparative designs. These limitations should be considered when interpreting the findings of this review.

### *Data Availability*

Data collection, maniplation and analysis in this review were conducted using Python [43] in *Visual Studio Code* [114] and *Jupyter Notebooks* [115]. The manuscript was compiled using *LaTeX* [116]. Specific packages used include: *Pandas* [117], *scikit-learn* [118], *statsmodel* [45], *seaborn* [119].

The data and code used in this systematic review are available on Github at http://github.com/jackgedge/iifo_systematic_review.

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# APPENDIX A
# ELIGIBILITY CRITERIA

## A. Inclusion Criteria

| Category | Details |
|---|---|
| Population | Any human.<br>Any age group. |
| Interventions or exposures | Humans that have:<br>– Non-accidental ingestion<br>– Ingestion of a true foreign body (non-nutritive items) |
| Comparators / Control group | Demographic:<br>– Gender<br>– Age<br>– Detained Person<br>– Psychiatric Inpatient<br>- Displaced Person<br>- Under Influence of Alcohol<br>- Psychiatric History<br>- Severely Disabled<br>- Previous Ingestion<br>Motivation:<br>– Intent to harm<br>– Psychiatric<br>– Psychosocial<br>– Protest<br>– Other<br>Object characteristics:<br>– Button battery<br>– Magnet<br>– Long (>5 cm)<br>– Large diameter (>2.5 cm)<br>– Multiple<br>– Blunt objects<br>– Sharp-pointed objects |
| Outcomes of interest | – Endoscopic intervention<br>– Surgical intervention<br>– Conservative management<br>– Complication rates<br>– Mortality rates |
| Setting | Any setting. |
| Study designs | Any design. |

TABLE VII: Inclusion criteria structured using the PICO framework.

## B. Exclusion Criteria

| # | Exclusion Criterion |
|---|---|
| 1 | Full text not available in English. |
| 2 | Studies not focusing on intentional self-ingestion (into the gastrointestinal tract) of a foreign object via the oral cavity (mouth), or where it is unclear if ingestion occurred. |
| 3 | Studies focusing solely on accidental ingestion. |
| 4 | Non-human or animal studies. |
| 5 | Reviews, editorials, commentaries, and opinion pieces without original empirical data. |
| 6 | Duplicate publications or studies with overlapping datasets (only the most comprehensive or recent study was included). |
| 7 | Studies focusing on ingestion or co-ingestion of substances (e.g., poisons, medications) rather than physical foreign objects. |
| 8 | Ingestions undertaken in controlled environments as part of a voluntary study. |
| 9 | Ingestions not explicitly stated to be intentional and not suggestive of deliberate ingestion. |
| 10 | Does not meet inclusion criteria. |
| 11 | Ingestions where death resulted from other means (e.g., suicide by other method). |
| 12 | Studies published before the advent of endoscopy (1906). |
| 13 | Outcomes not reported. |
| 14 | Motivation not reported. |
| 15 | Object characteristics not reported' |

TABLE VIII: Exclusion criteria for study selection.

# APPENDIX B
# KEYWORDS AND MESH TERMS

## A. PubMed

| Concept | Keywords | MeSH Terms |
|---|---|---|
| Foreign Bodies | "foreign obj*"<br>"foreign bod*" | Foreign Bodies [MeSH] |
| Intentional Ingestion / Self-harm | "intent*"<br>"deliberate*"<br>"purpose*"<br>"self-injur*"<br>"selfharm*"<br>"self-harm*" | Self-Injurious Behavior [MeSH] |
| Ingestion Behavior | "ingest*"<br>"swallow*" | – |
| Interventions | "surg*"<br>"endoscop*"<br>"EGD"<br>"OGD"<br>"Esophagogastroduodenoscopy"<br>"Oesophagogastroduodenoscopy"<br>"manag*" | Endoscopy [MeSH]<br>Surgical Procedures, Operative [MeSH]<br>Conservative Treatment [MeSH]<br>Drug Therapy [MeSH] |

TABLE IX: Concepts with associated keywords and MeSH terms used in PubMed search strategy.

## B. Embase

| Concept | Keywords | EMTREE Terms |
|---|---|---|
| Foreign Bodies | "foreign obj*"<br>"foreign bod*" | "foreign body"/exp |
| Intentional Ingestion / Self-harm | "intent*"<br>"deliberate*"<br>"purpose*"<br>"self-injur*"<br>"selfharm*"<br>"self-harm*" | "automutilation"/exp |
| Ingestion Behavior | "ingest*"<br>"swallow*" | "swallowing"/exp |
| Interventions | "surg*"<br>"endoscop*"<br>"EGD"<br>"OGD"<br>"Esophagogastroduodenoscopy"<br>"Oesophagogastroduodenoscopy"<br>"manag*" | "endoscopy"/exp<br>"surgery"/exp<br>"conservative treatment'/exp<br>'drug therapy"/exp |

TABLE X: Concepts with associated keywords and EMTREE terms used in Embase search strategy.

### C. Cochrane (CENTRAL)

| Concept | Keywords | Cochrane MeSH Terms |
|---|---|---|
| Foreign Bodies | "foreign obj*"<br>"foreign bod*"<br>(foreign NEXT obj*)<br>(foreign NEXT bod*) | [mh foreign bodies] |
| Intentional Ingestion / Self-harm | intent*<br>deliberate*<br>purpose*<br>(self NEXT injur*)<br>(self NEXT harm*) | [mh self-injurious behavior] |
| Ingestion Behavior | ingest*<br>swallow* | – |
| Interventions | surg*<br>endoscop*<br>EGD<br>Esophagogastroduodenoscopy<br>Oesophagogastroduodenoscopy<br>manag* | [mh endoscopy]<br>[mh surgical procedures, operative]<br>[mh conservative treatment]<br>[mh drug therapy] |

TABLE XI: Concepts with associated keywords and Cochrane MeSH terms used in CENTRAL search strategy.

### D. Web of Science

| Concept | Keywords | Search Field |
|---|---|---|
| Foreign Bodies | foreign obj*<br>foreign bod*<br>automutilation | ALL= |
| Intentional Ingestion / Self-harm | intent*<br>deliberate*<br>purpose*<br>self-injur*<br>selfharm*<br>self-harm* | ALL= |
| Ingestion Behavior | swallowing<br>ingest*<br>swallow* | ALL= |
| Interventions | endoscopy<br>surgery<br>conservative treatment<br>drug therapy<br>surg*<br>endoscop*<br>EGD<br>Esophagogastroduodenoscopy<br>Oesophagogastroduodenoscopy<br>manag* | ALL= |

TABLE XII: Concepts with associated keywords and Web of Science fields used in the search strategy.

### *E. Scopus*

| Concept | Keywords | Search Field / Syntax |
|---|---|---|
| Foreign Bodies | foreign PRE/0 obj*<br>foreign PRE/0 bod* | ALL() |
| Intentional Ingestion / Self-harm | intent*<br>deliberate*<br>purpose*<br>self PRE/0 injur*<br>self PRE/0 harm* | ALL() |
| Ingestion Behavior | ingest*<br>swallow* | ALL() |
| Interventions | endoscopy<br>surgery<br>'conservative'<br>'treatment'<br>'drug'<br>'therapy'<br>surg*<br>endoscop*<br>egd<br>esophagogastroduodenoscopy<br>oesophagogastroduodenoscopy<br>manag* | ALL() |

TABLE XIII: Concepts with associated keywords and Scopus syntax used in the search strategy.

### *F. PsycINFO*

| Concept | Keywords | PsycINFO Descriptors |
|---|---|---|
| Foreign Bodies | foreign obj*<br>foreign bod*<br>automutilation | – |
| Intentional Ingestion / Self-harm | intent*<br>deliberate*<br>purpose*<br>self injur*<br>self harm* | DE "Nonsuicidal Self-Injury" |
| Ingestion Behavior | ingest*<br>swallow* | DE "Ingestion" |
| Interventions | endoscop*<br>conservative treatment<br>drug therapy<br>surg*<br>egd<br>esophagogastroduodenoscopy<br>oesophagogastroduodenoscopy<br>manag* | DE "Surgery" |

TABLE XIV: Concepts with associated keywords and controlled vocabulary (Descriptors) used in PsycINFO search strategy.

### G. Google Scholar

| Concept | Keywords | Search Field |
|---|---|---|
| Foreign Bodies | "foreign obj*"<br>"foreign bod*" | – |
| Intentional Ingestion / Self-harm | "intent*"<br>"deliberate*"<br>"purpose*"<br>"self-injur*"<br>"selfharm*"<br>"self-harm*" | – |
| Ingestion Behavior | "ingest*"<br>"swallow*" | – |

TABLE XV: Concepts with associated keywords used in Google Scholar search strategy.

## APPENDIX C
## VARIABLE DEFINITIONS

Used for case report data extraction. Aggregates of which where used to create Variable_Rate and Variable_Cases.

| Variable | Definition |
|---|---|
| Is_Prisoner | Documented in prison, police custody, or detained (including immigration detention) at the time of the encounter; 'N' if not detained; 'UK' if unknown. |
| Psych_Hx | Documented DSM-V mental disorder (including substance-related disorders) [120]; 'N' if no diagnosis; 'UK' if data unavailable. |
| Is_Displaced_Person | 'Y' if: meets the UN General Assembly [121] definition of 'Refugee'; or meets UNHCR [122] definition of an 'internally displaced person'; or meets the UNHCR [123] definition for 'asylum seeker'; 'N' if not displaced; 'UK' if unknown. |
| Under_Influence_Alcohol | Evidence, suspicion, or self-report of alcohol influence at presentation; 'N' if no indication; 'UK' if unknown. |
| Is_Psych_Inpat | Admitted (voluntarily or involuntarily) to a psychiatric facility/ward at encounter; 'N' if not admitted; 'UK' if unknown. |
| Severe_Disability_Hx | History of severe learning disability or impaired consciousness; 'N' if absent; 'UK' if unknown. |
| Previous_Ingestions | Prior episode of foreign-body ingestion documented; 'N' if first ingestion; 'UK' if history unknown. |
| Motivation_Intent_To_Harm | Ingestion intended for self-harm, self-injury, or suicide; 'N' if other motive; 'UK' if unclear. |
| Motivation_Protest | Ingestion as protest, demonstration, or manipulation (e.g., objection to detention conditions); 'N' if not protest-related; 'UK' if unclear. |
| Motivation_Psychiatric | Ingestion driven primarily by an underlying psychiatric condition (psychosis, impulsivity, etc.); 'N' if not psychiatric; 'UK' if unclear. |
| Motivation_Psychosocial | Ingestion motivated by social or interpersonal factors (imitative acts, shock value, body-image, safekeeping, etc.); 'N' if not psychosocial; 'UK' if unclear. |
| Motivation_Unknown | No clear motivation identified in documentation; 'N' if specific motive recorded; 'UK' if ambiguous. |
| Object_Button_Battery | Button battery ingested; 'N' if not; 'UK' if object type not recorded. |
| Object_Magnet | Magnet ingested; 'N' if none; 'UK' if unknown. |
| Object_Long | Ingested object length $>$ 5 cm; 'N' if $\leq$ 5 cm; 'UK' if dimensions unknown. |
| Object_Sharp | Object described as sharp or pointed (e.g., blades, nails, needles); 'N' if not sharp; 'UK' if unclear. |
| Object_Multiple | More than one object ingested in same episode; 'N' for single object; 'UK' if number unspecified. |
| Object_Unknown | Where object characteristics are unknown. 'N' if known; 'UK' if Unknown. |
| Outcome_Endoscopy | Endoscopic intervention performed during episode; 'N' if not; 'UK' if unavailable. |
| Outcome_Surgery | Surgical intervention performed (operative procedure under anaesthesia); 'N' if not; 'UK' if not documented. |
| Outcome_Conservative | 'Y' if managed without endoscopy or surgery; 'N' if either procedure performed. |
| Outcome_Death | Death causally related to ingestion complications; 'N' if survived; 'UK' if outcome unknown. |
| Outcome_Complication | 'Y' if any complication directly related to ingestion or resulting from management strategy; 'N' if no complication; 'UK' if unknown. |
| Outcome_Unknown | Where no outcome identified; 'N' if outcome identified; 'UK' if Unknown. |

*Demographic:* Individuals were considered detained if they were documented to be in prison, police custody, or immigration detention at the time of the encounter. If they were not detained, this was recorded as 'N'; if the status was unknown, it was marked as 'UK'. Psychiatric history was defined as a documented diagnosis of a mental disorder according to DSM-V criteria, including substance-related disorders [120]. Absence of a diagnosis was recorded as 'N', and unavailable data as 'UK'. Displacement status was defined as meeting one of the following: the UN General Assembly's definition of a 'refugee' [121], the UNHCR's definition of an 'internally displaced person' [122], or the UNHCR's definition of an 'asylum seeker' [123]. Those who did not meet these definitions were marked as 'N', and those with unknown status as 'UK'. Alcohol use was defined as any evidence, suspicion, or self-report of being under the influence of alcohol at the time of presentation. A lack of such indication was recorded as 'N', and unknown status as 'UK'. Psychiatric inpatient status was defined as being admitted (voluntarily or involuntarily) to a psychiatric facility or ward at the time of the encounter. If the person was not admitted, this was recorded as 'N'; unknown status was marked as 'UK'. A history of severe disability included documented cases of severe learning disability or impaired consciousness. Absence of such a history was recorded as 'N', and 'UK' was used when data were unavailable. Previous ingestions referred to any documented prior episode of foreign-body ingestion. If it was the first recorded incident, this was marked as 'N'; if unknown, 'UK' was used.

*Motivation:* Intent to harm was defined as ingestion carried out with the purpose of self-harm, self-injury, or suicide. If the ingestion was for another reason, it was recorded as 'N'. If the intent was unclear, it was marked as 'UK'. Protest-related ingestion was defined as an act of ingestion carried out as a form of protest, demonstration, or manipulation—for example, in response to detention conditions. If the ingestion was not motivated by protest, it was marked as 'N'; if unclear, as 'UK'. Psychosocial motivation included ingestion motivated by social or interpersonal dynamics—such as imitative behaviour, a desire to shock, body-image concerns, or the use of ingestion for safekeeping objects. If these factors were not involved, the case was marked as 'N'; if unclear, as 'UK'. Unknown motivation was recorded when no clear motivation was identifiable in the documentation. If a specific motive was documented, this was marked as 'N'. If the available information was ambiguous, it was recorded as 'UK'.

*Object:* Button battery ingestion was recorded when documentation confirmed that a button battery had been ingested. If no button battery was ingested, this was marked as 'N'; if the type of object was not recorded, it was marked as 'UK'. Magnet ingestion was identified when a magnet was reported as the ingested object. If no magnet was ingested, this was marked as 'N'; if the object type was unknown, it was marked as 'UK'. Long objects were defined as any ingested object longer than 5 cm. If the object was 5 cm or shorter, this was recorded as 'N'. If the object's dimensions were not known, the entry was marked as 'UK'. Sharp objects included those described as pointed or capable of causing injury—such as blades, nails, or needles. If the object was not sharp, it was marked as 'N'; if the description was unclear, it was recorded as 'UK'. Multiple object ingestion referred to the ingestion of more than one object during a single episode. A single ingested object was recorded as 'N', and cases with unspecified object counts were marked as 'UK'. Unknown object characteristics were recorded when no reliable information about the ingested object was available. If the object was identified, this was marked as 'N'; if unknown, it was marked as 'UK'.

*Outcome:* An endoscopic intervention was recorded when a procedure using flexible or rigid endoscopy via natural orifices was performed to retrieve an ingested object or assess complications. If no endoscopy was performed, this was recorded as 'N'; if the information was unavailable, it was marked as 'UK'. A surgical intervention was defined as any operative procedure carried out in a sterile operating theatre under general or regional anaesthesia. This included procedures such as laparotomy, laparoscopy, thoracotomy, or cervical exploration—either to remove an ingested object or to manage complications. If surgery was not performed, the case was marked as 'N'; if it was not documented, it was recorded as 'UK'. Conservative management referred to cases managed without either endoscopy or surgery. These were marked as 'Y'. If either procedure was performed, the case was recorded as 'N'. Mortality was defined as death causally related to ingestion or its complications. If the patient survived, this was recorded as 'N'; if the outcome was unknown, it was marked as 'UK'. Complications were recorded when there was a direct clinical consequence related to the ingestion or the treatment strategy—for example, perforation, bleeding, or infection. Absence of complications was recorded as 'N'; if the status was unclear or undocumented, it was marked as 'UK'. Finally, unknown outcome was recorded when no clinical outcome (such as discharge, intervention, or death) could be identified from documentation. If an outcome was clearly documented, this was marked as 'N'; if unknown, it was marked as 'UK'. """

### *Effects Measures*

*Case Reports:*

*Univariate Association Testing:* For binary outcomes (endoscopy, surgery, conservative management, complications, and death), the effect measure used was the odds ratio (OR), calculated from 2x2 contingency tables. Each odds ratio was accompanied by a 95% confidence interval (CI) and a p-value derived from either a chi-square test of independence or, where expected cell counts were below 5, Fisher's exact test. [41]

This approach was used consistently across all pairwise comparisons between binary exposure variables (e.g., motivations, object types, population characteristics) and binary outcome variables. Significant associations were identified at a threshold of $p < 0.05$ and reported alongside their respective ORs and CIs. Due to the small number of deaths observed, effect estimates for death should be interpreted with caution.

*Logistic Regression Modelling:* To explore which factors were independently associated with clinical outcomes, the analysis looked at multivariate logistic regression analyses for five outcomes of interest: endoscopy, surgery, conservative management, complications, and death. For each outcome, a logistic regression model was developed and included the afforementioned groups of predictor variables: age group, gender, demographic, motivation, and object characteristics.

Age group, gender, and motivation variables were entered as one-hot encoded categorical variables with a reference category omitted. Population characteristics and object type variables were included as binary indicators. A constant term was included in each model. All variables were selected a priori based on clinical

relevance and prior univariate (chi-square, Fisher's exact test) analyses.

Missing values in predictor variables were imputed as zero. Models were fitted using maximum likelihood estimation via the *statsmodels Python* library [45]. In the event that a model failed to converge or could not be fitted (as occurred for the death outcome due to small sample size), an empty result table was substituted to maintain consistency of reporting across outcomes.

For each predictor, the odds ratio (OR) with corresponding 95% confidence interval (CI) and p-value were reported. Results from all models were summarised in a single grouped wide table, with predictors grouped into their logical domains (age, gender, demographic, motivation, object). The intercept term (`const`) was excluded from the summary table. Significant predictors ($p < 0.05$) were flagged with an asterisk.

*Case Series:*

*Meta-analysis of Proportions:* To provide descriptive summary estimates of clinical outcomes across included case series, a meta-analyses of proportions included: endoscopy, surgery, complications, death, and conservative management. For each outcome, the observed proportion was calculated within each series and performed a random-effects meta-analysis using the Der Simonian-Laird method to pool proportions on the logit scale. Between-study heterogeneity was quantified using the $I^2$ statistic and between-study variance ($\tau^2$). These analyses provided overall estimates of outcome frequencies across studies and informed interpretation of subsequent meta-regression analyses. All meta-analyses were conducted using custom *Python* [43] code implementing standard meta-analytic formulas.

*Meta-Regression:* It was anticipated that the number of independent case series would be small, limiting the feasibility of multivariable modelling. To increase the effective number of contributing series, the series-level data were combined with the aggregate case report data, collapsed to series level.

Univariate meta-regression was performed to explore associations between predictor variables (gender, demographic, ingestion motivations, object characteristics) and clinical outcomes (endoscopy, surgery, conservative management, complications, death). For each outcome, the logit-transformed proportion of cases was modelled using weighted least squares, with inverse variance weighting to account for differing series sizes.

Significant associations ($p < 0.05$) were reported for each predictor, grouped by conceptual domain. All other comparisons were noted as non-significant. /Users/jackgedge/Projects/msc$_d$issertation/iifo$_m$otivation/output/reports/final$_r$eport/sections/appendix$_f$.texIntheagegroupsubgro
$-60agegroupwassignificantlyassociatedwithreducedoddsofsurgery(OR =$
$0.18, 95\%CI[0.04, 0.76], p = 0.019).Inthemotivationsubgroup, intenttoharmmotivationwassignificantlyassociatedwithincreasedodd$
$5.40, 95\%CI[1.36, 21.43], p =$
$0.024); othermotivationwassignificantlyassociatedwithreducedoddsofsurgery(OR =$
$0.14, 95\%CI[0.03, 0.75], p = 0.023).Intheobjectsubgroup, sharpobjectingestionwassignificantlyassociatedwithreducedoddsofendos$
$0.34, 95\%CI[0.13, 0.90], p = 0.048).Therewerenosignificantassociationswithoutcomesinthegender, andpopulationsubgroups.$

*Multivariate Logistic Regression:* A full table of grouped series-level logistic regression results is available in Table V. In the motivation subgroup, protest motivation was significantly associated with increased odds of complication (aOR = 231.67, 95% CI [1.16, 46389.11], p = 0.044). In the object subgroup, multiple object ingestion was significantly associated with increased odds of complication (aOR = 27.80, 95% CI [3.18, 242.85], p = 0.003); long (>5cm) object ingestion was significantly associated with increased odds of complication (aOR = 13.74, 95% CI [1.27, 148.57], p = 0.031). In the population subgroup, detained person was significantly associated with reduced odds of surgery (aOR = 0.04, 95% CI [0.00, 0.77], p = 0.033); detained person was significantly associated with reduced odds of complication (aOR = 0.02, 95% CI [0.00, 0.47], p = 0.015). There were no significant associations with outcomes in the age group, and gender subgroups.

*Case Series:*

*Meta-analysis of Proportions:* A plot of aggregate series-level meta-analysis of pooled outcome proportions is shown in Figure 2. Meta-analyses of proportions was performed for endoscopy, surgery, death, complication, and conservative. The pooled proportion of patients undergoing endoscopy was 45.4% (95% CI 9.4%–86.9%), with substantial heterogeneity ($I^2$ = 93.5%). The pooled proportion of patients undergoing surgery was 27.9% (95% CI 9.4%–59.0%), with substantial heterogeneity ($I^2$ = 90.3%). The pooled proportion of patients dying was 3.4% (95% CI 1.1%–10.1%), with low heterogeneity ($I^2$ <0.5%). The pooled proportion of patients experiencing a complication was 34.3% (95% CI 3.5%–88.4%), with substantial heterogeneity ($I^2$ = 96.6%). The pooled proportion of patients conservative management was 50.4% (95% CI 8.3%–91.9%), with substantial heterogeneity ($I^2$ = 94.7%).

*Meta Regression:* A full table of grouped aggregate series-level results for univariate meta-regression is available in Table VI.

## APPENDIX D
## APPENDIX D

## APPENDIX E
## COMPUTATIONAL RISK OF BIAS ASSESSMENT

*Case Reports:* For case reports, the JBI Checklist for Case Reports was used. This tool assesses eight domains of reporting quality, including whether patient demographics were clearly described, a timeline of clinical history was provided, the presenting condition and diagnostic assessment were outlined, and whether the intervention, post-intervention condition, and any adverse events were reported. The final domain evaluates whether the case provides meaningful takeaway lessons.

In addition to manual JBI appraisal, a logic-based validation filter was applied to all case reports using *Python Pandas* [117]. This secondary filter assessed whether key variables — specifically, outcomes, object characteristics, and motivation — were completely unreported. For each domain, a binary flag was generated:

- *Outcome_Unknown* was marked `1` if all outcome-related fields were either missing or marked as unknown.
- *Object_Unknown* was marked `1` if all object-related fields (excluding *Object_Other_Long*) were missing or unknown.
- *Motivation_Unknown* was predefined in the dataset and indicated absence of motivational information.

If any of these flags were triggered, the corresponding JBI item most affected by the missing domain was marked as not reported (e.g., *Post_Intervention_Condition_Described* or *History_Timeline* set to `N`). Finally, an *Overall_Appraisal* score of *Exclude* was assigned, indicating high risk of bias and exclusion from analysis. This ensured that only case reports with sufficient information to meaningfully contribute to the review question were retained.

*Case Series:* For case series, the JBI Checklist for Case Series was applied. The JBI Checklist for Case Series assesses 10 domains of methodological and reporting quality. These include whether the case series defined clear inclusion criteria, applied valid and consistent methods to identify the condition, and included participants consecutively and completely. The checklist also evaluates whether participant demographics and clinical information were clearly reported, whether outcomes or follow-up results were adequately described, and whether the study setting was detailed. Finally, it considers whether the statistical analysis used was appropriate for the data presented.

In addition to manual JBI appraisal, a logic-based exclusion filter was applied using *Python Pandas* [117]. This filter assessed whether key variables — specifically, motivation, object characteristics, and outcomes — were unreported for the entire study population. For each of these domains, a derived rate variable was calculated:

- *Outcome_Unknown_Rate* was marked as `1` if all outcome-related fields were missing or marked as unknown (i.e. the entire population had an had an unknown outcome).
- *Motivation_Unknown_Rate* indicated whether motivation was absent or only partially reported across cases within the study.
- *Object_Unknown_Rate* was derived if all object-related fields were missing or unknown.

If any of these indicators were flagged, the corresponding JBI checklist item (e.g., *Clear_Outcome_Followup_Reported*, *Clear_Demographic_Reporting*, or *Clear_Clinical_Info_Reporting*) was marked as `N`, and the study received an *Overall_Appraisal* of `Exclude`. This logic-based validation ensured that case series lacking essential variables could be systematically excluded from the final analysis, maintaining consistency with the review question and minimising risk of bias in the dataset.