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Identification of preliminary core outcome domains for communication about childhood vaccination: An online Delphi survey

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ABSTRACT

Background: Communication interventions for childhood vaccination are promising strategies to address vaccine hesitancy, but current research is limited by the outcomes measured. Most studies measure only vaccination-related outcomes, with minimal consideration of vaccine hesitancy-relevant intermediate outcomes. This impedes understanding of which interventions or elements are effective.

It is also unknown which outcomes are important to the range of stakeholders affected by vaccine hesitancy. Outcome selection shapes the evidence base, informing future interventions and trials, and should reflect stakeholder priorities.

Therefore, our aim was to identify which outcome domains (i.e. broad outcome categories) are most important to different stakeholders, identifying preliminary core outcome domains to inform evaluation of three common vaccination communication types: (i) communication to inform or educate, (ii) remind or recall, and (iii) enhance community ownership.

Methods: We conducted a two-stage online Delphi survey, involving four stakeholder groups: parents or community members, healthcare providers, researchers, and government or non-governmental organisation representatives. Participants rated the importance of eight outcome domains for each of the three communication types. They also rated specific outcomes within one domain (“attitudes or beliefs”) and provided feedback about the survey.

Results: Collectively, stakeholder groups prioritised outcome domains differently when considering the effects of different communication types. For communication that aims to (i) inform or educate, the most important outcome domain is “knowledge or understanding”; for (ii) reminder communication, “vaccination status and behaviours”; and for (iii) community engagement communication, “community participation”. All stakeholder groups rated most outcome domains as very important or critical. The highest rated specific outcome within the “attitudes or beliefs” domain was “trust”.

Conclusion: This Delphi survey expands the field of core outcomes research and identifies preliminary core outcome domains for measuring the effects of communication about childhood vaccination. The findings support the argument that vaccination communication is not a single homogenous intervention – it has a range of purposes, and vaccination communication evaluators should select outcomes accordingly.

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Abbreviations: COS, core outcome set (also sometimes used to refer to a core outcome domain set).

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1. Background

Effective communication with parents and communities is crucial to generating and maintaining demand for vaccines, improving global vaccination coverage and addressing vaccine hesitancy [1–7]. Communication strategies for childhood vaccination – here referred to as ‘vaccination communication interventions’ – operate at an interpersonal, community or population level and are delivered in many different ways, including via face-to-face interactions, print, mail/email, phone/SMS, websites, TV and radio, community events and live performances [8–14]. While varied, all vaccination communication interventions can be organised according to an identifiable number of common *purposes*: to inform or educate; remind or recall; enhance community ownership of vaccination; teach skills; provide support; facilitate decision-making or enable communication [9,14]. Organising vaccination communication interventions by purpose may aid in selection of interventions to address identified needs or problems and assists in drawing together this broad field for study [8,9,11,12].

Selection of vaccination communication interventions should ideally be evidence-informed, but it is difficult to estimate effectiveness because implemented interventions are frequently evaluated by measuring inadequate or inappropriate outcomes. A review of the outcomes measured in 112 controlled trials of vaccination communication interventions showed most trials focused solely on a limited range of endpoint outcomes, such as vaccination rates [15], a finding echoed in the final report of the World Health Organization’s SAGE (Strategic Advisory Group of Experts) working group on vaccine hesitancy [16]. This is problematic because vaccination communication interventions are often complex, aiming to do more than increase vaccination rates alone (e.g. some may also aim reduce decisional conflict or increase knowledge), and they may be delivered in multi-component packages with other public health interventions. While obviously critically important, vaccination rates alone cannot tell us how a vaccination communication intervention worked, where or why it succeeded or failed, or which components were effective, essential or even harmful [17–19]. Basing decisions about intervention selection on a limited range of outcomes hampers future intervention development or tailoring and impedes building evidence [20]. For example, there is a fundamental ethical argument for ensuring that people not only adhere to vaccinations, but that their decisions are adequately informed [21]. Measuring only vaccination-related outcomes cannot reveal whether these additional goals have been realised.

This is particularly important when evaluating communication that aims to address vaccine hesitancy. Parents who are vaccine hesitant fall somewhere in the middle of the continuum between total vaccine acceptance and complete refusal [16,22]. While they may fully vaccinate their children, they may still feel some degree of reluctance or doubt about this decision, making them more susceptible to misinformation or safety scares [23]. Vaccination rates alone, therefore, give an incomplete picture of hesitancy [16,24]. To identify whether vaccination communication interventions can reduce hesitancy, additional relevant outcomes need consideration.

Vaccine hesitancy affects all stakeholders in child health – parents, healthcare providers, researchers and policymakers [16] – either personally or through the potential impacts of hesitancy on vaccination rates and public health. Internationally, different stakeholder groups are being invited by researchers to identify the outcomes of key importance for future evaluations of interventions in many other health areas such as cancer, rheumatology and oral health [25]. These activities have shown that different stakeholders may rate the importance of outcomes in different ways,

reflecting their priorities [26–28]. It is not yet known if this is the case in vaccine communication. Understanding what outcomes stakeholders want to achieve or experience may be critical to designing or delivering future interventions.

1.1. Improving vaccination communication evaluation

One way to help researchers and evaluators select and measure relevant outcomes is through the development and use of a core outcome set (COS) [29,30]. A COS is a set of outcomes that stakeholders agree should be measured, at a minimum, in evaluations of a condition or intervention [31,32]. Most COSs begin by defining core outcome domains (i.e. broad categories of what should be measured). Later COS stages move towards identifying specific outcomes within these domains and may also establish measurement methods [33].

In this paper, we describe the identification of preliminary sets of core outcome domains for vaccination communication, the first stage of COS development. A recent study has used COS-related methods to identify ‘core values’ for the evaluation of vaccines themselves [20], but we are not aware of any comparable research into the types of outcomes that could be measured in vaccination communication evaluations.

Because this field is uncharted, our approach was broad. We focused on three common types of vaccination communication interventions with potential to address vaccine hesitancy [34], defined by their purposes: (i) communication to inform or educate, (ii) to remind or recall, or (iii) to enhance community ownership [9]. Using an online Delphi survey, we asked different stakeholders to rate the importance of outcome domains that could be measured for each communication type. Delphi surveys are commonly used for outcome prioritisation related to health conditions [25,26], but the method is largely untested for prioritising communication outcomes. This study gave us the opportunity to examine the Delphi survey’s feasibility in the context of vaccination communication.

This study is the third and final stage in a larger project about outcomes for vaccination communication [35]. Findings have been reported on the outcomes measured in trials [15] and the comprehensive range of specific outcomes that could be measured within each outcome domain [36].

2. Aims

Our aims were:

- (1) To identify outcome domains that are most important to stakeholders when measuring the effects of different vaccination communication types.
- (2) To explore which specific outcomes within one outcome domain (“attitudes or beliefs”) are most important to stakeholders.
- (3) To identify and describe patterns in stakeholder responses relevant to future outcomes research.
- (4) To collect feedback on the applicability and acceptability of the Delphi survey format to prioritise outcome domains for communication interventions.

3. Methods

We used a Delphi survey to identify stakeholder-relevant outcome domains for three common types of vaccination communication. In Delphi surveys, anonymous participants with relevant expertise answer two or more sequential surveys to identify con-

sensus or convergence [37–39]. We used the Delphi survey to identify the outcomes of importance to each stakeholder group, allowing participants to reconsider their own views in the second survey round in light of those of other participants. We anticipated that this process could lead to convergence towards identifying three preliminary sets of core outcome domains.

The La Trobe University Human Ethics Committee approved this study (S16-68).

3.1. Recruitment and participants

There is no consensus on the optimal number of participants for a Delphi survey [26], and panel sizes are generally guided by practicality or question scope [40]. Delphi participants are not sampled for representativeness – rather, they are ‘experts’ drawn from different stakeholder groups to allow comparison and consideration of different perspectives [41]. Therefore, we used stratified purposive sampling [42] to recruit participants from four stakeholder groups: (1) parents or community members; (2) healthcare providers (both professional and lay health workers); (3) researchers; and (4) representatives of governmental, inter- or non-governmental organisations (NGOs). We aimed to reach as many participants in LMIC settings as possible to ensure the COS would include global perspectives.

Using email invitations, we directly recruited people associated with or known to the author team. We also advertised on our research project’s website [35], shared the link on Twitter and Facebook parenting groups and through networks with high LMIC participation (e.g. Healthcare Information for All and the International Union for Health Promotion and Education), and asked participants to invite others (i.e. snowballing).

3.2. Delphi structure and administration

We designed and administered the Delphi survey online using REDCap software (Version 6.7.5) [43]. We understood an online format might limit participation in LMICs, due to inconsistent power supply and internet access. We considered paper surveys, but it was not feasible in the time available. Even with possible access limitations, an online Delphi enabled broad international participation, and the digital platform facilitated analysis and communication with participants. Shorter periods between rounds may improve Delphi survey quality [44], so we administered our rounds within 2–3 weeks of one another. We collected participant email addresses separately from survey responses, ensuring anonymity, though this meant participants’ Round 1 and Round 2 responses were not linked. Participants were not identifiable to one another.

Recruitment materials included the link to Round 1. The Round 2 link was sent to all email addresses from Round 1.

3.3. Generating the survey information

Survey elements are described below. A copy of the survey is available in [Additional File 1](#).

3.3.1. Outcome domains

Prior to survey administration, we reviewed the vaccination communication trial and health communication evaluation literature to identify outcomes potentially relevant to vaccination communication interventions. We also held seven focus groups to discuss vaccination communication experiences, preferences and outcomes with parents, researchers, healthcare providers, and government or NGO representatives. We organised all identified outcomes into a taxonomy of vaccination communication outcomes [15,36]. This taxonomy delineated the eight outcome domains

presented in the survey: “knowledge or understanding”, “attitudes or beliefs”, “decision-making”, “vaccination status and behaviours”, “health status and well-being”, “communication delivery and design”, “community participation”, and “cost”¹.

3.3.2. Interventions

Vaccination communication includes a broad range of interventions, which we had previously organised into a taxonomy of seven communication types based on intended purpose [9]. In this study, we aimed to identify priority outcome domains associated with three vaccine hesitancy-relevant communication types which were also most frequently encountered in literature and field work [8,11,12]: (i) communication to *inform or educate*; (ii) to *remind or recall*; and (iii) to *enhance community ownership* [9]. We focused on these three communication types to enable comparison of stakeholders’ views on the importance of outcomes for different communication purposes.

3.3.3. Specific outcomes within one domain

We also aimed to investigate whether the Delphi could be used to rate the importance of the more specific outcomes within one of the outcome domains: “attitudes or beliefs” (details in [Additional File 2](#)), chosen because these outcomes have particular relevance for understanding vaccine hesitancy [16].

3.4. Survey questions

We piloted the survey with a convenience sample of researchers and parents to gather feedback on its length and clarity, the language used and its accessibility on multiple platforms. This feedback was incorporated into the final design described below.

For each of the three communication types, we asked participants to rate how important they felt it was to measure outcomes from each of the eight outcome domains using a 5-point Likert scale. A rating of 5 meant the domain was considered “critical”; 3 was “important but not critical”; and 1 was “not at all important”. We emphasised that participants should rate the outcome domains from their perspectives (e.g. as parent, as researcher). They also rated the importance of specific outcomes in the “attitudes or beliefs” domain. Questions were repeated in both Delphi Rounds.

In Round 1 only we asked participants to propose and rate additional outcome domains if they felt these were needed. In both Rounds, participants could add additional comments after each question and at the survey’s conclusion. We considered all suggested domains and free text responses carefully. These contributed to our contextual understanding of the survey’s results, and to our assessment of the survey’s strengths and limitations.

The study’s fourth aim was to examine the viability of the Delphi survey as a method for prioritising outcome domains associated with multiple communication types. At the conclusion of Round 1, we gathered participant feedback about the clarity of the survey’s purpose, the description of communication types, and the description of outcome domains using a 5-point Likert scale (5 “very clear”, 3 “somewhat clear”, 1 “very unclear”).

3.5. Survey administration

Round 1 was open for three weeks in June 2016. For Round 2, we sent unique links to all email addresses entered in Round 1. Some participants who entered their email addresses but did not

¹ In the published version of the taxonomy, the title of the domain “communication delivery and design” was changed to “Intervention design and implementation,” and “Cost” was changed to “Resource use.” Their definitions and content were not changed.

complete Round 1 may have participated in Round 2. After Round 1, we tallied responses for each question according to stakeholder group and then, in Round 2, graphically presented the distribution of scores from 1 to 5 (Fig. 1). We asked participants to review these graphs for each question and answer them again.

All original outcome domains and outcomes were presented in both Round 1 to Round 2, regardless of their rating. We considered additional outcome domains proposed by participants in Round 1 but determined that these fell into existing domains, so no additional domains were considered in Round 2.

3.6. Data analysis

Using statistical software SPSS (Version 24), we calculated mean ratings of the outcome domains for each communication type across all stakeholders and by stakeholder group. We considered calculating median and inter-quartile range, as the data were skewed, but this did not illustrate relative differences in rankings between the domains. Therefore, we calculated the mean but acknowledge that this may be influenced by outliers.

We analysed specific outcomes in the “attitudes or beliefs” outcome domain using the same approach. We compared Round 1 and Round 2 using paired-sample t-tests and compared stakeholder ratings using one-way ANOVA with a post-hoc Bonferroni adjustment to identify significant contrasts.

4. Results

4.1. Participant demographics

Some LMIC participants experienced power or internet failures, which could cause them to exit the survey early, so we included data for all completed questions. A partial response was recorded if a participant completed at least one question, but not the entire survey. In total, we had 178 usable responses (i.e. at least one ques-

tion completed) in Round 1, and 136 (76% of first round) in Round 2 (Table 1).

Respondents came from 29 countries, with 21% overall residing in LMICs. An additional 6% lived in HICs but worked on vaccination-related issues globally or in LMICs. The most frequently-represented countries were Australia (44%), the United States (11%), Norway (5%), Nigeria (5%), and Portugal (5%). The high representation from Australia is likely due to the local networks of the lead researchers.

4.2. Survey results

For each communication type, we assessed ratings across all stakeholders (Table 2) and by stakeholder group (Table 3 and Additional File 3). Since this study is the first effort to develop a COS in this complex area, we aimed to establish the relative importance of outcome domains, rather than making an absolute distinction about which domains should or should not be measured. We have therefore presented the full list of domains for each communication type in Table 2 to show differences in ranking order. Any outcome domain rated 4 or greater was considered very important or critical. No domain received an average rating of low importance (1 or 2). There were no large changes in the overall ranking order of the domains between Round 1 and Round 2. Stakeholders tended to rate all outcome domains higher in Round 2 but the reasons for this are unclear.

The most important outcome domain for (i) communication to inform or educate was “knowledge or understanding”; for (ii) reminder communication, it was vaccination status or behaviours; and (iii) for community engagement communication, it was “community participation”. Stakeholders rated most outcome domains as very important or critical, with minimal variation in their priorities across groups (Table 3).

In addition to rating outcome domains for three communication types, participants rated the importance of specific outcomes within the domain “attitudes or beliefs.” All the outcomes were

Round 1 result: proportion of people that chose each rating for knowledge or understanding:



Fig. 1. Example of rating graphs for the outcome domain “knowledge or understanding” for communication to inform or educate. This figure shows an example of the bar graphs presented to stakeholders in Round 2 summarising the ratings from Round 1.

Table 1
Stakeholder responses in Round 1 and Round 2.

| Stakeholder group | Round 1 | | | | Round 2 | | | |
|----------------------------------|---------------------|--------------------|-------------------------------------|-----------------------------------|---------------------|-------------------|-------------------------------------|-----------------------------------|
| | Completed responses | Partial responses* | Total usable responses (% of total) | % of stakeholder group from LMICs | Completed responses | Partial responses | Total usable responses (% of total) | % of stakeholder group from LMICs |
| Parents | 37 | 11 | 48 (27%) | 8% | 30 | 3 | 33 (24%) | 9% |
| Healthcare providers | 61 | 8 | 69 (39%) | 16% | 50 | 1 | 51 (38%) | 14% |
| Researchers | 21 | 5 | 26 (15%) | 29% | 25 | 0 | 25 (18%) | 24% |
| Government / NGO representatives | 31 | 4 | 35 (20%) | 37% | 27 | 0 | 27 (20%) | 48% |
| TOTAL | 150 | 28 | 178 | 20% | 132 | 4 | 136 | 21% |

* Partial responses = at least one question completed.

Table 2
Ratings of outcome domains according to communication type, average across all stakeholder groups.

| Communication types | | | | | | | | | | All communication types combined | | | | | |
|-----------------------------------|-------------|-------------|----------|-----------------------------------|-------------|-------------|---|-----------------------------------|-------------|----------------------------------|----------|-----------------------------------|-------------|-------------|----------|
| Inform or educate | | | | Remind or recall | | | | Enhance community ownership | | | | | | | |
| Outcome Domain | Round 1 | Round 2 | | Outcome Domain | Round 1 | Round 2 | | Outcome domain | Round 1 | Round 2 | | Outcome Domain | Round 1 | Round 2 | |
| | Mean± (SD) | Mean (SD) | p | | Mean (SD) | Mean (SD) | p | | Mean (SD) | Mean (SD) | p | | Mean (SD) | Mean (SD) | p |
| | n | n | | | n | n | | | n | n | | | n | n | |
| Knowledge or understanding | 4.45 (0.81) | 4.56 (0.75) | – | Vaccination status and behaviours | 4.51 (0.72) | 4.66 (0.65) | – | Community participation | 4.62 (0.69) | 4.71 (0.60) | – | Vaccination status and behaviours | 4.28 (0.87) | 4.49 (0.73) | p < 0.05 |
| | n = 178 | n = 134 | | | n = 157 | n = 133 | | | n = 150 | n = 130 | | | n = 487 | n = 397 | |
| Attitudes or beliefs | 4.38 (0.89) | 4.48 (0.72) | – | Communication delivery and design | 4.12 (0.96) | 4.24 (0.84) | – | Attitudes or beliefs | 4.40 (0.86) | 4.67 (0.61) | p < 0.05 | Attitudes or beliefs | 4.24 (0.94) | 4.40 (0.83) | p < 0.05 |
| | n = 177 | n = 133 | | | n = 156 | n = 131 | | | n = 154 | n = 132 | | | n = 487 | n = 398 | |
| Vaccination status and behaviours | 4.22 (0.90) | 4.42 (0.77) | p < 0.05 | Knowledge or understanding | 3.90 (1.06) | 4.14 (0.98) | – | Knowledge or understanding | 4.16 (1.04) | 4.43 (0.83) | – | Knowledge or understanding | 4.08 (1.04) | 4.38 (0.87) | p < 0.05 |
| | n = 176 | n = 133 | | | n = 157 | n = 133 | | | n = 154 | n = 131 | | | n = 459 | n = 398 | |
| Communication delivery and design | 4.03 (0.97) | 4.27 (0.83) | – | Attitudes or beliefs | 3.93 (1.00) | 4.06 (0.98) | – | Communication delivery and design | 4.28 (0.89) | 4.39 (0.72) | – | Communication delivery and design | 4.14 (0.95) | 4.30 (0.80) | p < 0.05 |
| | n = 175 | n = 134 | | | n = 156 | n = 133 | | | n = 154 | n = 130 | | | n = 485 | n = 395 | |
| Community participation | 3.86 (1.08) | 3.99 (0.99) | – | Community participation | 3.81 (1.09) | 3.93 (0.99) | – | Vaccination status and behaviours | 4.11 (0.93) | 4.37 (0.75) | p < 0.05 | Community participation | 4.08 (1.04) | 4.21 (0.95) | p < 0.05 |
| | n = 173 | n = 134 | | | n = 154 | n = 130 | | | n = 154 | n = 131 | | | n = 477 | n = 394 | |
| Decision-making | 4.00 (0.95) | 3.95 (0.78) | – | Decision-making | 3.90 (1.00) | 3.92 (0.86) | – | Decision-making | 3.94 (1.00) | 4.09 (0.73) | – | Decision-making | 3.95 (0.98) | 3.99 (0.79) | |
| | n = 175 | n = 132 | | | n = 157 | n = 131 | | | n = 153 | n = 130 | | | n = 485 | n = 393 | |
| Health status and well-being | 3.84 (1.04) | 3.86 (0.85) | – | Health status and well-being | 3.65 (1.00) | 3.80 (0.90) | – | Health status and well-being | 3.77 (0.97) | 3.82 (0.85) | – | Health status and well-being | 3.76 (1.01) | 3.83 (0.86) | – |
| | n = 176 | n = 133 | | | n = 153 | n = 129 | | | n = 150 | n = 131 | | | n = 479 | n = 393 | |
| Cost | 3.79 (1.09) | 3.80 (0.98) | – | Cost | 3.75 (1.09) | 3.69 (0.93) | – | Cost | 3.75 (1.07) | 3.75 (0.89) | – | Cost | 3.76 (1.09) | 3.75 (0.93) | – |
| | n = 172 | n = 133 | | | n = 150 | n = 129 | | | n = 145 | n = 130 | | | n = 467 | n = 392 | |

* Domains listed in descending order for each communication type, based on Round 2 means; ±1 = not important; 2 = somewhat important; 3 = important but not critical; 4 = very important; 5 = critical.

Table 3
Final round ratings by stakeholder group.

| Outcome Domain | Communication types | | | | | | | | | | | | | | |
|-----------------------------------|-----------------------|---------------------------|-----------------------|-----------------------|------------------------------------|-----------------------|---------------------------|-----------------------|-----------------------|--------------------------|-----------------------------|---------------------------|-----------------------|-----------------------|-----------------------|
| | Inform or educate | | | | | Remind or recall | | | | | Enhance community ownership | | | | |
| | Parents (P) | Healthcare Providers (HP) | Researchers (R) | Govt/ NGO (G) | Significant contrasts ^a | Parents (P) | Healthcare Providers (HP) | Researchers (R) | Govt/ NGO (G) | Significant contrasts | Parents (P) | Healthcare Providers (HP) | Researchers (R) | Govt/ NGO (G) | Significant contrasts |
| Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | | |
| n | n | n | n | | n | n | n | n | | n | n | n | n | | |
| Knowledge or understanding | 4.64 (0.82) n = 33 | 4.65 (0.75) n = 49 | 4.28 (0.68) n = 25 | 4.56 (0.70) n = 27 | – | 4.23 (0.99) n = 31 | 4.46 (0.81) n = 50 | 3.48 (0.96) n = 25 | 4.07 (1.00) n = 27 | R < P R < HP | 4.62 (0.82) n = 29 | 4.66 (0.69) n = 50 | 3.88 (0.93) n = 25 | 4.30 (0.78) n = 27 | R < P R < HP |
| Attitudes or beliefs | 4.00 (0.94) n = 33 | 4.58 (0.61) n = 50 | 4.84 (0.37) n = 25 | 4.56 (0.58) n = 25 | P < HP P < R P < G | 3.68 (1.19) n = 31 | 4.38 (0.78) n = 50 | 3.56 (0.92) n = 25 | 4.37 (0.79) n = 27 | P < HP P < G R < P | 4.50 (0.82) n = 30 | 4.76 (0.43) n = 50 | 4.56 (0.77) n = 25 | 4.78 (0.42) n = 27 | – |
| Decision-making | 3.48 (1.00) n = 33 | 4.04 (0.66) n = 47 | 4.08 (0.57) n = 25 | 4.26 (0.59) n = 27 | P < HP P < R P < G | 3.68 (0.91) n = 31 | 4.12 (0.70) n = 49 | 3.50 (1.02) n = 24 | 4.22 (0.70) n = 27 | R < HP R < G | 3.80 (1.00) n = 30 | 4.21 (0.62) n = 48 | 4.08 (0.64) n = 25 | 4.22 (0.58) n = 27 | – |
| Vaccination status and behaviours | 4.16 (0.92) n = 32 | 4.46 (0.76) n = 50 | 4.60 (0.65) n = 25 | 4.50 (0.65) n = 26 | – | 4.61 (0.76) n = 31 | 4.64 (0.63) n = 50 | 4.76 (0.60) n = 25 | 4.67 (0.62) n = 27 | – | 4.3 (0.75) n = 30 | 4.41 (0.79) n = 49 | 4.28 (0.79) n = 25 | 4.48 (0.64) n = 27 | – |
| Health status and well-being | 3.73 (1.07) n = 33 | 4.02 (0.75) n = 49 | 3.64 (0.91) n = 25 | 3.92 (0.56) n = 26 | – | 3.57 (1.10) n = 30 | 4.11 (0.76) n = 47 | 3.48 (0.92) n = 25 | 3.81 (0.68) n = 27 | R < HP | 3.43 (0.90) n = 30 | 4.06 (0.83) n = 49 | 3.72 (0.74) n = 25 | 3.93 (0.78) n = 27 | P < HP |
| Communication delivery and design | 3.76 (1.06) n = 33 | 4.38 (0.70) n = 50 | 4.44 (0.65) n = 25 | 4.54 (0.65) n = 26 | P < HP P < R P < G | 3.70 (1.15) n = 30 | 4.37 (0.70) n = 49 | 4.32 (0.69) n = 25 | 4.56 (0.51) n = 27 | P < HP P < R P < G | 4.03 (0.98) n = 29 | 4.57 (0.58) n = 49 | 4.32 (0.63) n = 25 | 4.52 (0.58) n = 27 | P < HP |
| Community participation | 3.82 (1.04) n = 33 | 4.08 (0.99) n = 50 | 3.76 (1.01) n = 25 | 4.23 (0.86) n = 26 | – | 3.57 (1.25) n = 30 | 4.14 (0.79) n = 49 | 3.60 (1.04) n = 25 | 4.27 (0.72) n = 26 | P < G | 4.47 (0.94) n = 30 | 4.67 (0.52) n = 49 | 4.88 (0.34) n = 24 | 4.89 (0.32) n = 27 | P < G |
| Cost | 3.39 (1.06) n = 33 | 3.84 (1.07) n = 49 | 3.96 (0.75) n = 24 | 4.07 (0.73) n = 27 | P < G | 3.23 (0.97) n = 30 | 3.98 (0.85) n = 47 | 3.48 (0.87) n = 25 | 3.89 (0.89) n = 27 | P < HP P < G | 3.23 (0.97) n = 30 | 4.02 (0.84) n = 48 | 3.72 (0.79) n = 25 | 3.89 (0.75) n = 27 | P < HP P < G |

^a 1 = not important; 2 = somewhat important; 3 = important but not critical; 4 = very important; 5 = critical; [±]Contrasts were significant at the p<0.05 level.

Table 4

Outcome domain “attitudes or beliefs”, mean scores across all stakeholders and breakdown to Round 2 scores by stakeholder group.

| Specific outcomes | Outcome domain: attitudes or beliefs | | | | | | | | Significant contrasts [±] |
|--------------------|--------------------------------------|----|---------------------------|----|-----------------|----|----------------|----|------------------------------------|
| | Parents (P) | | Healthcare Providers (HP) | | Researchers (R) | | Govt/NGO (G) | | |
| | Mean [*] (SD) | n | Mean(S D) | n | Mean (SD) | n | Mean (SD) | n | |
| Trust | 4.29 (1.01) | 28 | 4.80 (0.57) | 50 | 4.83 (0.48) | 24 | 4.96 (0.20) | 26 | P < HP P < R P < G |
| Attitudes | 4.43 (0.94) | 30 | 4.68 (0.55) | 50 | 4.83 (0.38) | 24 | 4.70 (0.61) | 27 | – |
| Vaccine acceptance | 4.43 (0.90) | 30 | 4.68 (0.47) | 50 | 4.48 (0.59) | 25 | 4.74 (0.45) | 27 | – |
| Intention | 4.47 (0.90) | 30 | 4.51 (0.62) | 49 | 4.72 (0.54) | 25 | 4.56 (0.75) | 27 | – |
| Level of support | 4.10 (0.96) | 30 | 4.35 (0.60) | 48 | 3.92 (0.86) | 25 | 4.19 (0.63) | 26 | – |
| Confidence | 3.53 (0.97) | 30 | 4.43 (0.82) | 49 | 4.16 (0.75) | 25 | 4.12 (0.82) | 26 | P < HP P < R |

^{*} 1 = not important; 2 = somewhat important; 3 = important but not critical; 4 = very important; 5 = critical; [±]Contrasts were significant at the p < 0.05 level.

rated very important (4 or higher) in both survey rounds. Table 4 shows Round 2 mean scores by stakeholder group.

For the questions about survey clarity, mean scores (SD) across stakeholder groups were: 3.96 (0.92) for survey purpose; 3.87 (1.00) for communication descriptions; and 3.69 (0.97) for outcome descriptions, indicating that participants found these aspects to be generally clear, though there is room for improvement.

5. Discussion

To determine which elements of vaccination communication interventions are effective and whether they influence vaccine hesitancy, researchers must measure outcomes that can indicate whether interventions are impacting other outcomes, such as people’s knowledge, beliefs, attitudes or intentions, as well as vaccination status itself. According to the SAGE Working Group on vaccine hesitancy, such intermediate outcomes are important because they can “indicate important shifts along the vaccine hesitancy continuum” [16]. However these outcomes are not measured by most trials. This Delphi survey is the first step towards systematically addressing this problem by consulting with stakeholders to prioritise outcome domains for future evaluations of common communication interventions.

The preliminary core outcome domain sets indicate the types of outcomes that researchers can consider measuring to increase the likelihood that their evaluations reflect stakeholder priorities and are able to identify a greater range of relevant intervention effects.

5.1. Different types of communication should be assessed using different intermediate outcomes

When ratings for all three communication types were averaged, the most highly-rated outcome domain was “vaccination status and behaviours”, which is logical and confirms current practice, as trials essentially always measure outcomes from this domain [15].

However, when the outcome ratings for different communication types were considered separately, collective stakeholder responses clearly showed that they prioritised different intermediate outcomes for different types of communication. Outcomes associated with community participation, for example, were rated as important when evaluating communication strategies that aim to enhance community ownership and engage the community in

vaccination issues. Social mobilisation strategies are noted as potentially effective tools to address community-wide vaccine hesitancy [16], but trials rarely measure outcomes such as committee functionality or level of participation in community coalitions, which limits the growth of evidence in this area. Similarly, knowledge or understanding outcomes were prioritised for communication that aims to inform or educate. This finding is important, because it confirms that communication should not be conceptualised or evaluated as a single (or simple) homogeneous intervention [45]. Trialists could specifically consider the aims of the communication, and select outcomes reflecting these aims.

5.2. Patterns in outcome domain ratings

Across communication types and combining stakeholder responses, the outcome domain “communication delivery and design” was consistently rated relatively highly. This domain includes many intermediate outcomes related to the perception and experience of communication. Intermediate outcomes are critical to providing much-needed information on how a communication intervention may work [19]. Qualitative research with parents suggests their impressions of the person delivering vaccination communication and the timing, format, and delivery setting of the communication could all influence how they felt and their vaccination intentions [46]. The “health status and well-being” and “cost” domains were consistently rated as least important, perhaps because these concepts are not generally associated closely with communication.

Across stakeholders in both rounds, the average rating was over 4 (“very important”) for all of the specific outcomes within the “attitudes or beliefs” domain. Establishing nuances in the prioritisation of specific outcomes within a domain likely requires a Delphi survey that provides more contextual information about the specific nature and audience of an intervention, and may be a valuable future topic of investigation.

While we identified a few statistically significant differences in ratings between stakeholder groups, we are wary of making too much of these findings because we do not yet know why these emerged, or the degree to which differences in understanding or interpretation of the survey may have influenced ratings. Generally, the similarity of outcome priorities across stakeholder groups suggests that competing priorities, such as those identified for conditions like rheumatoid arthritis [47], may not be a major issue in vaccination communication evaluation.

5.3. Strengths and limitations

This study is the first to apply Delphi survey methods to the study of vaccination communication outcomes, and its successful administration shows that this is a useful method for establishing convergence and identifying indicative, relative patterns in ratings of outcome domains. Future COS research could build on this work, focusing on specific vaccination communication interventions and target audiences or adapting the method for other complex, socially-oriented interventions such as those to promote shared decision-making [48] and informed consent [49].

This study does not extend to the level of recommending specific outcomes or outcome measures. However, identifying preliminary core outcome domains is a critical first step to developing this area. The findings of this study can be utilised, alongside the previously-developed detailed taxonomy of vaccination communication outcomes [36], to help researchers consider additional relevant outcomes for their evaluations and to indicate priority outcome domains requiring further research to develop appropriate outcome measurement methods.

The online Delphi format was efficient for administration and analysis, and facilitated broad international participation, including from LMICs. While we were limited by time and resource constraints, future studies with high LMIC relevance should consider options which allow translation or physical administration of surveys. We sampled participants purposefully in order to compare the views of different stakeholder groups, but numbers within groups were relatively small and their specific views not generalisable.

We piloted the survey, substantially changing it in response to feedback. However, participants' responses suggest that we could further improve the accessibility of the survey's language, and issues with comprehension may have affected some results. For example, decision-making is a complex topic (itself the subject of a developing COS [48]) and may have been rated lower as an outcome domain because it was not readily understood by all participants. Conversely, "community participation" may have been rated highly for communication to *enhance community ownership* because it uses similar wording and "sounds" appropriate. Nevertheless, the retention rate was relatively high across rounds, and we received many positive comments from respondents from all stakeholder groups, suggesting that people were engaged with the material despite its complexity.

6. Conclusions

This Delphi survey expands the field of core outcomes research and identifies preliminary core outcome domains for measuring the effects of communication about childhood vaccination. Vaccination communication interventions impact more than just vaccination status and behaviours. Measuring intermediate outcomes related to the communication's purpose is crucial to unpacking these effects and may assist in understanding the differential effects of interventions intended to address hesitancy. The findings support the argument that vaccination communication is not a single homogenous intervention – it has a range of purposes, and vaccination communication evaluators should select outcomes accordingly. Trials and evaluations should also consider the potentially different values of stakeholders involved in the communication intervention, and how these might be reflected by the outcomes selected for measurement.

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Conflict of interest

None of the authors have any conflicts of interest to declare.

Authors' contributions

The Delphi survey was designed and built by JK, with extensive input from SH and RR. All authors provided feedback on multiple versions of the survey, including format and content. All authors participated in participant recruitment. JK collected and analysed data in discussion with SH and RR. All authors commented on drafts of this manuscript and approved the final version. JK's research and contributions to this publication were undertaken while completing a PhD at La Trobe University, Melbourne, Victoria, Australia.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.vaccine.2017.08.027>.

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