Emotional determinants of public responses to the risk of epidemics and pandemics: a systematic review

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Abstract

Background

Understanding how people's emotions influence their health decisions and behaviours at a population level is fundamental to designing effective communication strategies and public health interventions for infectious disease outbreaks. This review identifies relevant research to assess the role of emotional determinants and their impact on public responses to the risk of infectious disease outbreaks, specifically in relation to the uptake of public health interventions.

Methods

A comprehensive systematic review was conducted exploring the differences in public responses by emotion, infection, outcome and region. A basic consensus approach was followed in which emotional stimuli were categorised as being either pleasant or unpleasant, and predisposing people to bivalent behaviour (i.e., approach or withdrawal). All primary research studies published in five global databases between 1988-2019 were eligible for inclusion. Binomial tests (against a test proportion of 0.5 or 50% for each study outcome) were performed using the direction of effect observed in each study, i.e., either favouring or not favouring intervention uptake.

Results

A total of 75 studies from 28 different nations were eligible for inclusion in the review. A total of 97 correlations were made between 12 emotions, 10 infectious diseases, and the uptake of seven types of public health interventions. Unpleasant emotions were evoked much more often than pleasant following public health risk communications, with fear and anxiety being the most common. Overall, moderate anxiety-related emotions (worry, anxiety, stress, concern) seemed to be much more significant motivators for public action compared to extreme unpleasant emotions (fear, panic, hopelessness, shame), which had a statistically significantly negative effect on the uptake of public health interventions in several cases. Pleasant emotions (empathy, hope) also showed promise as motivators for public health intervention uptake, but more research is needed to corroborate this.

Conclusions

The results of this review show that the public's emotional responses to epidemics in the past 30 years have played a clear role in determining how successful the rollout of public health interventions has been. Emotions need to be considered in crisis communications, and these research findings can help inform communications strategies in the evolving context of the COVID-19 pandemic and future infectious disease outbreaks.
Background

Within public health, there is growing recognition that decisions about health are impacted by a range of feelings and emotions and, whilst these emotional determinants are intertwined with political and social determinants, they merit their own attention (1). Health behaviours of the public are of paramount importance in the context of infectious disease outbreaks; hence understanding the role of emotions in influencing risk perceptions and acceptance of public health interventions is fundamental to designing appropriate communication and engagement strategies (2). Yet, there has not been a systematic gathering of knowledge on emotions in the context of public health and epidemics thus far.

Understanding the role of emotions in the uptake of public health interventions and response to public health communications is increasingly pertinent in the context of Covid-19 (Coronavirus Disease-2019) public health measures, as well as for future pandemic preparedness and response. Research on emotions from a risk science perspective has shown that initial cognitive processing of a situation gives rise to emotions, which in turn guide the further, more elaborate cognitive processing which drives behaviour (3). Behavioural research shows that different individuals may have different probabilities for the same event and a key heuristic impacting that is the “affect heuristic”, which is the use of emotions and gut responses to judge benefits or risks (4, 5). Thus, how people understand risks and make decisions under crisis conditions relies not only on statistics and science, but also on intuition and heuristics. Indeed, studies on decision-making in conditions of uncertainty have shown that intuition and feelings are often the biggest driver of decisions (4). Furthermore, epidemics and pandemics are crises that can trigger diverse emotions, which in turn can influence people's interpretation of a situation, guide their behaviour and lead to outcomes with their own emotional consequences (6, 7). This helps move the conversation away from the notion that emotions are irrational and provides nuance to the debate on whether reason or emotion is more dominant in the functioning of the human mind; illustrating the reality that humans are capable of complex behaviours and emotions have the capacity to change peoples’ perceptions, attention, memory and influence decision-making (8).

This is not to suggest that intuitions and feelings are disorderly or individualistic. Psychological research on crowd responses to disasters has shown that emergencies often create a sense of shared fate and social support (9). Unfortunately, emergency response strategies can sometimes fail to acknowledge this capacity for self-control and collective behaviour in the face of an external threat, instead assuming mass public passivity or panic.

Despite a wealth of psychological research in this space and its application to emergencies and disaster responses, there has not been a systematic gathering of knowledge on emotions in the context of public health and epidemics. Hence, this study, above all, attempts to analyse and comment on the particular roles of emotional determinants which likely impact decision-making and behaviours in the context of longer-lasting public health crises.

Outside of the field of public health, the role of emotions is not a new topic. It has been studied substantially in behavioural economics. Sectors such as advertising and fundraising have been drawing
from insights on emotions for decades. Marketing attempts to attract customers by triggering memorable experiences suffused with emotion (10). Fundraising sees people fundamentally as emotional decision-makers, requiring an emotional connection to change their behaviour or to get them motivated to act (in this case, to donate) (11). Research in this sector has also shown that when people feel extreme unpleasant emotions (such as guilt and fear), they can go into a state of withdrawal and would be unlikely to take action and donate (12). Instead, evoking compassion, empathy, pride, and belonging, is much more likely to produce a positive outcome (13).

In the face of resistance to the uptake of public health measures, such as vaccine hesitancy, public health authorities’ responses have typically been to explain the evidence (14). However, this persistence in solely explaining the facts, without understanding the reasons for hesitancy, can be counterproductive (15). Objective facts are often interpreted in subjective ways (16). It is unlikely that any policy or strategy for the implementation or distribution of public health interventions will be able to succeed until public fears that motivate counterproductive behaviours are understood and addressed (17). The interplay between public perceptions, emotions and behaviours needs to be understood by governments and public health agencies and professionals. To achieve this understanding, public health professionals should question the overreliance on thinking that beliefs and reason are predominantly and solely governing decision making when it comes to health behaviours and open education up to emotional determinants.

A note on the language of “determinants”

In public health, determinants are understood as factors that influence health outcomes. These factors are influenced by the circumstances in which people are born, grow, live, work and age, which are further shaped by people's social and physical contexts, and communities’ historical experiences. These, in turn, are affected by the distribution of money, power and resources at global, national and local levels (Figure 1). Taking this “causes of the causes” approach suggests that it is meaningful to focus on emotional determinants whilst taking into account the broader influencing contexts and factors (18, 19). This study does not seek to suggest that emotions are a sole motivator of health behaviours or an isolated cause of failure of public health interventions. Instead, we attempt to uncover where emotional determinants have been the missing link in responding to epidemics effectively.

Aims

This review identifies relevant research to assess the role of emotional determinants, as well as to consider how they impact public responses to the risks around infectious diseases outbreaks, specifically in relation to the uptake of public health interventions. In doing so, we seek to generate crucial evidence to help inform the design of effective public health strategies and communication as well as future epidemic preparedness.

The specific research questions included:
1. Are emotional responses (to the risk, or perception of risk of infectious diseases outbreaks) of the public influencing their uptake of public health interventions?
2. How do these emotional determinants differ when considering specific emotions and which emotions act as motivators for action?
3. To what extent do these determinants vary by continent and region and type of infection, and what is their impact in cases of high-risk groups?

Methods

A systematic literature review was conducted initially by one researcher (AAK) with each step repeated and double-checked by an additional researcher, following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). A PICO framework was used, wherein Participants were populations exposed to an infectious disease outbreak, Interventions were public health campaigns or healthcare-led communication of risk of an epidemic, Comparators were not applicable, and the Outcome was the uptake of interventions (e.g. vaccination).

Operational definition of emotional determinants

In this review, emotional determinants of public responses to the risk of epidemics have been classified as specific human emotions that may influence an outcome, in this case, the uptake of public health interventions (20). It is understood that all emotions generally motivate some sort of action as a response to the eliciting event, and it is not the purpose of this study to comment on the role of emotions in human thriving or suffering or the socially constructed morality of those. Instead, the long supported biosocial framework that all emotions are essential in evolution and adaptation has been adopted. Hence, from this point of view, all emotions that humans experience are useful, they are not irrational, and their triggering is rationally explained based on individuals’ contexts.

A basic consensus approach was followed in this study in which emotional stimuli were categorised as being either pleasant or unpleasant and predisposing people to bivalent behaviour (such as approach or withdrawal) toward the stimuli (21). Emotional determinants were extracted from included manuscripts and assessed on their own right. For sensitivity and more in-depth analyses, they were also assessed in groupings of pleasant, unpleasant, high-intensity unpleasant (extreme) and anxiety-related (moderate) emotions (22). This framing is consistent with a very recent report on pandemic emotions and COVID-19 (6). It was considered in keeping with the latest evidence on emotions, and as covariates like region and population were also factored in, it is largely consistent with the modern contextual interpretation of emotions.

In recording emotions in this way, this review started with traditional classifications of “pleasant” (including emotions such as hope, love, happiness, joy, and empathy) and “unpleasant” emotions (including sadness, fear, anger, and worry) (also see Table 1) (23). These are motivated from a culturally interpreted distinction between an appetitive system associated with positive or pleasant feelings and an
aversive system associated with negative or unpleasant feelings. However, these terms are, in no way, used here to suggest an association with rationality or with happiness and wellbeing (24). Positive psychology research suggests that emotions can be positive in some contexts and negative in others, regardless of whether they are pleasant or unpleasant (25).

An informal consensus approach was used to classify the emotional determinants into these groups, to support the quantitative sensitivity analyses. Following the systematic search of the literature and initial data extraction, terms from relevant studies referring to emotions were recorded. To establish inter-rater reliability, a small group of expert colleagues were asked to classify those terms into the four suggested groupings above, and then compare and contrast their proposals. To establish face and content validity for emotions as determinants, an expert epidemiologist read 12 of the included papers at random and provided feedback on the correlations between emotions and outcomes that had been recorded.

For the terms on which there was no initial agreement, a method of discussion until reaching consensus was followed. Some concessions in the definitions of emotions had to be made for quantitative purposes: apathy, indifference and lack of threat awareness were all grouped together as “apathy”; wishful thinking was combined with “hope”; intense fear of a conspiracy and negative consequence was combined with “panic”. These only affected a total of four correlations and were not expected to significantly impact the results. It should also be noted that the emotions of anxiety, worry, stress and concern, though broadly describing similar reactions, were initially recorded and analysed separately following how they were mentioned in the various included studies; but were subsequently also grouped together for sub-analyses as “anxiety-related or moderate emotions”. Lastly, “surprise” was not included among the emotional determinants in this review as it was taken as a state linking cognition and emotion with the capacity to intensify emotions (26); hence, it could not be correlated directly to the outcomes.

Many of the terms referring to emotions are frequently used interchangeably in the literature with little critical thought or have multiple definitions (ranging from clinical to folk uses) attached to them. Hence, it is crucial to clarify how the emotions recorded in the review are understood, especially in the context of being interpreted as possible determinants of behaviour. The following definitions were adopted for the emotions identified in the literature searches:

- **Anxiety**: the affective (emotional) equivalent of uncertainty (27), especially in response to perceived vulnerability or susceptibility (28).
- **Apathy**: a lack of feeling, passion, or interest; lack of participation or action, loss of motivation, indifference to threat awareness (29).
- **Concern**: a feeling of anxiety in relation to a perceived uncertain threat (30).
- **Empathy**: used in this study in its popular psychology sense, meaning openness to the emotional perspective of another (31); includes: the perspective-taking of another person, staying out of judgement, recognising emotion in other people and communicating this, feeling with other people (32).
• Fear: an immediate, concrete and overwhelming feeling of physical danger. As such, fear is distinct to anxiety (mainly in the perception of a threat being concrete, rather than uncertain) (33, 34), and fear-related behaviours can be defined as the individual or collective behaviours and actions initiated in response to reactions that are triggered by a perceived threat or actual exposure to a potentially traumatising event (35).

• Hope: goal-directed thinking, characterised by the potential and motivation to find routes that lead to desired goals and thoughts (36). In health settings, hope is understood as arising from the confidence that everything humanly possible will be done for the good of the person at risk (or patient) (37).

• Hopelessness: understood as the lack of hope, with negative emotional and motivational impacts (37).

• Panic: panic is perhaps the most challenging term to find an agreed definition on and a tension continues to pervade definitions of panic (34). Historically, panic has long been associated with infectious disease outbreaks. It can be construed as a normal social phenomenon to explain extraordinary departures from routine (38), though it has acquired a collective folk usage over the years as a form of primitive “hysteria”, predominantly associated with the public (or subordinates or “natives” in other historical contexts), rather than the authorities (or the elite) (34). In this study, panic is seen as an intense, emotionally charged group response to some external menace, actual or imagined. In many ways, when referring to panic in this research, the popular view of “high anxiety” or “primitive fear” that creates blind spots in ways that other emotions do not is being adopted (38), primarily to allow for interpretation and comment on this folk terminology that the majority of the included literature utilises.

• Regret: an unpleasant feeling following the perception that one has taken the wrong course of action (39).

• Shame: a painful self-conscious feeling in which one perceives themselves to be defective, often in response to a perceived failure; sometimes may follow stigma and generally accepted moral values of majority culture (40, 41).

• Stress: anxiety or physical response to pressures from an event or ‘stressor’, especially in relation to experiencing something new or unexpected, something that threatens our competence/ego, and a feeling of little control over a situation (42).

• Worry: anxiety, especially in response to perceived susceptibility (43).

### Eligibility criteria

The following criteria were used to identify studies eligible for inclusion in the review:

• Study design: all primary observational research studies (including cross-sectional and cohort studies and randomised controlled trials). Modelling and statistical framework studies were excluded.
- Condition or domain studied: infectious diseases with the capacity to cause outbreaks, epidemics or pandemics.
- Setting: places of occurrences of infectious outbreaks worldwide.
- Time frame: 1988-2019 (starting date chosen as the last major update to Health Belief Model, a dominant approach to assessing people's capacity to act following risk communication). The last date of the search was 23 May 2019.
- Language: global, no limits (translation was sought where necessary).
- Publication status: articles, reports or protocols published or publicised ahead of print.

Exclusion criteria

Out of scope for inclusion were studies:

- assessing healthcare workers' perceptions (only studies on the general public were included);
- using a randomised controlled trial or any other experimental study design or looking at participation in a trial as an outcome (the review only covered real-world scenarios);
- specifically examining perceptions/emotions towards a vaccine or other interventions (i.e. within scope was emotion to the disease);
- looking at routine vaccinations (not focused on emergency settings);
- studying diagnosed psychiatric conditions and other mental health problems (not emotions) and their relation to attitudes;
- examining responses of people already infected or exposed to the disease.

Search

The following bibliographical databases were searched: Pubmed/MEDLINE (1946 to May 23, 2019), Embase (1974 to 2019 May 23), PsycInfo (1806 to May Week 3 2019), CINAHL, Global Health (1910 to 2019 Week 20). Further hand searches with some limited key terms were conducted in secondary research databases (e.g. Cochrane Library, Epistemonikos) to cross-reference sources and grey literature sources (e.g. OpenGrey). A consultation with expert sources (including colleagues from the London School of Hygiene & Tropical Medicine (LSHTM) Vaccine Confidence Project) further ensured that key studies were not missed.

Search terms included variations of the following: (emotion* OR panic* OR fear* OR afraid OR anxiet* OR anger* OR psychosomatic OR stress* OR empath*) AND (outbreak* OR epidemic* OR pandemic* OR infectio* OR ebola OR zika OR flu OR influenza) AND (perception OR perceive* OR risk* OR uncertain* OR associative thinking OR social contagion) AND (vaccin* or immuni#* or public health or preparedness or surveillance). This systematic review’s search strategy was peer-review by a librarian from the LSHTM Library and Archives Services (May 2019). The full search strategy for Medline is available [Additional File 1]. Key terms used for hand searches included: mass psychosomatic illness, immunisation stress-
related symptoms, emotional contagion, social contagion, associative thinking, risk amplification, mass drug administration, mass vaccination.

**Study selection and data extraction**

The articles retrieved from the online searches were entered into an EndNote Library, where duplicates were first automatically and then manually removed. The titles and abstracts of the remaining articles were screened for the eligibility criteria by the lead researcher. After this, the full-text articles were read and screened against the set criteria. From the identified relevant articles, data were extracted using a standardised form. These extracted data contained the following information: first author surname, year of publication, study design, region (including nation and continent) where the study was conducted, population (including size, percentage of women participants, and information on special subgroups), infection studied, emotions studied, outcomes studied, and statistical evidence of correlations. Emotions were studied in the context of being used in public health risk communications (i.e. reported through the communication used) or, intentionally or unintentionally, evoked by such messaging (i.e. reported or observed in the population studied). Additional information was extracted where deemed necessary narratively describing key conclusions or notes of the included articles. If any critical information was missing, study corresponding authors were contacted.

**Strategy for data synthesis**

A descriptive narrative approach was largely followed in the synthesis of the findings. Continuous variables were expressed as non-weighted means where possible. A narrative summary was produced per emotional determinant linking information about the targeted population, study design, type of outcome, determinant and correlations. Sub-analyses were explored for different regions/continents, infectious diseases, study designs (including data collection method), and special subgroups.

As a meta-analysis of individual- or community-level data was not possible due to large differences in study designs and reported effect measures, binomial tests were performed using the direction of effect observed in each study, i.e. either favouring or not favouring intervention uptake. Where this number was statistically significantly greater than what we would expect for a regular binomial draw, we interpreted it as evidence to believe that this is not due to chance. Hence, we performed binomial tests against a test proportion of 0.5 or 50% for each study outcome. A two-sided p-value of < 0.05 was considered significant. All analyses were undertaken with STATA 16 (StataCorp, College Station, TX, USA).

**Results**

**Search Results**

The search strategy yielded 11,522 potentially relevant articles from five databases. A further 5 records were identified via hand search in other sources. A total of 8,188 records remained for screening titles and abstracts after duplicates were removed. The full text was studied for a remaining 150 articles, 75 of which were excluded based on the exclusion criteria. In all, 75 studies were included in this review. A
relevant flow chart was constructed to detail the number of papers retrieved and the steps undertaken (Figure 2).

The 75 included studies had been published across almost all years between 1988 and 2019 and conducted across 28 different nations (most commonly in China and Hong Kong N=16, United States N=13, The Netherlands N=6, Australia N=6) in all continents except Central and Latin America. The studies included a total of 85,248 participants, with a further five studies conducted as national campaign evaluations covering substantial proportions of the nations’ populations but not necessarily involving direct participation. Data on age groups and gender for the participants were scarce. For the studies where study design information was available, 54 used a cross-sectional design and 18 a cohort design, whilst a variety of research methods was reported, 23 studies used quantitative methods (most commonly surveys), 17 used qualitative (most often focus groups and interviews), and seven used a mixed-methods designs. Baseline characteristics of the included studies and all the references are available in more detail in the appendix [Additional File 2].

Interventions and outcomes

Interventions included a range of public health approaches, such as national campaigns, risk communication via media or social media, targeted education in the context of qualitative research settings, and more generally non-targeted media information about emerging epidemics.

Emotional determinants were almost in all cases secondary study items or incidental findings. The outcomes studied as potentially correlated were collected and grouped into seven groups. Those included:

1. Healthcare seeking behaviour (i.e. to what extent participants would appropriately visit a doctor, hospital, or clinic to receive support or medication for symptoms);
2. Personal diagnostic testing (for infection);
3. Increased knowledge (about the infectious outbreak and appropriate action to take);
4. Further personal education (i.e. the extent to which people got motivated to further study or find information about the infection).
5. Personal prophylactic measures (including condom use, face masks, handwashing and personal hygiene);
6. Other prophylactic measures (e.g. compliance with quarantine, food hygiene methods, reduced travel, avoiding crowded places);
7. Vaccination (only in scope in cases of infections for which immunisations were available).

Emotions

The 75 eligible studies provided data on a total of 97 correlations between 12 emotions and the seven outcome groups. The 12 emotions identified, and their classifications are listed in Table 1. The word
cloud in Figure 3 presents the 12 emotions with the size of the words weighted by how frequently they were studied.

| Unpleasant Emotions | Pleasant Emotions | Intense/Extreme Unpleasant Emotions | Anxiety-related (moderate) Emotions |
|---------------------|-------------------|-------------------------------------|------------------------------------|
| Fear                | Stress            | Empathy                             | Fear                               |
| Anxiety             | Concern           | Hope                                | Panic                              |
| Worry               | Hopelessness      | Hopelessness                        | Stress                             |
| Panic               | Regret            | Shame                               | Concern                            |
| Apathy              | Shame             |                                     |                                     |

**Analyses**

Fear was the most commonly evoked emotion in the included studies, followed by anxiety, worry and panic. Empathy and hope were the only pleasant emotions studied in the included papers. There was evidence that the emotions of fear and panic had a negative effect on the uptake of public health interventions during the outbreaks studied, with 23 out of 27 studies and 10 out of 10 respectively showing a reduced uptake of interventions (p<0.001 and p=0.002 respectively). On the contrary, the emotions of worry (17 out of 17 studies, p<0.001) and empathy (6 out of 6 studies, p=0.031) emerged as the key motivators for action. Overall, moderate anxiety-related emotions (worry, anxiety, stress, concern) seemed to be much more significant motivators of action for the public compared to extreme unpleasant emotions (fear, panic, hopelessness, shame), which very rarely led to the uptake of interventions (10% of the studies, p<0.001). The correlations between emotions and the study outcomes are summarised in Table 2.
Table 2
Correlations between emotional determinants and outcomes (uptake of public health interventions) studied in the included papers.

| Emotions          | Correlations attempted | Proportion favouring intervention | 95% confidence interval for the proportion | p-value, two sided (* significance) |
|-------------------|------------------------|----------------------------------|------------------------------------------|-------------------------------------|
| 1 Fear ×^         | 27                     | 15%                              | 1% - 34%                                 | < 0.001 *                           |
| 2 Anxiety ×#      | 23                     | 65%                              | 43% - 84%                                | 0.210                               |
| 3 Worry ×#        | 17                     | 100%                             | 81% - 100%                               | < 0.001 *                           |
| 4 Panic ×^        | 10                     | 0%                               | 0% - 31%                                 | 0.002 *                             |
| 5 Empathy §       | 6                      | 100%                             | 54% - 100%                               | 0.031 *                             |
| 6 Apathy ×        | 4                      | 0%                               | 0% - 60%                                 | 0.125                               |
| 7 Hope §          | 4                      | 50%                              | 1% - 93%                                 | 1.000                               |
| 8 Stress ×#       | 2                      | 100%                             | 16% - 100%                               | 0.500                               |
| 9 Concern ×#      | 1                      | 100%                             | 1% - 100%                                | 1.000                               |
| 10 Hopelessness ×^| 1                      | 0%                               | 0% - 98%                                 | 1.000                               |
| 11 Regret ×       | 1                      | 100%                             | 1% - 100%                                | 1.000                               |
| 12 Shame ×^       | 1                      | 0%                               | 0% - 98%                                 | 1.000                               |
| × Unpleasant emotions | 87                 | 46%                              | 35% - 57%                                 | 0.520                               |
| § Pleasant emotions | 10                | 80%                              | 44% - 97%                                 | 0.109                               |
| ^ Extreme unpleasant emotions | 39           | 10%                              | 1% - 24%                                 | < 0.001 *                           |
| # Anxiety-related emotions | 43         | 81%                              | 67% - 91%                                 | < 0.001 *                           |

“Correlations attempted” refers to how many associations were observed between an emotion and an outcome in the included studies, and, hence, may be higher than the number of studies.

“Proportion favouring intervention” means the proportion of studies in which a positive effect on intervention uptake was observed.

A total of 10 different types of infections were studied in the included papers, with research usually published around or following the years of outbreaks in specific regions. The word cloud in Figure 4 presents these 10 infections with the size of the words weighted for how frequently they were studied.
Influenza was the most common (N=40), with A/H1N1 (Hemagglutinin Type 1 and Neuraminidase Type 1) the most common subtype and most research published between 2009-2011, followed by HIV/AIDS (Human Immuno-Deficiency Virus / Acquired Immuno-Deficiency Syndrome) (N=26), with the bulk of the research between 1988-1998. Twelve correlations were recorded for SARS (severe acute respiratory syndrome), with the majority of studies focusing on anxiety from Singapore and Hong Kong between the years 2003 and 2005. For Ebola, most studies were conducted in African countries between 2016-2017, and there were also four recent studies on Zika. Any other statistically significant correlations are included in Table 3.
Table 3
Correlations between the emotional determinants and uptake of public health interventions by type of infection and region

| Domain                        | Emotional determinants | Correlations attempted | Proportion leading to positive outcome | p-value, two sided (*significance) |
|-------------------------------|------------------------|------------------------|---------------------------------------|-----------------------------------|
| AIDS                          | Unpleasant emotions    | 24                     | 29%                                   | 0.063                             |
|                               | Extreme emotions       | 19                     | 21%                                   | 0.019 *                           |
| Ebola                         | Extreme emotions       | 6                      | 0%                                    | 0.031 *                           |
| Influenza                     | Moderate emotions      | 28                     | 79%                                   | 0.004 *                           |
| SARS                          | Unpleasant emotions    | 8                      | 88%                                   | 0.070                             |
|                               | Moderate emotions      | 6                      | 100%                                  | 0.031 *                           |
| Direct contact transmitted infections | Extreme emotions | 27                     | 19%                                   | < 0.001 *                         |
|                               | Moderate emotions      | 12                     | 83%                                   | 0.039 *                           |
| African nations               | Unpleasant emotions    | 11                     | 0%                                    | < 0.001 *                         |
|                               | Extreme emotions       | 11                     | 0%                                    | < 0.001 *                         |
| Asian nations                 | Extreme emotions       | 12                     | 17%                                   | 0.038 *                           |
| European nations              | Moderate emotions      | 14                     | 86%                                   | 0.013 *                           |
|                               | Unpleasant emotions    | 20                     | 75%                                   | 0.041 *                           |
| North American nations        | Extreme emotions       | 11                     | 18%                                   | 0.065                             |

"Outcome" means an observed increase in the uptake of interventions.

For reasons of brevity: “extreme emotions” are “extreme unpleasant emotions”, “moderate emotions” are “anxiety-related emotions”.

Extreme unpleasant emotions had a statistically significant negative effect on the uptake of public health interventions in several cases: in HIV/AIDS, in direct contact transmitted infections and studies conducted in African and Asian nations. On the other hand, anxiety-related emotions were key motivators for action.
in influenza and SARS and were studied much more commonly in European studies. Whereas in all African studies, only extreme unpleasant emotions were studied, with 11 out of 11 studies showing a lack of uptake of interventions (p<0.001).

For HIV/AIDS, the association between evoking an emotion of fear and uptake of testing for the condition was studied most often (N=6). A correlation to a positive outcome was recorded in just 17% of occurrences, significant at 90% (z=1.910, p=0.05912). For influenza, anxiety was the most common emotion evoked, leading, consistently to a positive outcome along with other moderate determinants. Fear was used in most cases hoping to lead to a positive outcome for Ebola, though with a 0% success rate (z=2.256, p=0.027). Evoking anxiety-related emotions was significantly correlated to a positive outcome for SARS (N=6, 100%, z=-2.082, p=0.040).

When assessed at a more granular level, by country or specific region, groupings were generally too small for statistical significance, though the overall trends were similar to the above observations (anxiety-related emotions much more frequently correlated to a positive outcome than extreme unpleasant emotions, and pleasant emotions mostly positively associated with the uptake of interventions). Further sensitivity analyses were conducted for special sub-groups studied in the included papers. Special groups included adolescent and young adults, black minority communities, LGBT+ people (Lesbian, Gay, Bisexual, Trans and other sexuality identities), people with long term conditions, high risk and pregnant women. Again, the trends were too small to assess statistically significant correlations between the emotional determinants and uptake of interventions during outbreaks.

**Risk of Bias Analysis**

The overall risk of bias of the included studies was low to medium. Out of the 75 included studies, 68% (N=51) were deemed as of high quality (low risk of bias), 25% (N=19) of medium quality, and 7% (N=5) of low quality (high risk of bias). However, for almost a third (N=23) of the included studies, ethical procedures were not described (or was unclear whether they had been followed), and for almost a third (N=24), it was not possible to conclude if the methodology was completely free of bias. In some cases, these were due to the potential for recall and social desirability bias due to the cross-sectional nature of surveys, while other potential sources of bias included small or non-representative samples.

All significant correlations for emotions, as outlined in Table 2, remained significant when limited to the medium and high-quality studies in the sensitivity sub-analyses, except for the correlation between empathy and uptake of interventions when limited only to high quality studies (Table 4).
Table 4
Analyses limited to the high and medium quality studies, for the significant correlations in the primary analyses.

| Emotions          | All studies | "High" quality studies | "High" and "medium" quality studies |
|-------------------|-------------|-------------------------|-----------------------------------|
|                   | Correlations p-value, two-sided, as in Table 1 | Proportion of correlations p-value, high quality | Proportion of correlations p-value, high & medium quality |
| Fear              | 29          | 0.008 *                 | 20/29                             | 0.041 *                   | 27/29                  | 0.019 * |
| Worry             | 17          | < 0.001 *               | 14/17                             | < 0.001 *                 | 17/17                  | < 0.001 * |
| Panic             | 10          | 0.002 *                 | 7/10                              | 0.015 *                   | 8/10                   | 0.008 * |
| Empathy           | 6           | 0.031 *                 | 5/6                               | 0.062                     | 6/6                    | 0.031 * |
| Extreme emotions  | 39          | < 0.001 *               | 27/41                             | 0.002 *                   | 37/41                  | < 0.001 * |
| Moderate emotions | 43          | < 0.001 *               | 31/43                             | < 0.001 *                 | 41/43                  | < 0.001 * |

* Significance

"Extreme emotions" are extreme unpleasant emotions; "Moderate emotions" are anxiety-related emotions.

Discussion

The strongest finding of this review was the evidence that extreme unpleasant emotions (fear, panic, hopelessness, shame) had a negative effect on the uptake of public health interventions during outbreaks.

Of note, panic was not followed by action favouring the uptake of interventions in any of the included studies. Within the public health community, and other sectors (especially political), there is still a view held by some that fear- and panic-based campaigns are effective in changing behaviours, and the evocation of fear through emotive language and graphic imagery has been used extensively in public health campaigns (44–46). An expanding body of research has been produced on this issue, some of which even firmly supports that fear-based campaigns are an effective way of increasing people's self-protective behaviour (47). Despite several study findings that fear-driven appeals and messaging result in non-sustainable, and often undesirable outcomes, including stigmatisation of vulnerable populations, mistrust towards authorities and delayed help-seeking (48), many still support this earlier view that fear-based campaigns are effective (46, 49). The results of this review indicate that, at least in the case of epidemics and pandemics, public health campaigns that appeal to fear are ineffective in motivating protective behaviours in the public.
The analysis in this review showed that unpleasant emotions were evoked much more often than pleasant following public health risk communications, with fear and anxiety being the most common. Moderate anxiety-related emotions covering concepts largely synonymous with “feeling concerned or anxious”, as opposed to extreme unpleasant emotions (fear, panic, shame, hopelessness), were significantly positively correlated with the uptake of interventions, clearly pointing to a direction for how the public can be motivated to take action in response to the risk of an epidemic. Given the detrimental effect of fear on following public health guidance and the uptake of interventions found, there is a demonstrable need for public health professionals to consider moderate emotional responses to public health strategies and crisis communications as a means by which health behaviours can be proactively influenced.

The emotion of empathy emerged as a key motivator for action in this systematic review, being positively and significantly associated with uptake of public health interventions, primarily following recommended measures and uptake of personal prophylactic measures. Despite the fact that few studies have researched how pleasant emotions may lead to uptake of intervention outcomes in epidemics, the trend was strong, with eight out of ten occurrences leading to uptake of interventions. More research is needed to confirm this trend. In keeping with these findings, an empathic response to the threat of SARS was found to predict increased adoption of the recommended health precautions, independent of the level of perceived viral threat (50). This finding was also observed in a study of response to the West Nile virus (51) and a study in the H1N1 pandemic setting during which the pandemic vaccine was produced and distributed (52). These findings suggest that empathic responding may modify the effect of the stressor itself to facilitate protective health behaviours (50, 52).

This is consistent with the research on prosocial behaviours, in which empathy has been well documented as leading to more effective social functioning, that benefits both the direct recipients of actions and behaviours and the wider society (53, 54). Recent research on Covid-19 illustrates the importance of altruistic, prosocial motivations in protective behaviours, with appeals to protect one’s community found to be stronger predictors for engaging with preventative public health behaviours than messaging promoting protecting oneself (55, 56). Notably, Heffner et al. found prosocial messaging that produced a strong, positive emotional response led to increased willingness to engage with preventative behaviours (57). Pfattheicher et al. have also found that inducing a prosocial emotional process, empathy for those most vulnerable to Covid-19, relates to motivation to adhere to preventative measures, bolstering the evidence of empathetic emotions’ potential to promote public health guidance adherence (58). Thus, open communications strategies rooted in care and compassion could help facilitate more protective and altruistic decision-making by the public, and public health communications should be refined to incorporate and acknowledge the important role that empathy and compassion can play.

This finding is particularly relevant in the context of vaccination uptake in the current Covid-19 pandemic, in which eliciting empathic responses may be crucial. Vaccination has long been an emotionally charged subject, and public health professionals attempting to combat vaccine hesitancy need to work with awareness of the influence emotions play in vaccine risk perception and move away from the belief that
the evidence will speak for itself (56, 59, 60). In the current climate of concern over Covid-19 vaccine safety and availability prompted by the expedited approval process and vaccine misinformation campaigns which have thrived online over recent years and during the Covid-19 pandemic, an empathetic and open style of communication, which is the most effective in galvanising the population to take positive action or refrain from a harmful act, could be employed effectively (14, 56). A recent study has already identified eliciting empathy for those most vulnerable to the virus as a potential means to improve intentions for vaccine uptake (61). Empathy and caring show honesty, dedication and openness, all of which are essential elements in persuasive communications and further research in this area is needed (62).

Despite the included papers covering a range of nations and continents, in the case of studies in African nations (largely focused on Ebola) only extreme unpleasant emotions were assessed, with a complete lack of associations on taking action on uptake of interventions. There were no relevant studies conducted in Central and Latin America, although a recent study has assessed the role of hope and trust amongst healthcare workers (37).

**Limitations**

This review had some anticipated limitations: emotions were never the primary variable in the included studies, quantitative data were scarce, it was only rarely reported where certain emotional determinants were counterproductive to an outcome, and the actual definitions of emotions in the included studies were far from systematic and consistent. Since most of the quantitative data were drawn from cross-sectional studies, causal inference cannot be made based on the observed associations between the various emotions and intervention uptake. Furthermore, the outcome in the studies (intervention uptake) was studied in a dichotomous way (yes or no), and no effect sizes were available. Hence, for the data synthesis, we did pool some very diverse data, and the analysis conducted seems to have been all that was feasible given the significant heterogeneity between studies and what was reported. In addition, effect sizes were not recorded in the included studies for the variables and outcomes studied and individual participant data were not assessed. However, the review derived its evidence from a total overall sample of over 80,000 subjects across a variety of nations, continents and contexts. An important limitation of the review is the narrow assessment of emotions and outcomes in the included studies, which fails to capture the depth and breadth of the human experience in response to outbreaks. This can only be addressed by a more in-depth study of outbreaks as they occur in local regions.

**Future Research**

Empathy and hope were the two pleasant emotions studied that resulted in an uptake of public health interventions. The outcomes evoking pleasant emotions, such as empathy, hope and compassion, remain under-researched and poorly understood in public health and warrant further study. The emerging research on the positive role of empathy in promoting physical distancing and vaccination intention during Covid-19 is a valuable contribution to this area and strengthens the case for further research (58, 61).
Going forward, new research frameworks will be needed to produce a more nuanced understanding of how emotional responses are born and manifest themselves during health crises. This is particularly relevant to empathic and prosocial responses to distress, which may predict distinct behavioural responses to the threat of global viral infections. Research indicates that coping strategies are associated with engaging in health behaviours in response to health threats. Future research should expand on how coping strategies are investigated and investigate the potential effectiveness of promoting effective coping and decreasing maladaptive strategies in response to future health threats (51).

More sophisticated and targeted research and evaluation analyses are also needed to understand which outbreak responses are most effective. Comparative psychobehavioural surveillance and analysis could yield important insights into generic versus population-specific issues that could be used to inform, design, and evaluate public health infection control policy measures (63). The Appraisal Tendency Framework, which proposes a theoretical connection linking one's discrete emotions with their cognitive appraisals, could be used more in public health (64). Researchers should use the opportunity of real-world infectious disease outbreaks – such as the current COVID-19 pandemic – to study emotional regulation in natural settings, that is, what strategies individuals use to manage their emotions in the face of risk (65).

Given identified differences between pleasant and unpleasant, moderate anxiety-related and extreme unpleasant emotions, and some variability by infection, outcome and region in the findings of this review, a nuanced understanding of how emotional determinants determine public responses and health outcomes at a local level is needed, and there is much potential learning to be recorded by the various national responses to COVID-19.

**Conclusion**

This is the first review of its kind, studying the role of emotional determinants, the influence of emotions on the perceived risk of an infectious disease outbreak, and the capacity of emotions to determine the success of public health interventions. The observed correlations between emotions and the uptake of public health interventions highlights the need for government and public health agencies to take emotional factors into account in crisis communications strategies throughout the life cycle of epidemic and pandemic response.

The current COVID-19 pandemic, either directly through personal or family experienced morbidity and mortality or indirectly through the immense media coverage and the endless political debates, has generated, fuelled, and amplified a wide range of emotional responses (6). The evidence emerging around emotions is largely consistent with the findings of this review, and certain experts and national leaders have appealed to public emotions in a variety of successful or unsuccessful ways (6, 58, 61, 66). The findings of this review can inform future public health communications in the evolving context of the COVID-19 response, post-pandemic recovery and future infectious disease outbreaks (67).
Abbreviations

AIDS          Acquired immune-deficiency syndrome
COVID-19      Coronavirus disease 2019
H1N1          Hemagglutinin Type 1 and Neuraminidase Type 1
HIV           Human immuno-deficiency virus
LSHTM         London School of Hygiene & Tropical Medicine
PRISMA        Preferred reporting items for systematic reviews and meta-analyses
SARS          Severe acute respiratory syndrome

Declarations

- *Ethics approval and consent to participate*
  - *Not applicable*
- *Consent for publication*
  - *Not applicable*
- *Availability of data and materials*
  - "The dataset(s) supporting the conclusions of this article is(are) included within the article (and its additional file(s))."
- *Competing interests*
  - HL reports grants from GSK for a study on maternal vaccine acceptance and grants from Merck for research on health-care provider vaccine hesitancy and is a member of the Merck vaccine confidence advisory board. MF reports being supported by a grant from GSK for a study on maternal vaccine acceptance. We declare no other competing interests.
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  - *First Author Biography:* Dr Kousoulis is a public health specialist, Director for England and Wales at the Mental Health Foundation, and a collaborator of The Vaccine Confidence Project at the London School of Hygiene & Tropical Medicine.
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**Figures**

**Figure 1**

The "causes of the causes" approach applied to emotional determinants.
Figure 2

PRISMA flow diagram of the different phases of the systematic review process
Figure 3

Word cloud of emotions studied in the review, weighted by frequency.
Figure 4

Word cloud of infections studied in the review, weighted by frequency

Supplementary Files

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