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## Supporting thinking on sample sizes for thematic analyses: a quantitative tool

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Thematic analysis is frequently used to analyse qualitative data in psychology, healthcare, social research and beyond. An important stage in planning a study is determining how large a sample size may be required, however current guidelines for thematic analysis are varied, ranging from around 2 to over 400 and it is unclear how to choose a value from the space in between. Some guidance can also not be applied prospectively. This paper introduces a tool to help users think about what would be a useful sample size for their particular context when investigating patterns across participants. The calculation depends on (a) the expected *population theme prevalence* of the least prevalent theme, derived either from prior knowledge or based on the prevalence of the rarest themes considered worth uncovering, e.g. 1 in 10, 1 in 100; (b) the number of *desired instances* of the theme; and (c) the *power* of the study. An adequately powered study will have a high likelihood of finding sufficient themes of the desired prevalence. This calculation can then be used alongside other considerations. We illustrate how to use the method to calculate sample size before starting a study and achieved power given a sample size, providing tables of answers and code for use in the free software, R. Sample sizes are comparable to those found in the literature, for example to have 80% power to detect two instances of a theme with 10% prevalence, 29 participants are required. Increasing power, increasing the number of instances or decreasing prevalence increases the sample size needed. We do not propose this as a ritualistic requirement for study design, but rather as a pragmatic supporting tool to help plan studies using thematic analysis.

**Keywords:** sample size determination; power analysis; thematic analysis

Thematic analysis is a qualitative method for uncovering a collection of themes, ‘some level of patterned response or meaning’ (Braun & Clarke, 2006, p. 82) within a data-set. It goes beyond word or phrase counting to analyses involving ‘identifying and describing both implicit and explicit ideas’ (Guest, MacQueen, & Namey, 2012, p. 10). Themes tend to emerge when answering the question, ‘What is this expression an example of?’ (Ryan & Bernard, 2003, p. 87). Thematic analyses are widely used in psychology, healthcare research, social research and beyond. Topics addressed are diverse, including understanding experiences, understandings, perceptions, practices, and causal factors underlying phenomena (Braun & Clarke, 2013,

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pp. 44–55). This paper tackles the question of how large a sample is sufficient to uncover all themes of interest and provides a partial solution that can be combined with other considerations.

Being able to plan ahead with an estimate of numbers required is of great practical value in carrying out research, in grant proposals or when seeking ethical review (Guest, Bunce, & Johnson, 2006). Indeed, good research practice and governance, including public engagement, requires researchers to explain what they plan to do before they do it, and why.

We do not presume to provide a final context-free formula for sample size that we think all researchers must use. Rather, we offer a tool that we believe can assist thinking and contribute to the already lively debate around sample size.

For quantitative studies, sample size may be calculated using a power analysis from a chosen probability of finding a statistically significant result (power) for a given population effect magnitude (Cohen, 1988) and such calculations are now commonplace. Such calculations are context-dependent and part of a subjective process (Schulz & Grimes, 2005; Spiegelhalter & Freedman, 1986; Whitley & Ball, 2002), even if reviewers sometimes expect more precision in them than is feasible (Bacchetti, 2002). For instance, a well-controlled lab-based study would be expected to show larger differences between conditions than a complex social intervention and so will require a smaller sample size. Guidelines on interpretations of effect magnitude – and hence sample size – are domain specific and differ between, for instance, educational attainment (Hattie, 2009), memory research (Morris & Fritz, 2013), and social psychology (Richard, Bond, & Stokes-Zoota, 2003). Although a rich toolbox of mathematics is available to guide sample size determination, other factors are important such as ethical concerns, practical matters such as the availability of participants and other resources such as researcher time, whether the study is a pilot or a confirmatory study, and also the particular research question (Barker, Pistrang, & Elliot, 2002; Cocks & Torgerson, 2013). ‘N of 1’ quantitative studies are also run, for instance in psychotherapy research (Borckardt et al., 2008) so ‘quantitative’ need not imply ‘large sample’, although the questions answered by a single case study are different to those answered by a large scale probability sample.

Qualitative studies are different to quantitative studies since they aim to map out the qualitatively different patterns observed in a data-set rather than to quantify magnitudes. Sandelowski (1995, p. 179) argued that ‘There are no computations or power analyses that can be done in qualitative research to determine a priori the minimum number [...] of sampling units required’. The main goal, Sandelowski argues, is to ensure that the sample size is small enough to manage the material and large enough to provide ‘a new and richly textured understanding of experience’ (p. 183) and this is always a matter of subjective judgment, i.e. guided by researcher experience and assessing the data as it is analysed in relation to the goals of the research. However, prior work has sought to suggest numbers.

A major review of the ‘tacit knowledge of a series of renowned social scientists’ (Baker & Edwards, 2012) revealed a broad range of suggestions of the numbers of participants needed for qualitative interviews from 12 to 101, with some suggesting a mean of 30 or 40, another suggesting zero interviews (the contributor here reminding the reader that qualitative research may include observation) or providing no suggestion. The justifications often focussed on resources available and the depth of analysis desired. Recent guidelines for thematic analysis (Braun & Clarke, 2013, p. 50) categorise suggestions by the type of data collection and the size of the

project ('small', 'medium', or 'large'). For small projects, 6–10 participants are recommended for interviews, 2–4 for focus groups, 10–50 for participant-generated text and 10–100 for secondary sources. The upper range for large projects is '400+'. It is unclear exactly how these numbers were arrived at, however justification alludes to having enough data to demonstrate patterns while ensuring there is not too much data to manage. An earlier review (Onwuegbuzie & Leech, 2007) of a range of recommendations from the literature notes that the authors provide no clues for how they arrived at their estimates. There are virtually no guidelines in this area (Guest et al., 2006) and guidance to date has even been rejected as having 'little if any value' (Emmel, 2013, p. 146) as no evidence is given to justify the offered advice.

Another approach is to investigate empirically when no further themes are found, a state known as *theoretical saturation* (Glaser, 1965, pp. 441–443). Studies have reported saturation after as few as 6 interviews (e.g. Isman, Ekéus, & Berggren, 2013; Isman, Mahmoud Warsame, Johansson, Fried, & Berggren, 2013). Another study began with 10 interviews, developed themes, and then continued collecting data, plotting the cumulative additions of themes to enable the visualization of diminishing returns as few new themes were discovered (Francis et al., 2010). Guest et al. (2006) took an empirical approach using a set of 60 interviews and concluded that saturation occurred within 12 interviews, with broader themes apparent after merely 6, numbers much lower than some of the suggested estimates of numbers needed that they reviewed. They noted that factors such as heterogeneity of the sample will affect how many interviews are required, but conclude that, 'For most research enterprises [...] in which the aim is to understand common perceptions and experiences among a group of relatively homogeneous individuals, twelve interviews should suffice' (Guest et al., 2006, p. 79). A similar approach by Francis et al. (2010) found a higher number of 17. Other studies have reported saturation only after much larger numbers, e.g. 63 (Wright, Maloney, & Febowitz, 2011). One problem with this empirical approach is that it does not provide a straightforward prediction for when to stop; for any given study, the saturation point may vary, making planning difficult. Also it seems true that 'each life is unique, no data are ever truly saturated' (Wray, Markovic, & Manderson, 2007, p. 1400). One needs to decide how detailed the analysis should be.

The present paper offers a quantitative tool to inform sample size choices for thematic analysis and related approaches, like content analysis and framework analysis, when used to identify qualitatively different patterns across a typically multiple-participant data-set. We do not consider the problem in other areas of qualitative research, like discourse analysis or narrative analysis, nor do we argue the model will be suitable for approaches like interpretive phenomenological analysis. As with all models, simplifying assumptions have been made. This model should only be used as part of a broader consideration of sample size taking into account other issues, such as the volume of material to be analysed from each participant and the case selection approach taken. It is hoped that formalizing a model helps progress research on sample size determination for qualitative studies.

A quantitative model for a qualitative approach strikes some as inherently misguided. However, tensions between quantitative and qualitative methods can reflect more on academic politics than on epistemology. Qualitative approaches are generally associated with an interpretivist position, and quantitative approaches with a positivist one, but the methods are not uniquely tied to the epistemologies. An interpretivist need not eschew all numbers, and positivists can and do carry out

qualitative studies (Lin, 1998). ‘Quantitative’ need not mean ‘objective’. Subjective approaches to statistics, for instance Bayesian approaches, assume that probabilities are mental constructions and do not exist independently of minds (De Finetti, 1989). Statistical models are seen as inhabiting a theoretical world which is separate to the ‘real’ world though related to it in some way (Kass, 2011). Physics, often seen as the shining beacon of quantitative science, has important examples of qualitative demonstrations in its history that were crucial to the development of theory (Kuhn, 1961).

There has been a move in recent years towards research being more inclusive (Gorard & Taylor, 2004) and pluralist (Barker & Pistrang, 2005). New paradigms favour combining approaches, e.g. mixed methods research (Tashakkori & Teddlie, 2010), the realist approach (Pawson, 2006), and meta-narrative reviews (Greenhalgh, Potts, Wong, Bark, & Swinglehurst, 2009; Wong, Greenhalgh, Westhorp, Buckingham, & Pawson, 2013). In a spirit of pluralism and the belief that different epistemological perspectives can learn from each other, we offer this approach as a pragmatic tool that may help those planning studies using thematic analysis.

### The proposed model

Let us assume a particular theme has a certain prevalence in the population of interest, for instance the general population, people referred for mental health care, or others. (We use the term ‘population of interest’ as a construct reflecting whatever sampling approach you take.) Given this, we can calculate how many participants are needed to be at least 80% sure (or some other number) of capturing the theme. We will talk about interviews as the commonest method where we see an application for this method, but the approach generalises to observations, the use of existing texts and so forth.

Themes are complex and have a hierarchical nature. Suppose we are investigating how people construct their idea of emotional wellbeing. They may or may not describe something that a clinical psychologist would recognise as a disorder.

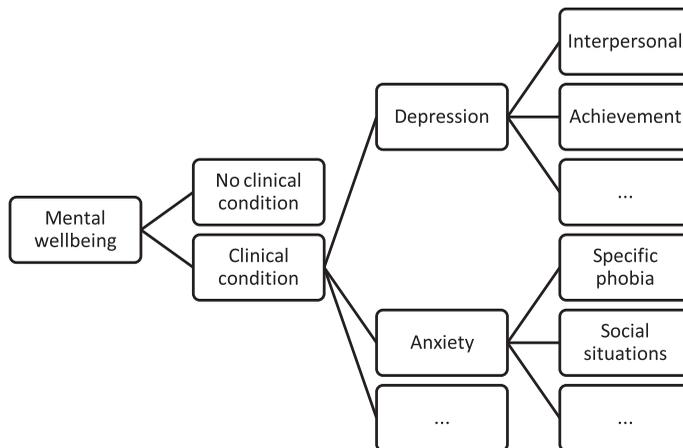


Figure 1. Hierarchical structure to themes concerning mental wellbeing.

Perhaps what they describe may be seen as anxiety or depression, a particular type of depression (with interpersonal concerns or achievement concerns) or anxiety (specific phobia, social situations). See Figure 1 for a graphical depiction. What counts as a theme here?

The probability of anxiety specifically in social situations being mentioned is likely to be less than that of any kind of anxiety (more generally) being mentioned, which is in turn less than that of some clinical condition being mentioned. One might reject the notion of clinical disorder altogether and instead focus on emotions discussed, which will give a difference space of probabilities. With a fully inductive approach, one might refuse to have any expectations about the nature of the themes uncovered before the data have been collected.

To have any hope of developing a model to guide sample size choice, we will need to make simplifying assumptions. These assumptions are a starting point. Later, we will consider what happens when we relax them.

- (1) If a theme is present in someone's views, it will come out in their interview (or other material) and be apparent to the researcher. A theme either occurs or does not.
- (2) Themes, or more precisely theme-relevant material such as collections of utterances which inspire themes, are independent of each other. This simplifies calculations and, at present, there is little information on likely correlations between themes.
- (3) The depth analysed in theme hierarchies will be constrained by the number of times a theme-relevant event (an utterance, an action) has occurred and the number of similar themes discovered. For instance, if in a study of mental wellbeing with 10 participants, one person describes self-criticism and sadness and another being fearful in social situations, then it is likely there will be one theme for either 'distress' or 'sadness/anxiety' rather than the more specific themes, since it is likely there are other types of negative experience which could have been mentioned.

### ***Sketch of the model***

Suppose we are collecting qualitative data from a sequence of participants. We are interested in observing an event that we assume occurs with particular population theme prevalence across participants. Furthermore we would like to observe the theme in a given number of participants. Probability distributions may be used to answer questions like these. We chose the negative binomial probability distribution since this models how long one has to wait for a certain number of 'successes' when observing a sequence of events. Here 'success' means observing a theme. Using this distribution, and assuming random sampling from the population of interest, we can determine:

- (1) *Power*: the probability of observing the desired number of instances of a particular theme, given the population theme prevalence and sample size.
- (2) *Sample size*: the number of participants required to be confident at a particular level (say 80%, i.e. the power) that we would actually observe the number of events desired.

Table 1. Sample size required as a function of the population theme prevalence and how many instances of the theme are desired, with 80% chance of observing the desired number of instances (power).

Population theme prevalence (%)	Desired number of theme instances							
	1	2	3	4	5	10	20	30
5	32	59	85	110	134	249	471	687
10	16	29	42	54	66	124	234	343
15	10	19	28	36	44	82	156	228
20	8	14	21	27	33	61	116	170
25	6	11	16	21	26	49	93	136
30	5	9	14	18	21	40	77	113
35	4	8	12	15	18	34	66	96
40	4	7	10	13	16	30	57	84
45	3	6	9	11	14	26	50	74
50	3	5	8	10	12	24	45	66
55	3	5	7	9	11	21	41	60
60	2	4	6	8	10	19	37	55
65	2	4	6	7	9	18	34	50
70	2	4	5	7	8	16	31	46
75	2	3	5	6	8	15	29	43
80	1	3	4	6	7	14	27	40
85	1	3	4	5	7	13	25	37
90	1	2	4	5	6	12	23	35
95	1	2	3	4	6	11	22	33

Table 1 shows the samples sizes required for 80% power, which is a level commonly used in quantitative studies (Cohen, 1992; Kraemer & Kupfer, 2006; Senn & Bretz, 2007), and Table 2 for 90% power to discover themes with a range of values for population prevalence. Tables 3 and 4 show power for 1 and 5 theme instances, respectively. The Appendix 1 shows how to compute answers for arbitrary parameters using R, a free statistical program (R Core Team, 2013).

### Using the model

We will first explore the method via a hypothetical study investigating how people construct a concept of mental wellbeing, continuing the idea introduced above. This is more deductive than in typical thematic analyses as we use an external reference for theme prevalence: data for the prevalence of mental health diagnoses. However, the idea here is not simply to rediscover diagnoses but rather to use the prevalence data to get an idea of what is already known about the likelihood of a range of experiences. This serves to illustrate the approach. As we shall see later, the approach can also be used when relevant prevalence data are not available and in more inductive analyses.

### *Searching for themes with known population prevalence*

We use data from a study of over 2000 adults aged 18–29 which reports the percentage who have ever experienced a disorder (according to a structured assessment) up to the time of interview (Kessler, Berglund, & Demler, 2005, p. 596). Different answers to estimated population theme prevalence may then be estimated. Suppose

Table 2. Sample size required as a function of the population theme prevalence and how many instances of the theme are desired, with 90% chance of observing the desired number of instances (power).

Population theme prevalence (%)	Desired number of theme instances							
	1	2	3	4	5	10	20	30
5	45	77	105	132	158	282	515	740
10	22	38	52	65	78	140	256	368
15	15	25	34	43	52	93	170	244
20	11	18	25	32	38	69	126	182
25	9	15	20	25	30	55	100	145
30	7	12	16	21	25	45	83	120
35	6	10	14	18	21	38	71	102
40	5	9	12	15	18	33	61	89
45	4	8	10	13	16	29	54	79
50	4	7	9	12	14	26	48	70
55	3	6	8	11	13	23	44	63
60	3	5	7	9	11	21	40	58
65	3	5	7	9	10	19	36	53
70	2	4	6	8	9	18	33	49
75	2	4	6	7	9	16	31	45
80	2	4	5	6	8	15	28	42
85	2	3	5	6	7	14	26	39
90	1	3	4	5	7	13	24	36
95	1	2	4	5	6	12	22	33

we wish to ensure we have at least two examples for the least common theme and 80% power.

- The overall prevalence of any disorder up to the time of interview was around 50%. So if we just want themes about any kind of disorder, then only three participants would be required.
- One might be interested in themes concerning combinations of two diagnoses ('comorbidity'), in which case the prevalence drops to 34% and four participants would be required.
- Or perhaps it is seen as important to have a chance of capturing themes related to the least likely subcategory in the anxiety disorders, which is 'agoraphobia without panic' with a prevalence of around 1%; now 161 participants would be required to have a good chance of sampling relevant experiences. Here one might decide to use purposive sampling (see Teddlie & Yu, 2007), i.e. specifically recruit participants with the relevant characteristics for instance by approaching a relevant mental health service or advertising through social media. The expected prevalence in this group would then be 100%. Then the power analysis may be run again to find subthemes *within* this group.

The different diagnoses – even if the researcher is opposed to diagnostic categories and diagnoses are never mentioned by participants – may be used as a guide to how many people with particular experiences are likely to be encountered. So for instance an underpowered study would be most likely to discover themes related to specific phobia and social phobia and perhaps miss out a range of important themes arising from experiences of the less common mental health conditions.

Table 3. Power to detect 1 theme instance, by population theme prevalence and sample size (omitted if 100% to nearest percent).

Population theme prevalence (%)	Total sample size												
	10	20	30	40	50	60	70	80	90	100	150	200	250
1	10	18	26	33	39	45	51	55	60	63	78	87	92
2	18	33	45	55	64	70	76	80	84	87	95	98	99
3	26	46	60	70	78	84	88	91	94	95	99		
4	34	56	71	80	87	91	94	96	97	98			
5	40	64	79	87	92	95	97	98	99	99			
6	46	71	84	92	95	98	99	99					
7	52	77	89	95	97	99	99						
8	57	81	92	96	98	99							
9	61	85	94	98	99								
10	65	88	96	99	99								
11	69	90	97	99									
12	72	92	98	99									
13	75	94	98										
14	78	95	99										
15	80	96	99										
16	83	97	99										
17	84	98											
18	86	98											
19	88	99											
20	89	99											
21	91	99											
22	92	99											
23	93	99											
24	94												
25	94												
26	95												
27	96												
28	96												
29	97												
30	97												

There are also data on mental health problems which transcend the need for a categorical diagnosis. Community norms are available, for instance, for the Strengths and Difficulties Questionnaire (Goodman, 2001; Goodman & Scott, 1999) and could be used as a guide to the likelihood of finding participants with particular levels of distress. For example, around 20% of parents report that their children aged 11–15 experience some level of difficulties in relation to ‘emotions, concentration, behaviour or being able to get on with other people’. Therefore eight participants would be required to get some sense of the themes around having a child experiencing these difficulties in a sample of parents in general.

### *Setting a lower limit on theme prevalence*

It is a common problem in quantitative studies to be unsure about what effect size is likely to be found. Often a constraint is then what the smallest effect size worth finding would be. Similar reasoning may be used for the present approach to qualitative power analysis. Do we want to be sure to find a theme which occurs in (e.g. is

Table 4. Power to detect 5 theme instances, by population theme prevalence and sample size (omitted if 100% to nearest percent).

Population theme prevalence (%)	Total sample size													
	10	20	30	40	50	60	70	80	90	100	150	200	250	
1	0	0	0	0	0	0	0	0	0	0	2	5	11	
2	0	0	0	0	0	1	1	2	3	5	18	37	56	
3	0	0	0	1	2	3	6	9	13	18	47	72	87	
4	0	0	1	2	5	9	15	22	29	37	72	90	97	
5	0	0	2	5	10	18	27	37	47	56	87	97		
6	0	1	3	9	18	29	41	53	63	72	95	99		
7	0	1	6	15	27	41	55	67	76	84	98			
8	0	2	9	21	37	53	67	78	86	91	99			
9	0	3	13	29	47	64	77	86	92	95				
10	0	4	18	37	57	73	84	91	95	98				
11	0	6	23	45	66	80	90	95	98	99				
12	0	8	29	53	73	86	93	97	99	99				
13	1	11	35	61	80	90	96	98	99					
14	1	14	41	68	85	94	98	99						
15	1	17	48	74	89	96	99							
16	1	21	54	79	92	97	99							
17	2	24	59	83	94	98								
18	2	28	65	87	96	99								
19	3	33	70	90	97	99								
20	3	37	74	92	98									
21	4	41	79	94	99									
22	5	46	82	96	99									
23	6	50	85	97	99									
24	7	54	88	98										
25	8	59	90	98										
26	9	62	92	99										
27	10	66	94	99										
28	12	70	95	99										
29	13	73	96											
30	15	76	97											

mentioned by, observed in the behaviour of) 1 in 100 participants or would 1 in 10 suffice? Consider a study that is trying to uncover the themes that affect the majority of participants. A suitable lower threshold might then be 30% for theme prevalence. However if a study seeks to uncover as many themes as possible, then a lower threshold might be applied; for instance, one might decide that the study should have a good chance of uncovering themes which affect as few as 5% of the chosen population. Note that it is not necessary to know what the themes are beforehand to make a judgement as to the lowest theme prevalence that is of interest. One can make an estimate and thus determine a sample size while still retaining an entirely inductive approach to what themes may appear.

The number of instances can also be decided in this manner. Only one mention would be sufficient for many studies, however in order to aid the recognition of a theme, then at least two or three could be required. Repetition is one of the most common ways to recognise themes in data (Ryan & Bernard, 2003).

This decision-making process is not uniquely determined by a formula – as is also the case with power analysis for quantitative studies. The advantage is that the

consequences of different assumptions are made explicit and can then be considered and discussed by the research team, reviewers and other stakeholders.

### **Calculating achieved power**

Another common question for quantitative studies is to determine the power a completed study had to find an effect of a particular magnitude, especially to get a sense of how likely it is that an effect has been missed. Something analogous can also be achieved for thematic analysis. Let's take as an example a thematic analysis of the goals young people set for therapy in child and adolescent mental health services (Bradley, Murphy, Fugard, Nolas, & Law, 2013). Three major themes and 25 sub-themes were found in a sample size of 80 participants. Figure 2 shows the achieved power by prevalence and desired number of instances of each theme. The study had 80% power to discover at least one instance of themes with 2% population prevalence.

### **Relaxing assumptions**

We developed this model based on a number of assumptions. We now consider what happens if we relax these assumptions. In assumption 1, we presumed that themes would be expressed and are obvious. However, if that is not the case, we can follow the same approach, but adjust the expected prevalence. For example, if a theme only has a 50% chance of being expressed by the participant *and* noticed by the researcher, then we can treat its prevalence as being half as much.

Themes are not necessarily independent, as we assumed in assumption 2. For instance, a study of experiences of mental health interventions is likely to uncover relationships between the difficulties participants experience and the type of

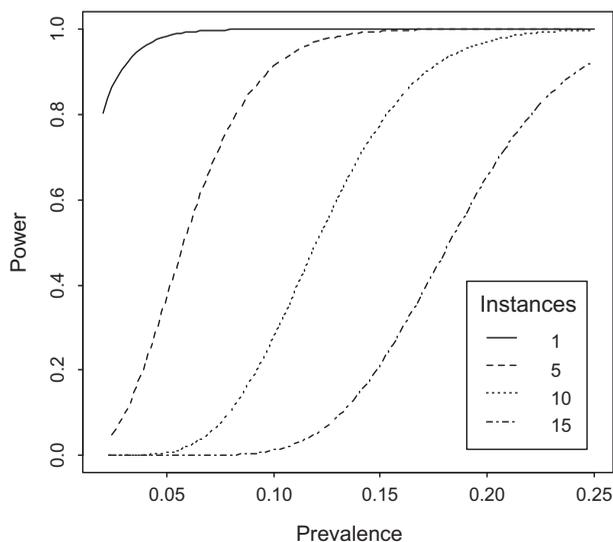


Figure 2. Obtained power for a sample size of 80 as a function of the population theme prevalence (from 2 to 25%) and number of theme instances.

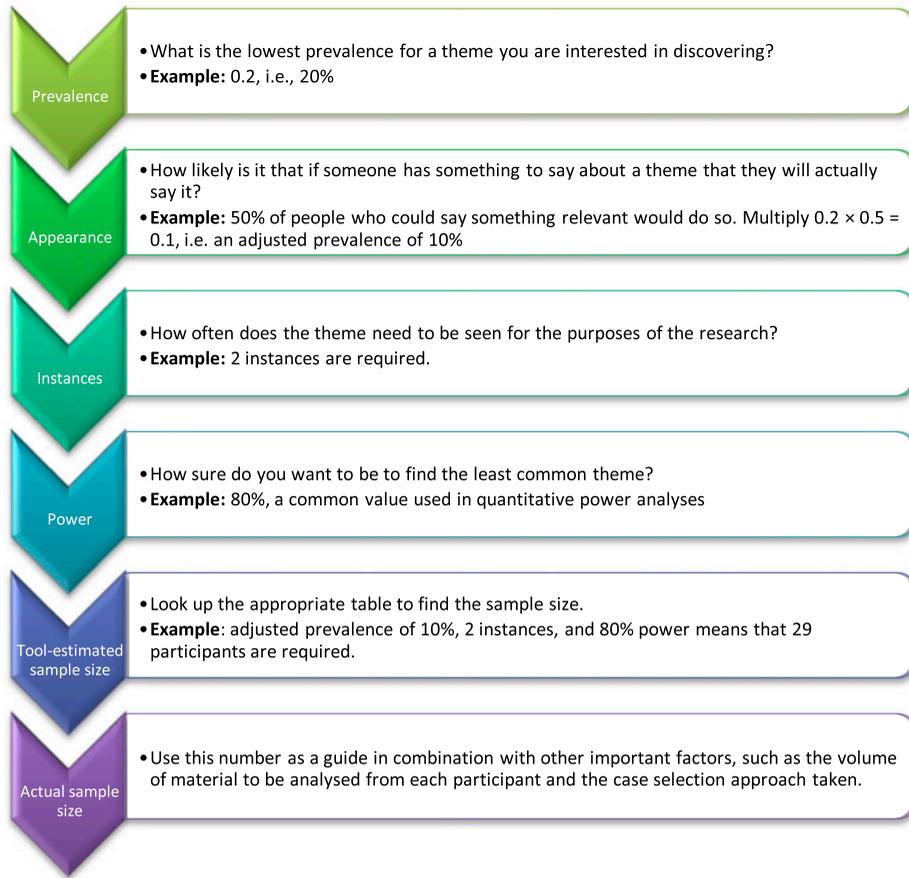


Figure 3. Summary of approach taken.

intervention. However, if a calculation is based on the least prevalent theme desired to be seen, dependence does not present a problem. We can be sure that we have sufficiently many participants so that at least one instance of the least common theme's prevalence has been uncovered. Another way to think about this is that we have given at least one minority participant a voice. Allowing additional instances also increases the likelihood that more themes of the same prevalence are uncovered.

We also assumed (assumption 3) that theme hierarchies are constrained by the number of instances of a given theme uncovered in analysis. This assumption may be relaxed by increasing the role of theory when interpreting the material collected in the study. For example, participants' descriptions of mental health difficulties may reveal the use of emotion words which the researcher recognises as basic emotions or combinations of basic emotions (Oatley & Johnson-Laird, 1987; Power & Tarsia, 2007). In this way, even given insufficiently many instances, a theory-guided (and justified) theme hierarchy may be constructed.

### Summary and conclusions

This paper proposed a simple quantitative approach to inform sample size choice for thematic analyses and related qualitative methods. The key parameters used to make the decision are the population theme prevalence for the least prevalent theme desired to be seen, adjusted, if necessary, by the likelihood that a theme will be expressed; the desired number of instances of this theme; and the power of the study, i.e. the probability of obtaining the desired number of instances for the least prevalent theme. The resulting answer may then be used to inform the final decision in combination with other sources of advice on sample size. This process is summarised in Figure 3.

Existing proposals for sample size in thematic analysis rely on what sample sizes seem to have worked in the past and are limited in their ability to take account of the particular circumstances of a planned study. The concept of theoretical saturation, whereby collecting more data does not add further themes, is problematic for prospective study planning and also since new data will always bring more information. We have argued that a helpful perspective to take is that of how prevalent the themes are that one wants to uncover. We suggest it is intuitively obvious that a larger sample is sensible if wanting to detect less commonly expressed themes, and that a larger sample is sensible if wanting to see a theme expressed more often in the data. We argue that the use of probability theory to understand those relationships should not trouble qualitative researchers. We note the figures produced by our approach are consistent with the suggestions given in the prior literature, but our tool allows researchers to better explore their specific needs and context.

One limitation of the approach is that we have not attempted to address the effect of within-participant sampling. Intuitively a longer interview or repeated interviewing with someone makes it more likely they will produce more theme-relevant material.

We do not claim that this proposal completely determines the chosen sample size. We offer it as a tool to help explore choices and to support decision-making. Other factors such as the cost of data collection, transcription and depth of analysis are also important and are covered in detail elsewhere (e.g. Robinson, 2014). These same caveats apply to power calculations for quantitative studies too, but are often ignored (Schulz & Grimes, 2005). Quantitative and qualitative researchers have warned how reviewers and readers can be dazzled by ‘the allure of the number  $n$ ’ (Emmel, 2013, p. 146) and an apparently precise power calculation (Bacchetti, 2002). Quantitative power calculations can become ‘a ritualistic dance’ (Goodman & Berlin, 1994, p. 203). In proposing this tool to help qualitative researchers, we adamantly do not wish to import the same bad habits.

It is hoped that attempting to formalise the sampling problem for thematic analyses and related approaches is a useful step for future research, and thinking explicitly about the possible prevalence of themes will help support justifications for the sample sizes chosen.

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## Appendix 1. Computing sample size and power

Let  $NB(x, k, \pi)$  denote the negative binomial probability mass function which calculates the probability that there will have been  $x$  failures before  $k$  events, each of which occurs with probability  $\pi$ . Now suppose the total sample size is  $N$ , the number of theme instances required is  $i$ , and the population theme prevalence is PTP. Then the power is computed as

$$\sum_{k=0}^{N-i} NB(k, i, \text{PTP})$$

Let  $NB^{-1}(p, k, \pi)$  denote the inverse, i.e. the quantile function, where  $p$  is the required power. Then the required sample size is computed as  $NB^{-1}(p, i, \text{PTP}) + i$ .

## Implementing in R

The following R (R Core Team, 2013) functions computes the power achieved for a given sample size (SampSize), theme prevalence (ThemePrevalence), and number of instances desired (NumInstances). To run the code, simply copy and paste it into the ‘R Console’ window.

```
powerForQual = function(SampSize, ThemePrevalence,
                        NumInstances) {
  pnbinom(SampSize-NumInstances,
          size = NumInstances,
          prob = ThemePrevalence)
}
```

To compute the power for  $N = 30$ , a theme prevalence of 0.1, and to find 2 instances, run:

```
powerForQual(30, 0.1, 2)
```

This gives the answer 0.816305, i.e. about 82% power.

The following function computes the necessary sample size for given power (Power), theme prevalence (ThemePrevalence), and number of instances desired (NumInstances).

```
sampSizeForQual = function(Power, ThemePrevalence,  
                           NumInstances) {  
  qnbinom(Power, size = NumInstances,  
          prob = ThemePrevalence) + NumInstances  
}
```

To compute the sample size required for a power of 80% to find a theme prevalence of 0.1, and 2 instances, run:

```
sampSizeForQual(0.8, 0.1, 2)
```

This gives the answer 29.

This code may be run even if R is not installed, for instance via R-Fiddle (<http://www.r-fiddle.org>) or Ideone (<http://ideone.com/oT4BRE>).