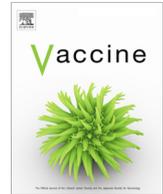




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Tick-Talk: Parental online discourse about TBE vaccination

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ABSTRACT

This study aimed to understand parental discourse about vaccination, and to provide guidance for communication that addresses the needs of parents. We analyzed parental discourse on child vaccination in general and tick-borne encephalitis (TBE) specifically in a Swiss parental online community. For this purpose, a data set containing 105k posts written by parents between 2007 and 2019 was analyzed using a combination of linguistic discourse analysis and qualitative content analysis. Results show that parents enter into a multidimensional decision-making process, characterized by elaborate practices of negotiation, consideration of vaccination recommendations as well as six distinct influencing thematic factors (vaccination safety, development and control, effectiveness, epidemiology, necessity, alternatives or additional prevention methods). The study shows a clear pattern of seasonality, with parents talking about TBE vaccination mostly triggered by events such as tick bites in spring and summer. From a public health perspective, the study emphasizes the need for sufficient, balanced, and tailored information about TBE vaccination. Online forums provide valuable information about what matters to parents and when, which can help public health authorities and practitioners provide information according to these concerns and enhance health literacy among parents.

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1. Introduction

Tick-borne encephalitis (TBE) is one of the most common tick-borne diseases [1,2]. Approximately one third of human TBE infections are asymptomatic [3]. Symptoms include fever, fatigue, headache, muscular ache, and nausea [4]. Severe cases with symptoms of meningitis and/or encephalitis are found in 15 % of cases [5]. Up to 46 % of patients are left with permanent sequelae at long-time follow-up and in 1–5 % of cases of TBE infection may lead to death [6,7]. While prognosis tends to be good in the majority of children who get TBE, an infection is associated with substantial morbidity and mortality in some and can have negative impacts on attention and other neuropsychological challenges [8]. While vaccine side effects are mostly “mild” [9], serious adverse reactions affecting the central nervous system have been reported [10].

Switzerland represents a highly endemic country according to the WHO definition and one of the most affected countries in Cen-

tral Europe [11–13]. Although TBE may be prevented by avoiding tick bites, active immunization offers the most effective way to prevent a TBE virus infection in endemic countries [14].

Due to a sharp increase in tick-borne encephalitis in 2005 [15], the Swiss Federal Office of Public Health (FOPH) since 2006 recommends vaccination for anyone aged six years or older living in a high risk area or who spends time in one [16]. The cost of vaccination is reimbursed by health insurance. Nevertheless, TBE vaccine uptake remains suboptimal. Between 2017 and 2019, only 32 % of children aged 8 and 41 % of adolescents aged 16 were vaccinated with all three recommended doses [17]. Among adults (18–79), a national survey in 2018 yielded a vaccination coverage of 32.9 % (range 8.4 % to 50.4 %) for a complete primary series of three doses [12]. Consistent with other studies in Europe [18,19], lack of knowledge about and low risk perception of TBE were associated with lower vaccination [12]. Overall, reasons why people do and do not follow vaccination recommendations are influenced by interacting emotional, cultural, social, religious, logistical, political, and cognitive factors [20].

In studies focused on childhood immunizations, parents expressed uncertainty about whether they had sufficient

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information to make a decision [21] and wished for balanced information about benefits and harms of vaccination [22]. Online sources, such as forums and other types of social media, facilitate the exchange of information, concerns, and personal stories and play an important role in parental vaccination decision-making [23]. Thus, understanding what is discussed among parents and when they discuss such topics provides insights into the relevance of health topics and related information needs.

To understand parental online discourse about tick vaccination, we analyzed language patterns in a popular Swiss parental forum. We used a discourse analytical approach applied in different research disciplines such as linguistics, sociology, and social psychology to study how language use is intertwined with social life [24–26]. It is concerned with the collective knowledge that is shared by a community with regard to a specific topic [[25], p.267] and aims at identifying “what people (in a given era and social setting) need to know in order to understand each other” [[26], p. 76].

The analysis had a twofold aim. First, to describe and understand parental vaccine-related beliefs and information needs [28–31], with a specific focus on TBE, and, second, to inform public health communication and interventions [32–34].

2. Material and methods

2.1. Material

The population addressed in this study are parents who participated in online discussions on a Swiss parental forum between April 2007 and September 2019. 5'148 threads in six thematic subforums were collected via web crawling and processed with a corpus linguistic pipeline [35] (see Table 1). Almost all thread postings are written in Standard German. A very small number of posts is written in Swiss German.

2.2. Thematic analysis of forum threads: Topic modeling

Though the division in individual subforums already gives a rough thematic organization, a fine-grained thematic structuring into specific topics was needed to identify threads related to child vaccination. For this task, an LDA topic model with 100 topics was calculated [36]. Topics represent probability distributions over the vocabulary of the threads [37] and are characterized by thematic coherence. For each thread, the percentage of words belonging to a specific topic was calculated. Metadata on time stamps of a thread allowed us to map a topic on a time axis to investigate seasonality of topics.

Topics were labeled by three team members in a collaborative consensus approach [38], reaching for communicative validity [39] and eventually divided into four general health domains (medical, systems/services, social/pedagogical, non-child topics), following a domain analysis approach [40]. Topic 94 was labeled *child vaccination* (category: medical health) and thus identified as relevant to the study aim (cf. Table 2). It was used in 31 threads (proportion of topic 94 > 20 %), consisting of 2141 posts. The quantitative linguistic analysis (cf. section 2.3) is based on all 31 child vaccination threads. Out of these, 13 threads (having tick related titles) were used for the qualitative content analysis (cf. section 2.4), cf. see Table 3.

2.3. Quantitative linguistic analysis of vaccination related threads: Semantic domains and collocations

All 31 vaccination related threads were analyzed linguistically, focusing on patterns of word usage and parental vaccination

Table 1

Corpus: threads, posts and word forms per thematic sub-forum. Most of the posts were written in standard German, only some in Swiss German. Usernames were anonymized prior to the analysis. The forum can be accessed and read without prior registration.

| subforum | number of threads | number of posts | words |
|--|-------------------|-----------------|-------------------|
| health forum | 867 | 16'055 | 1'292'559 |
| toddlers | 777 | 15'759 | 1'495'588 |
| first year of life | 653 | 11'277 | 1'025'807 |
| nutrition and health | 546 | 10'019 | 823'586 |
| playgroup/kindergarten/ school kids | 2'047 | 49'147 | 5'613'474 |
| breastfeeding and baby nutrition | 258 | 2'929 | 269'009 |
| total | 5'148 | 105'186 | 10'520'023 |

Table 2

Topic 94 on child vaccination: top words included vaccination¹ to vaccinate, side effects and vaccine as well as tick, Lyme disease, TBE, and tick bite. Furthermore, other vaccinations occur amongst the top 30 words (e.g., against pertussis and measles).

| topic | 30 most frequent words in topic | label |
|----------|--|-------------------|
| topic 94 | vaccination, to vaccinate, tick, lyme disease, disease, pediatrician, side effects, TBE, pertussis, measles, physician, forest, risk, protection, to live, human, to read, vaccination damage, tetanus, aluminum, tick bite, to recommend, vaccine, study, decision, blood test, to protect, to inform | child vaccination |

¹ For simplicity, all examples from the corpus will be given in an English translation only.

discourse in general. In a first step, nouns, adjectives, and verbs were annotated semantically to identify the most frequently occurring conceptual domains, e.g., words referring to concepts like “fear” or “concern” [41]. A lexicon [42] which allows to find words related to the same semantic field was used for this (e.g., the words *physician* and *lawyer* are listed under the subcategory “profession”). Words could be annotated with multiple categories, e.g., *physician* is categorized both as “profession” and “help”, reflecting the polysemous nature of language [43]. For words not listed in the lexicon, the 50 next neighbors in a word embedding model [44] of the corpus were extracted and looked up in the lexicon. The model allows to find semantically similar words in a multidimensional vector space. E.g., the word *Kia* (abbreviation for *Kinderarzt* ‘pediatrician’) is not listed in the lexicon, but its next neighbors in the word embedding model (e.g., *pediatrician, physician, therapist*) suggest the semantic domain “profession”.

In a second step, collocation analysis was performed for the most frequent words per domain (minimum raw frequency: 20) [45]. It operationalizes the distributional hypothesis [44], stating that the meaning of a word is contextually determined. A collocation is defined as a statistically significant co-occurrence of two words in a predefined contextual window [46]. Table 4 shows the first ten collocates for the word *physician*. For the interpretation of the results, the first 30 collocates per word were examined to keep the interpretation manageable (a collocation list can contain several hundred words). The final collocation list contained 3'176 collocations for 114 words.

Collocations were interpreted per domain, following DIMEAN, a multilayered methodological model for linguistic discourse analysis [27]. We focused on the intratextual and agent layer by selecting semantically related collocates (word-oriented analysis), which are indicative of roles of interaction and discourse positions (such as expertise and authority). E.g., the word *physician* (cf. table 4) collocates with the communicative verbs *to say* and *to recommend*, with words referring to official authorization (*studies, position*) and with verbs expressing trust (*to trust*). In sum, this gives

Table 3
Data used for quantitative linguistic analysis and qualitative content analysis based on threads containing topic 94 on child vaccination.

| | number of threads | number of posts | users | words |
|----------------------------------|-------------------|-----------------|-------|---------|
| quantitative linguistic analysis | 31 | 2'141 | 315 | 231'319 |
| qualitative content analysis | 13 | 398 | 131 | 32'186 |

Table 4
First 10 collocates for the word *physician*, based on the study corpus. Log likelihood ratio (LLR) was used as a statistical association measure with a context window of five words to the right and left, respectively. The joint co-occurrence frequency of a word and its potential collocate was set to a minimum of three. Collocates with an LLR less than 3.84 (p less than 0.05) were excluded.

| rank | collocates | LLR |
|------|-----------------------|-------|
| 1 | <i>job</i> | 39.75 |
| 2 | <i>studies</i> | 29.81 |
| 3 | <i>to trust</i> | 29.49 |
| 4 | <i>to say</i> | 23.92 |
| 5 | <i>to recommend</i> | 23.20 |
| 6 | <i>specialization</i> | 22.44 |
| 7 | <i>to diagnose</i> | 22.44 |
| 8 | <i>to oblige</i> | 22.44 |
| 9 | <i>position</i> | 22.12 |
| 10 | <i>to act</i> | 20.88 |

evidence of how parents express the quality of parent-physician interaction and that physicians are constructed as authorities.

2.4. Qualitative content analysis of tick related threads

Threads dealing with TBE vaccination in more depth were analyzed with a qualitative content analysis, following the approach of Schreier [47], where researchers focus on “selected aspects of meaning” rather than quantitative aspects of the data material. Accordingly, both inductive methods (interpretative approach) and deductive techniques [48] were used. Deductive codes were based on literature on vaccination hesitancy and parental vaccination concerns. Inductive codes were added based on the joint pre-coding of five randomly chosen threads, resulting in an initial coding frame with four overarching themes: Vaccination safety, necessity, recommendations, decision-making. Moreover, the coding structure included 11 “umbrella” main codes, 31 codes, and 118 sub codes. To anchor the codings empirically, direct narrations from the threads (“anchor quotes”) were assigned. Anchor quotes were originally assigned in German and translated into English afterwards using DEEPL Pro for an international readership and to ensure anonymity of forum users.

3. Results

3.1. Discursive patterns: When do parents talk about TBE and vaccination?

A clear annual pattern of mean topic probability per month can be observed for topic 94 across 12 years of data (see Fig. 1), with a first prominent peak in March and a second peak during November. On the contrary, a trough can be observed for December, indicating little exchange on the topic. For comparison, a non-vaccination related topic on pacifiers (topic 98) shows a very different seasonality pattern with less prominent peaks and troughs.

3.2. Quantitative linguistic data analyses

The semantic annotation identified 826 different conceptual domains, most of them represented by only a small number of word types. Thus, we concentrate on the 20 domains with the

highest number of different word types. Due to similarity among individual domains, the top 20 domains were grouped into thematic domains, communicative domains, and domains for practices of negotiation (Fig. 2).

We identified eight **thematic domains** which all focus on health issues. In particular, the domains “treatment” and “professions” denote doctors and health care professionals with whom parents interact. Most frequently mentioned are *physician* and *pediatrician*, the latter occurring in several colloquial forms. Most collocates are positive and describe the interaction with parents: doctors are considered authorities whom parents consult for questions regarding vaccination (*to ask, to call, to recommend, to like, to understand, to trust, to explain, competent, according to, to talk, expert*). A small number of collocates have a negative connotation and indicate that doctor’s authority is questioned by parents (*lie, to force, to distrust, to exaggerate, blind*).

Furthermore, the domain “time period” shows that the topic of tick bites and TBE vaccination occurs in seasonal contexts. It includes words for seasonality and vaccination timing: *January, summer, winter, autumn, spring*. *Summer* collocates with *bite mark, tick vaccination, outside, meadow, skin, forest, Lyme disease, and tick*. *Winter* and *January* do not collocate with tick or TBE related vocabulary but with other seasonal diseases and vaccinations (e.g., *otitis media*).

The thematic domain “obligation” refers to arguments for and against vaccination. A frequently mentioned word is *responsibility*, collocating with *social, fellow human, society, to take over, to carry*. Thus, a social argument, influencing the decision to vaccinate, is formulated: vaccination prevents the spread of a virus and protects others and the health system. Parents negotiate about and weigh different arguments, demonstrated by the usage of the word *right*, collocating with *both, you, two* and *sides*.

Further thematic domains are “cause” and “prevention”. The former describes the cause of health-related problems (e.g., *reason, cause, source*). Collocates are *tick, injury, nutrition, drinking water, poison*. The latter refers to preventive measures, either in public schools or in private life: The word *plan* collocates with *according to, our, we, have and vaccination*. The collocates of *school* refer to specific measures (*close, outbreak, to exclude, contact*).

A second, smaller group of domains refers to asking for advice or support, exchange of experience, or entering into dialogue and was thus labeled as **communicative domains**. The group includes, firstly, the domain “support” which contains the words *to help, recommendation and contribution*, illustrating the parental need for advice by peers and authorities. Collocates demonstrate this: *help* collocates with *decision, thanks, further and human*; *contribution* collocates with *your* and *thanks*; *recommendation* collocates with *strong* and *FOPH* (referring to the official vaccination recommendations). Secondly, the domain “names” mostly contains usernames, since most posts are ended with a greeting followed by the username. The third domain in this group refers to connections between two things, either in a physical or metaphorical sense. The most frequently used word is *way*, with the collocates *to convince, to find and own*, indicating that parents try to understand different points of view and to convince each other of something.

As a third group, we identified seven domains for **practices of negotiation**, referring to negotiating knowledge about child vaccination. More specifically, the domains “knowledge”, “inform/com

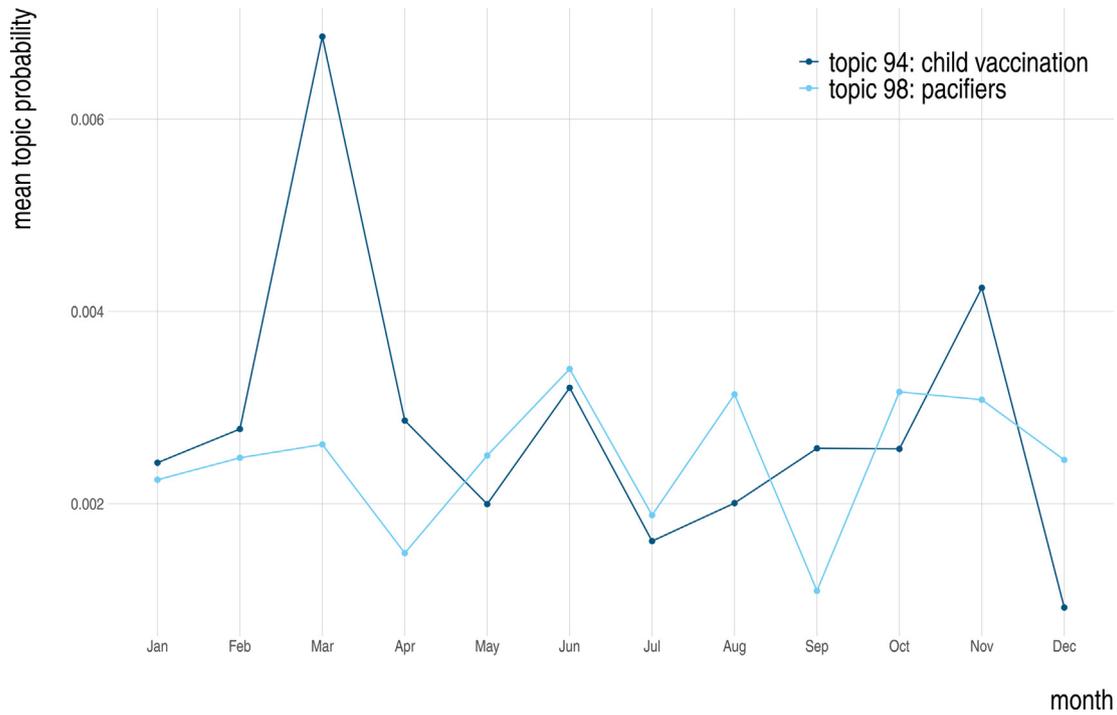


Fig. 1. Seasonality of topics.

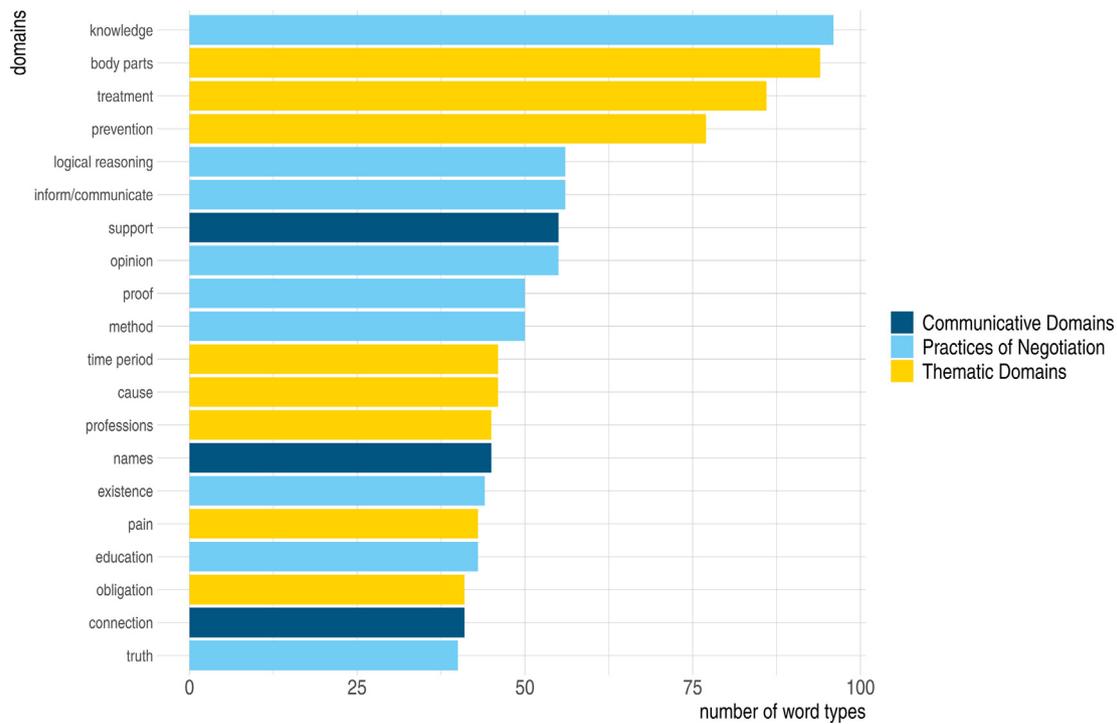


Fig. 2. Type frequency of semantic domains. A complete list of all 114 words in the domains and the collocations for these words are provided in the supplementary material in the German original.

communicate” and “education” refer to sources of information (in addition to pediatricians/general physicians, categorized under “professions” and “treatment”). Frequently mentioned are *book*, *statistics*, *conventional medicine*, *internet*. Collocates show that these sources are mentioned controversially as either trustworthy or untrustworthy: *statistics* collocates with *opposite*, *countless*, *to proof*; *book* collocates with *wisdom*, *valuable* and with names of

specific authors; *internet* collocates with *plausible*, *to trust*; *traditional medicine* collocates with *against*. Additionally, the verb *to know* refers to personal experience and anecdotal evidence as a source of information, demonstrated by the collocates *I*, *somebody*, *no one*, *numerous*, *personally*, *vaccination damage*, *many*, *several*.

Another practice of negotiating knowledge refers to the voicing of opinions. This domain contains verbs to express beliefs, convic-

tions, and viewpoints (*to think, to mean, to believe, to be convinced*). They collocate with *I, you* and *but*, indicating that parents debate their opposing attitudes towards vaccination by distinguishing their own opinion from other users' opinions. Collocates show an emotionally loaded discussion: *to think* collocates with *naive, anxious* and *sooth*; *to mean* collocates with *attacking* and *evil*.

The domains “proof” and “existence” contain words indicating the accuracy of an argument, a conclusion, or some information. A frequently used word is *study*, i.e., parents refer to scientific and pseudo-scientific vaccination studies as a source of knowledge (in addition to pediatricians and anecdotal evidence, see above). Collocates refer to trustworthiness of such studies (*meaningful, to prove, to fake, to show*). Other frequently occurring words are *statement, information* and *argument* whose collocates are evaluative adjectives: *blatant* (collocate of *statement*), *anecdotal* and *formal* (collocates of *argument*), *plausible* (collocate of *information*). Closely connected to the domain “proof” is the domain “truth” because it also refers to the veracity of an argument. A frequently used word is *really*, whose collocates indicate that parents critically question cited studies or arguments formulated by others (*?, whether, not, to question, to trust*).

In order to negotiate knowledge about child vaccination, parents furthermore address methods to explain and evaluate specific approaches. A frequently occurring word in the domain “methods” is *course*, referring to the clinical course of a disease. Collocates indicate that parents factor in the severity and probability of diseases when deciding to vaccinate their child (*frequently, mild, severe, damage, permanent, complication*). The word *vaccination opponent* is significantly often used with degree markers like *in principle, rigorous, totally*. Collocates indicate that vaccination opponents are perceived as a group which cannot be convinced with scientific or social arguments.

Lastly, the domain “logical reasoning” contains words for practices of reasoning, evaluation, and argumentation. Frequently used words are *clear, right* and *logical*. Collocates again indicate that parents enter into a multidimensional process of decision-making and use the forum for elaborate and emotionally loaded debates: *feeling, to hope, ultimately* (collocates of *right*); *very, sign, cautious* (collocates of *clear*); *explanation, to seem* (collocates of *logical*).

Linguistic results show that parental online discourse about child vaccination is characterized by specific linguistic practices: expressing knowledge, opinions, beliefs, and emotions and presenting arguments for and against vaccination. Child vaccination is negotiated in a multidimensional way, i.e., the forum cannot be characterized as an anti- or pro-vaccination forum. Instead, as the communicative domains have shown, parents use the forum to enter into dialogue with other parents.

3.3. Qualitative content analysis

Fig. 3 displays the main categories of parental discourse about TBE vaccination, derived from the qualitative coding structure.

3.3.1. Parental decision-making and recommendations

Parental decision-making in the context of TBE vaccination is connected to various perceived responsibilities. Before deciding for or against a vaccination, parents enter a process of calculation by analyzing desirable and undesirable effects including benefits (e.g., vaccination induced immunity) and risks (e.g., side and adverse effects, impact on everyday life, e.g., a sick child after vaccination).

Parents reported to use various information sources, such as private and federal/institutional web pages, social media (e.g., YouTube), media reports, books, patient instruction leaflets, and scientific studies. In some cases, parents reported uncertainty towards online information (e.g., “*I am unsure about the side effects. It simply*

depends on how you search for it online.”, Z2127) or voiced skepticism towards scientific information (e.g., “*How can one do a convincing study on the effectiveness of vaccination?*”, Z2093). Additionally, they are influenced by opinions and information received from healthcare professionals (e.g., pediatricians, nurses). In contrast to online information, material provided by healthcare professionals is mostly perceived trustworthy. Parents tend to give weight to authority-based statements from the medical field, such as explanations in health or medical books or suggestions by a medical professional or institution. Similarly, parents consider numbers and online statistics to be especially objective, and therefore true in a medical context (e.g., “*I guess numbers are the only reliable data for the effectiveness of a vaccination.*”, Z1653). Nevertheless, parents are aware that information might be biased:

“I have now tried to inform myself, BUT neither one nor the other side makes a serious impression to me. While traditional medicine classifies such cases as not reportable and vaccine-critical side refers to very special principles. I cannot figure it out and I still do not know if I should give the next dose of the one vaccination. I find it difficult to get an own thorough picture on the subject.” (Z1251).

Another important factor in parental decision-making includes reported experiences, especially by friends and family members (e.g., “*My [close relative] almost died of Lyme disease when she was 13 years old [...]. So, every-one has their own experiences [...].*”, Z2111). When deciding for or against vaccination, parents try to be as self-determined as possible, factoring in thoughts about the right timing, social standards (e.g., vaccination is necessary for a place in children's nursery), and emotions (e.g., “*I don't know what my decision will be in the future, but right now it's not (yet) right for me to vaccinate against TBE.*”, Z2087). Parents express the importance of feeling good with the decision, which needs to meet their personal beliefs and ideologies regarding vaccination and dealing with a disease in general. Nevertheless, parents are also influenced by fears about vaccination implications, constantly balancing between consequences of side effects of the vaccination or the disease itself:

“In the end, I weighed what made me more afraid: the possibility of possible vaccination complications or disease complications. The answer was very clear: vaccinations scare me, diseases don't.” (Z0752).

Parents show the ability to make decisions, but also express insecurities. Their self-efficacy depends not only on their experience as parents but also on their information seeking strategies (e.g., using different information sources) and health literacy (e.g., understanding and evaluation of the information). Moreover, parents show strategic thinking by having multiple alternative plans. E.g., they discuss who or where to turn to under certain adverse circumstances (such as health insurance hotline, pediatrician).

Apart from perceived responsibilities, parents' decisions are influenced by vaccination recommendations. Parents rely on official Swiss recommendations and compare them with German and Austrian guidelines, as well as alternative suggestions. The recommendations are critically discussed, especially the additional recommendations regarding TBE. Parents are very interested in the rationale behind the recommendations, their development and changes, asking for explanations:

“Starting at the age of six, children can be vaccinated. Can this disease become dangerous, exactly on the sixth birthday (I'm being ironic here!)? How do doctors explain this? Just vaccination without more detailed explanations?! [...] I really don't see how this can make sense.” (Z1657).

Moreover, parents frequently discuss the ideal vaccination timing, considering different contexts, e.g., age, kindergarten/school, season, regular pediatric check-ups, specific exposures (hobbies, animals) or holidays.

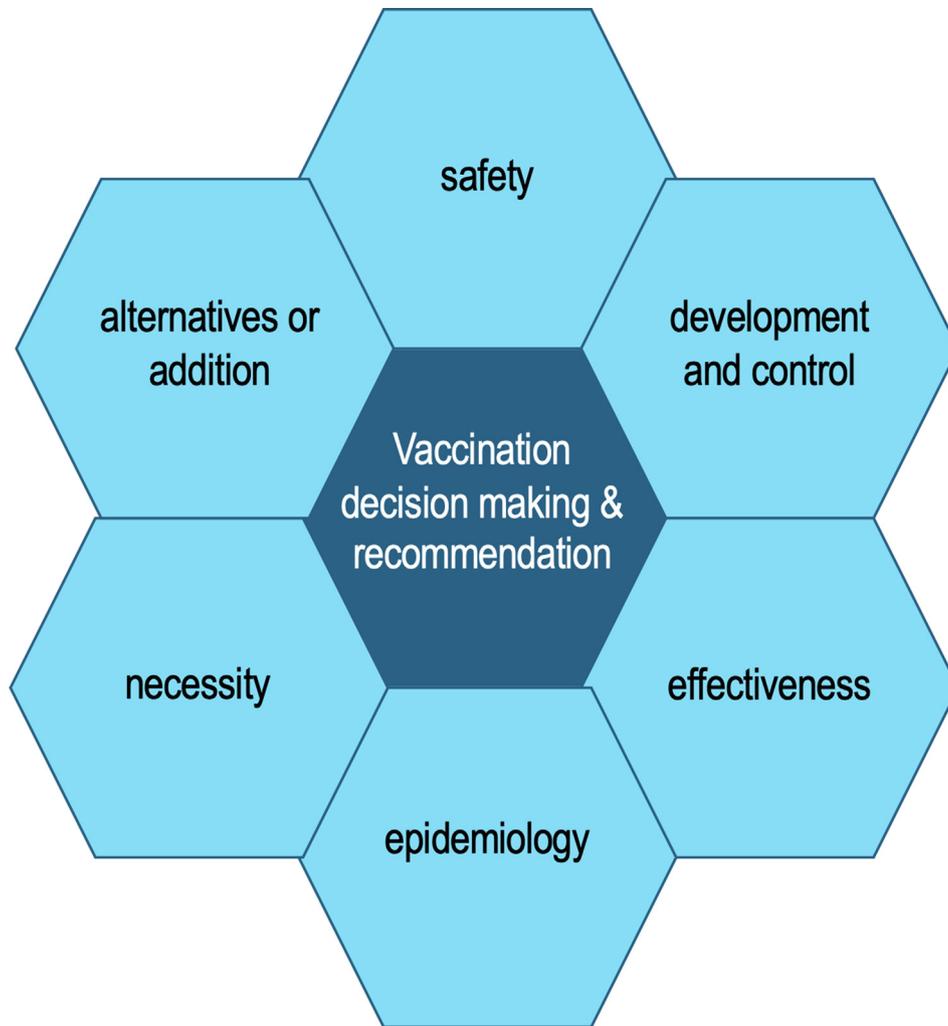


Fig. 3. Main categories in online forum discussions, derived from the qualitative content analysis.

3.3.2. Vaccination safety, development, and control

Parents express concerns about TBE vaccination safety (e.g., “I have heard that some of the reactions are more severe than with other kind of vaccinations.”, Z2055). They are worried about short-term (e.g., nausea, sleeping problems) and long-term (e.g., neurological complications such as paralysis, seizures, meningitis) medical side effects, but also about possible contraindications (e.g., in the context of multiple sclerosis). In addition, they voice concerns regarding vaccine composition (e.g., possible intolerances to additives), the development of vaccines in general (e.g., “One doesn’t know if the vaccination works and how well it works. That has never been tested.”, Z1637), and the proper registration of side effects (e.g., “It is not easy to prove vaccination damage. That is why very few are ‘registered’ as such.”, Z1683). Parents wish for more explanations and reason by the FOPH and clearer proof of the efficacy of TBE vaccination.

3.3.3. Vaccination necessity and epidemiological aspects

Parents frequently discuss vaccination necessity. They consider treatability of diseases (e.g., “Meningitis can’t be treated, it is caused by a virus and the disease’s course varies from mild to severe.”, Z0001) and the severity of the diseases prevented by vaccines, e.g.:
 “I also decide according to the lesser evil. For me, vaccinating is not an evil. So, vaccination is the lesser evil than maybe picking up a disease. [...] Flu, I find harmless, but I find meningitis dangerous.” (Z1669).

Parents also express societal arguments (e.g., “By the way, on *zecken.ch* it is also mentioned that a nationwide vaccination would be desirable”, Z0478). However, herd immunity was considered irrelevant for TBE, given it is an animal vector-borne disease, e.g.:

“TBE can’t be eradicated. It’s not really-one of the bad diseases. If you’re worried about polio, tetanus, etc., I can understand that.” (Z1668).

Although parents did not use the word *epidemiology* itself, they do rely on epidemiological reference points to determine the necessity of a vaccination. As mentioned before, they rely on statistics and numbers (e.g., number of symptomatic infections, infection rates in risk areas).

Parents often compare TBE with Lyme disease and question the need for TBE vaccination considering Lyme disease is more prevalent and can’t be prevented by vaccination, e.g.

“I do not vaccinate my children and ourselves, because the vaccination protects only against TBE, but not against Lyme disease, which is much more common.” (Z0246).

Moreover, parents, for example, inform themselves about the disease’s mode of transmission:

“TBE is transmitted right away, no use to search. Lyme disease is transmitted after about 12 h.” (Z1618).

Parents try to factor in additional risk components such as having a dog or being part of the boy/girl scouts. Apart from regional factors or leisure activities, parents mention seasonality aspects

when discussing the necessity of a TBE vaccination or other preventive measures.

3.3.4. Effectiveness of vaccination

Parents also consider vaccine effectiveness. They ask whether and how the effectiveness of the TBE vaccination is proven and compare TBE case numbers before and after vaccine introduction. They ask whether antibodies and (duration of) immunity after an infection or vaccination differ and how a TBE infection after vaccination is still possible. They discuss vaccination failures and state:

“It is not known whether and how well [the vaccination against TBE] protects. Some vaccinated people get sick, others don’t. Some unvaccinated people get sick, others do not.” (Z1645).

Comparable to HPV vaccinations that only protect from some viral strains, a wish for broader protection against tick-borne diseases is expressed, e.g.:

“If there was a vaccination against both pathogens [of TBE and Lyme disease], I think I would be willing to have it done.” (Z2087).

3.3.5. Alternatives to vaccination and additional prevention methods

Parents consider alternatives and additional prevention methods (e.g., homeopathy). They argue with concerns about the unnatural nature of vaccines, but they also suggest and ask for alternative solutions to protect their children, e.g., visual control and mechanical or chemical measures against ticks such as long clothes, sprays, etc. They also discuss how to deal with ticks, for example how to remove them, or how long to observe the bite mark for the development of an Erythema migrans.

Parents stress the importance of regularly checking their children for tick bites, irrespective of the vaccination status, due to the risk of Lyme disease. However, some parents question the feasibility of regular body checks for tick bites, e.g.:

“I don’t find checking every night simple [...] Do all of you check thoroughly every night from toe to hair?” (Z2120).

4. Discussion

The study focused on peer-to-peer, parental online communication about vaccination in general and TBE vaccination specifically. It reveals beliefs, knowledge, experiences, and advice that parents discuss with other parents about protecting their children. Results indicate that, given both vaccination supporters and opposers frequented the forum, parents can find support for either pre-existing beliefs or positions. The discussion about TBE vaccination is disproportionately high compared to other, especially childhood related vaccinations. Parents request verification, arguments, and additional explanations, as well as further information from their peers. We identified seasonality effects and a strong interest in safety, effectiveness, and epidemiological data to support parents’ decision-making process.

The content analysis provided six distinct topics of interest regarding TBE vaccination: safety, development and control, effectiveness, epidemiology, necessity, and alternatives or additional prevention methods. These topics correspond to the information parents expect from medical and public health professionals and to the recommendations they receive on vaccination in general and for TBE.

4.1. What and how do parents discuss about TBE vaccination?

Parents enter into a multidimensional process of decision-making: they exchange on personal and societal aspects, such as views on benefits and risks of a vaccination, self-determination, as well as scientific and public health aspects, vaccination timing

and safety of vaccinations. Regarding safety, parents talk about side effects and lack of information about them.

Parents broadly discuss the necessity of TBE vaccination. The difficulty parents have with the concept of necessity partly lies in the official vaccine recommendations, that differentiate between basic and recommended vaccinations. The recommendation for TBE vaccination in all risk regions underlines both its necessity and its safety. TBE vaccination is only recommended starting at the age of 6 and for high-risk areas. However, 24 of 26 Swiss cantons are deemed to be high-risk areas. Thus, parents debate not only if, but when to vaccinate referring to exposures due to hobbies, family holidays, or school outings. Further, the existence of other tick-transmitted diseases in Switzerland (Lyme disease), not preventable by vaccination, attenuates the necessity. In view of necessity, parents also rather pragmatically consider the consequences of potential short term side effects of TBE vaccination (e.g., fever).

Parents showed critical information seeking skills and awareness for the multidimensionality of the information landscape. They enter into a *meta*-reflection on why to consider certain sources as either trustworthy or untrustworthy. In the aim of objectivity and trust, parents simulate a scientific discourse on vaccination, demonstrated by intensive discussions about methodology and epidemiology.

Parents employed different practices of negotiating such as logical reasoning, expression of opinions, argumentation. Most parents try to rely on facts, but personal experiences have equal value for some. Thus, parents use the forum for a decision-making process influenced by multiple, heterogeneous factors, consistent with the literature [20].

Parents with sufficient [21], balanced and tailored information [22] about vaccination benefits and harms more often decide to vaccinate their children. Thus, the forum can have a positive impact on vaccination coverage. However, lay vaccination narratives may effectively fuel doubts and confidence in the safety and effectiveness of vaccination [32–34]. In general, positive attitudes towards the vaccination were found to be associated with deciding to vaccinate, and vice versa [49]. Parents aimed to be objective in their decision-making process, considering scientific and statistical facts, but many also admitted to an emotional component of their decision.

Parents use a high variety of sources of information, including medical and public health sources, personal communication, scientific and pseudo-scientific sources. While parents tend to trust information stemming from the dominant medical field (e.g., health professionals and institutions), they also factor in personal experiences and experiences from their social environment.

4.2. When do parents talk about TBE vaccination?

With a view on communication campaigns, seasonality is an important factor, since people are more responsive to public messages when they are ready to receive the message. From the qualitative data it is clear that talking about TBE vaccination is triggered by tick bites and outdoor activities. The linguistic data indicates the highest peak for the vaccination topic in spring, too late to be fully vaccinated by the beginning of tick-season. A second, but smaller peak, was found in November, which is synchronous with official recommendations, recommending TBE vaccination in winter season for a full protection against TBE in the next tick season.

4.3. Strengths and limitations

Given the study design, an analysis of a Swiss-German parental forum, the results cannot be generalized. We have no information

on the personal characteristics of the parents (e.g., sex, socioeconomic status) and the corpus is thus not representative of the Swiss population. Some parents passively consume the forum and we do not know how representative active users are of parents. While Jaks et al. identified the forum as the number one parental platform for German speaking parents [50], we cannot extend our results to the non-German speaking population in Switzerland. Lastly, the results reflect peer-to-peer online communication among parents, other forms of communication (e.g., oral interaction) might present different parental views and attitudes in the context of TBE vaccination.

4.4. Implications for authorities and public health experts

Our study provides insight on parental discussions and expectations relevant for authorities and public health experts. In general, information provided should and may be multidimensional and complex. But oversimplification comes with limitations. For example, it could help to explain not just that vaccines are safe, but how we know that they are safe, the difference in efficacy and effectiveness, and risk of side effects versus risk of getting sick from the virus. Parents' questions and concerns should actively be taken into consideration and addressed in public communication. To assist parents in their decision-making process with relevant and up to date information, public health authorities could provide safe and trustworthy places for parents to speak to each other (online or offline), where experts or knowledgeable parents could translate and help with complex topics.

5. Conclusion

Overall, our data show that parents try to be responsible and try to come to the “right” decision about vaccination. TBE vaccination of children is embedded in the broader context of child health and vaccination. The insights of our study can inform both public health and the medical community on TBE specific and more generally on child vaccination information needs. The seasonality of the tick vaccine discourse indicates times throughout the year at which parents are more open for information, taking this into account could improve vaccination promotion campaign responses. Our study identified six distinct topics of interest: safety, development and control, effectiveness, epidemiology, necessity and alternatives or additional prevention methods that relate to the decision-making process and recommendations expected by parents. Parents want and need trustworthy facts and arguments, but also personal stories and the possibility to discuss with peers. Against the backdrop of the pseudo-scientific facts and misinformation available, public health authorities and practitioners should be aware of parents' concerns and information expectations. Tapping into this kind of parental discussion also can provide insights on how the public perceives the tensions between different viewpoints, provided by various stakeholders and parties on vaccinations. In view of the global challenge regarding vaccine hesitancy, these considerations are highly relevant.

6. Data availability statement

The data presented in this study are openly available in OSF at <https://doi.org/10.17605/OSF.IO/6UKDB>. The analyzed threads and posts from the parental online forum (primary data) are not publicly available due to privacy restrictions.

7. Ethics

The study does not fall within the scope of the Human Research Act, BASEC-Nr. Req-2019–00861).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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