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# Anticipated Regret and Health Behavior: A Meta-Analysis

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## Abstract

**Objective—**Risk beliefs are central to most theories of health behavior, yet many unanswered questions remain about an increasingly studied risk construct, anticipated regret. We sought to better understand anticipated regret's role in motivating health behaviors.

**Methods—**We systematically searched electronic databases for studies of anticipated regret and behavioral intentions or health behavior. We used random effects meta-analysis to synthesize effect sizes from 81 studies ($n$=45,618).

**Results—**Anticipated regret was associated with both intentions ($r_+$= .50, $p$<.001) and health behavior ($r_+$= .29, $p$<.001). Greater anticipated regret from engaging in a behavior (i.e., action regret) predicted weaker intentions and behavior, while greater anticipated regret from not engaging in a behavior (i.e., inaction regret) predicted stronger intentions and behavior. Anticipated action regret had smaller associations with behavioral intentions related to less severe and more distal hazards, but these moderation findings were not present for inaction regret. Anticipated regret generally was a stronger predictor of intentions and behavior than other anticipated negative emotions and risk appraisals.

**Conclusions—**Anticipated inaction regret has a stronger and more stable association with health behavior than previously thought. The field should give greater attention to understanding how anticipated regret differs from similar constructs, its role in health behavior theory, and its potential use in health behavior interventions.

### Keywords

Anticipated regret; health behavior theory; systematic review; risk appraisal; affect; regret management theory

Regret is an aversive cognitive emotion that "we experience when realizing or imagining that our current situation would have been better, if only we had decided differently" (Zeelenberg & Pieters, 2007, p. 3). Over time, experience shapes our expectations of regret

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related to decisions and the ensuing outcomes (Baumeister, Vohs, DeWall, & Zhang, 2007). While anticipated regret is an expectation that is primarily cognitive, it likely also has an affective component, as imagining an unpleasant future may elicit emotion in the present. Studies have located neural substrates of anticipated regret during decisions as reactivation of the orbital prefrontal cortex and the amygdala, which is consistent with anticipated regret having cognitive and affective components (Coricelli, et al., 2005, 2007).

Expectancy value theories suggest that motivators of health behavior include expectations about the chances (such as perceived likelihood) and extent (such as perceived severity) of future outcomes (Edwards, 1954; Weinstein, 1993). The intuition that anticipated regret motivates behavior dates back at least 2,500 years to Buddhist scriptures that suggest regret is a useful marker for something to be avoided in the future (Bodhi, 2012). Health behavior research has seized on anticipated regret as novel risk appraisal (Sheeran, Harris, & Epton, 2014), useful above and beyond the other more traditional risk constructs (Weinstein, et al., 2007; Ziarnowski, Brewer, & Weber 2009). Empirical study of anticipated regret's role in motivating health and risk behaviors began in the mid-1990s (Richard, van der Pligt, & de Vries, 1995), and the pace of this research has increased markedly in the last decade. A growing body of evidence suggests that anticipated regret motivates people's actions (Sandberg & Conner, 2008).

Regret management theory suggests that people act to reduce the regret they experience and expect to experience from blaming themselves (Zeelenberg & Pieters, 2007). Thus, anticipating regret from taking action should discourage health and risk behaviors, while anticipating regret from inaction should encourage these behaviors (Hypothesis 1). Examples of how both types of anticipated regret (action and inaction) can motivate or discourage behaviors appear in Table 1. For example, a retiree might expect to regret getting a seasonal flu shot if she were to experience serious side effects. Conversely, she might expect to regret not vaccinating if she were to get the flu. Our conceptualization emphasizes forgoing alternatives and feeling responsible for a decision that could lead to a bad outcome: "I'll wish I hadn't done it."

The difference between action and inaction (Knobe, 2003; Thomson, 1976) has been a central concern of the regret literature (Gilovich & Medvec, 1995). Some of this interest comes from research on the omission bias, the tendency to judge harmful action as worse than equally harmful inaction (Ritov & Baron, 1990, 1995). Based on this literature, we propose the *action regret enhancement hypothesis* that suggests a stronger role for anticipated action regret than for inaction regret (Hypothesis 2a). People feel more responsible for action than for inaction (Knobe, 2003), and it follows that feeling culpable should enhance anticipated regret (Anderson, 2003; Zeelenberg & Pieters, 2007). Research shows greater experienced regret as a result of greater perceived opportunity (Roese & Summerville, 2005) or lost opportunity (Beike, Markman, & Karodogan, 2008). Several predictions follow from this hypothesis. First, mean ratings of anticipated regret should be higher for taking action than for inaction (Ritov & Baron, 1995), as the greater feelings of culpability for action can lead people expect greater regret (Anderson, 2003). Next, the association of anticipated regret with health behaviors should be larger in absolute terms for actions than inactions. Finally, anticipated action regret's impact may be more potent when

feedback about the results of the behavior is expected or imminent (Anderson, 2003). We build on this idea to suggest a larger role for anticipated action regret when the behavior is linked to a hazard that is more proximal (e.g., vaccination that can cause immediate side effects vs. smoking that can cause cancer later in life) or that is a more severe consequence (e.g., death vs. illness).

We propose a competing hypothesis, the *action regret minimization hypothesis* (Hypothesis 2b). Some researchers suggest that regret is more potent for inaction than action in the longer term (Gilovich & Medvec, 1994; Kahneman, 1995). As health behaviors generally concern the longer term, inaction regret may be of greater interest. Researchers have also questioned the relevance of work on the omission bias to understanding anticipated regret (Connolly & Reb, 2003). Further, while norms surround commonly studied behaviors such as gambling or financial investing, health behaviors often are accompanied by an added layer of medical guidelines and societal expectations on how to act (e.g., believing that cancer screening is “almost always a good idea”; Schwartz, Woloshin, Fowler, & Welch, 2004). Such norms and expectations and the feelings of blame they generate may make inaction even more regrettable. Three predictions follow from this hypothesis: people should report less anticipated action regret than inaction regret; anticipated action regret should be a less potent motivator of behavior; and it should have less ability to motivate behaviors that address proximal hazards or have more severe consequences.

Regret is an emotion that is specific to making decisions, and for this reason, anticipated regret may be different from expectations about other negative emotions (Zeelenberg & Pieters, 2007). This approach fits with previous empirical findings (e.g., Saffrey, Summerville, & Roese, 2008) and the broader theoretical framework of regret management theory (Zeelenberg & Pieters, 2007). Anticipated regret is similar to but distinct from expecting to feel: anxious about the future; guilty about one’s actions; disappointed by an outcome; or angry with oneself about an outcome. Although these anticipated emotions share a similar negative valence, they do not have the added cognition of the wish to have made a different decision. We focus specifically on anticipated regret as it is future oriented, whereas experienced regret may or may not look to the future. Anticipatory emotions like fear that one feels in the present when considering a future action can also play an important role in shaping behavior (Loewenstein, Wever, Hsee, & Welch, 2001), but they are not our primary focus. We hypothesize that anticipated regret is a more potent motivator of health behavior than expectations about other negative emotions, due to its special focus on the evaluation of one’s own decisions (Hypothesis 3). By enriching expectations with affect, anticipated regret may make these imagined futures more meaningful (Peters, 2006; Slovic, Finucane, Peters, & MacGregor, 2007). For this reason, we expected anticipated regret would have a stronger association with health behavior than more solely cognitive risk appraisals, including perceived likelihood, perceived severity and worry (Hypothesis 4).

These hypotheses led us to predictions that we sought to test in a meta-analysis of the literature on anticipated regret and health behavior. A previous meta-analysis by Sandberg and Conner (2008) examined a similar topic but focused only on studies testing the theory of planned behavior/reasoned action (Ajzen, 1991; Fishbein & Ajzen, 1975) and did not examine our four hypotheses. First, we expect that anticipating regret of action will

discourage health behavior, while anticipating regret from inaction will encourage health behavior (Hypothesis 1). Second, the action regret enhancement and minimization hypotheses offer competing predictions. The former suggests higher means, larger effects, and more stability across different situations, for anticipated regret of action than for inaction, while the latter suggests the opposite (Hypotheses 2a and 2b). Third, we expect larger effects for anticipated regret than for other anticipated negative emotions (Hypothesis 3). Finally, we expect larger effects for anticipated regret than for other risk appraisals such as perceived likelihood, perceived severity, and worry (Hypothesis 4).

## Methods

### Data sources and searches

We systematically searched five databases (MEDLINE, PsycInfo, Web of Science, CINAHL, and EMBASE) to identify studies published through December 2013. Searches of titles, abstracts, and keywords used the following terms: (anticip* regret*) OR (expect* regret*) OR (prospective regret*) OR (regret* avoid*) OR (regret* avers*) OR (action regret*) OR (inaction regret*). To identify additional studies, we manually searched the reference sections of included articles, examined articles that the included papers cited, and circulated requests for unpublished studies among colleagues and the authors of included articles.

### Study selection

Two investigators (JD and MG) independently reviewed titles and abstracts and, for relevant articles, we conducted full-text reviews. At this and subsequent steps, we resolved disagreements about inclusion through discussion with a third investigator (NB). We included English-language articles that assessed health behaviors or intentions to practice health behaviors as an outcome. We defined *health behaviors* broadly as actions that may protect one's own health or the health of a child or dependent (Glanz, Rimer, & Viswanath, 2008). We broadened this definition of health behaviors to include avoidance of risk behaviors (i.e., behaviors that may cause harm). We excluded behaviors with health-related consequences that were a matter of individual preferences rather than being recommended or discouraged by medical guidelines or consensus. Excluded behaviors included elective and cosmetic surgery, blood and organ donation, and fertility treatment as well as genetic testing and other screening services that did not have medical guidelines (e.g., screening older adults for alcohol problems). We defined *intentions* as plans (e.g., "I [intend/plan] to…."), desires (e.g., "I would like to…."), and expectations (e.g., "I expect to….") to practice a health behavior (Conner & Sparks, 2005). We also included behavioral expectation, perceived likelihood of engaging in the behavior and willingness in intentions as the constructs share a common psychological foundation (Kruglanksi et al., 2002, 2014). For behavior, we accepted assessments based on self-report, insurance claims, medical records, or direct observation.

We included studies of anticipated but not experienced regret. To distinguish between anticipated regret and other constructs, we required that measures include at least one item that used the words "regret" or "wish" (e.g., "If I did not vaccinate my child, I would [regret

it/wish I had]"). We included two studies that did not use these terms but used language we believed would elicit a similar thought process (e.g., "If I don't get the flu shot and end up getting the flu, I'd be mad at myself for not getting the flu shot"; Weinstein et al., 2007). For studies that used multi-item measures, we noted whether at least one item assessed other anticipated negative emotions including anxiety, guilt, disappointment, and anger. We included only studies that had quantitative data on the association of anticipated regret and health behavior or intentions.

## Data extraction

Two investigators (JD and MG) independently extracted data using a standardized coding form. For missing or ambiguous data, we contacted study authors to request additional information. Study characteristics included those related to design (cross-sectional or longitudinal), sampling strategy (probability or non-probability), sample size, and response and retention rates. For behavioral outcomes, we extracted data on source (self-report or other). We coded five characteristics of the health behaviors: 1) frequency of behavior (infrequent or frequent); 2) severity of health-related consequences associated with the behavior (disease or death); 3) delay in time for those consequences (shorter or longer, defined as less or more than a year); 4) whether the behavior was a health or risk behavior; and 5) health behavior category (e.g., vaccination, cancer screening). We confirmed categorizations for the first three characteristics through coding by five behavioral scientists (kappa=1.0, .67 and .66 respectively).

For anticipated regret measures, we extracted data on type of regret (action or inaction), number of survey items (1 or >1), inclusion of other anticipated emotions, specifying the time period under consideration (e.g., regret felt in the next year), who the harms affect (self or another person), and whether researchers dichotomized anticipated regret. We extracted data on three other risk appraisals related to the consequences of performing (or failing to perform) a health behavior: perceived likelihood, perceived severity, and worry. We defined *perceived likelihood* as an individual's assessment of the probability of experiencing a consequence, *perceived severity* as an assessment of the seriousness of the consequence (Brewer et al., 2007; Weinstein, 1993), and *worry* as an anticipatory emotion of concern or anxiety about a future consequence (Hay, McCaul & Magnan, 2006).

## Data synthesis and analysis

We conducted analyses using Comprehensive Meta-Analysis (v. 2; Biostat, Inc., Englewood, NJ). We calculated effect size *r* for the association of anticipated regret with intentions and with behavior (Wolf, 1986; Chinn, 2000), using multivariate data when bivariate data were unavailable. We reverse coded associations if the anticipated regret measure referred to action (e.g., anticipated regret of getting cancer because of smoking) but the outcome was inaction (e.g., intention to quit smoking) or the converse was present. We also calculated effect sizes for the association of perceived likelihood, severity, and worry with intentions and with behavior. For studies reporting multiple effect sizes for the same outcome, we followed the approach described by Brewer et al. (2007).

Separately for behavioral intentions and for behavior, we calculated pooled effect sizes ($r_+$=) using random-effects meta-analyses. To characterize heterogeneity among studies, we report the *Q* statistic. Analyses combining anticipated action and inaction regret reversed the sign for action effects sizes. We stratified analyses when separate effect sizes were available for action and inaction regret. To compare pooled effect sizes for anticipated regret to other risk appraisals, we identified a subset of studies that assessed both constructs, meta-analyzed within-study difference scores (risk appraisal minus anticipated regret), and adjusted variances according to methods described by Borenstein and colleagues for dealing with correlated data (Borenstein, Hedges, Higgins, & Rothstein, 2009). For studies that measured both anticipated regret of action and inaction, we calculated standardized mean difference scores (Cohen's *d*) to compare the two measures. We meta-analyzed the difference scores using random effects meta-analysis.

## Results

We identified 81 studies of the role of anticipated regret on health outcomes. The studies included 45,618 participants (Figure 1). Fifty-six studies were from Europe, 17 from North America, 6 from Australia and New Zealand, and 2 from Asia (online Appendix A). Studies were commonly cross-sectional (58%) and relied on convenience samples (74%).

From the included studies, we calculated 128 effect sizes. We found more assessments of intentions (*k*=80 effect sizes) than behavior (*k*=48) and of inaction regret (*k*=81) than action regret (*k*=47). The most commonly studied categories of health behavior were vaccination (*k*=32) and cancer screening (*k*=14). Studies on promotion of health behaviors (e.g., physical activity) typically examined inaction regret only, whereas studies on risk behaviors (e.g., speeding/unsafe driving) typically examined action regret only (online Appendix B; Table 1). Studies of vaccination were a notable exception as they commonly examined both inaction and action regret. We identified 39 effect sizes from studies that used single-item measures of anticipated regret, 19 based on multi-item measures of anticipated regret alone, and 70 based on multi-item measures that also included other anticipated negative emotions.

### Meta-analyses of associations

Anticipated regret was associated with having higher behavioral intentions ($r_+$= .50; 95% *CI* =.46, .53; $p$<.001) and with being more likely to engage in the health behaviors ($r_+$= .29; 95% *CI* =.24, .34; $p$<.001), across 128 effect sizes, in combined analyses that reversed the sign for anticipated action regret effect sizes. Analyses of health behavior categories found stronger associations, when compared to vaccination, for physical activity (intentions $r_+$= .46 vs. .55, $p$=.03; behavior $r_+$= .27 vs. .46, $p$=.001) and speeding/unsafe driving (behavior $r_+$= . 27 vs. .45, $p$=.01) (Table 2).

### Meta-analyses of associations, stratified by action/inaction

Anticipated regret of inaction and action had oppositely signed associations with outcomes (Table 3) (Hypothesis 1). Anticipated action regret was associated with lower behavioral intentions ($r_+$= −.45; 95% *CI*= −.51,−.38; $p$<.001) and being less likely to engage in health behaviors ($r_+$= −.28; 95% *CI*= −.36,−.19; $p$<.001). In contrast, anticipated inaction regret

was associated with higher intentions ($r_+$= .52; 95% *CI* =.48, .56; $p$<.001) and being more likely to engage in behavior ($r_+$= .29; 95% *CI* =.23, .35; $p$<.001). In absolute terms, the association of anticipated inaction regret with intentions was somewhat stronger than that for action regret ($p$=.06); the associations were the same for behavior ($p$=.76). Forest plots of the effect sizes appear in online Appendices C and D.

Anticipated action regret showed weaker associations for intentions to engage in health behaviors that were less frequent compared to more frequent ($r_+$= −.29 vs. −.52, $p$ <.001) (Table 4) (Hypothesis 2b). Anticipated action regret also showed weaker associations for intentions to engage in health behaviors ($r_+$= −.29) that addressed less severe ($r_+$= −.36) and more distal hazards ($r_+$= −.37) than for their counterparts ($r_+$= −.52, −.55 and −.53 respectively; all $p$<.05). These four characteristics did not moderate the association of anticipated action regret and behavior, though the pattern was the same and the findings were all marginally statistically significant ($p$=.06 to.09). These characteristics did not moderate anticipated inaction regret associations. Cross-sectional studies yielded a smaller pooled effect size than longitudinal studies for anticipated inaction regret and behavior ($r_+$= . 20 *vs*. .31, $p$= .02) but not for intentions or anticipated action regret. We did not find any differences in effect sizes based on whether the harm affected the self or another person such as a patient or child, the anticipated regret item specified the time period, or anticipated regret measure was dichotomous.

Effects were larger for multi-item measures of anticipated action regret only compared to measures that included other anticipated negative emotions (Table 4) (Hypothesis 3). The finding held for intentions ($r_+$=−.64 vs. −.50, $p$< .05) and behavior ($r_+$=.−.50 vs. −.30, $p$< . 05). Pooled effect sizes were also larger for studies that used multi-item measures of anticipated regret only (absolute value of range $r_+$= .36−.64) rather than single-item measures of anticipated regret only (absolute value of range $r_+$= .17−.45) for 3 of 4 outcomes (all $p$<.05). Effect sizes for anticipated inaction regret were similar when comparing multiple item measures of anticipated regret alone and that includes other anticipated negative emotions. In sensitivity analyses that repeated our main analyses after dropping anticipated regret measures that included other anticipated emotions, we again found anticipated regret had a larger pooled effect size for inaction than for action as a correlate of intentions ($r_+$= .50 vs. −.38, $p$=.04); there was no difference for behavior ($r_+$=.28 vs. −.26, $p$=.79).

## Meta-analyses comparing to other risk appraisals

Anticipated regret was more strongly associated with intentions than were perceived likelihood ($r_+$= .47 vs. .15), perceived severity ($r_+$= .50 *vs*. .17) and worry ($r_+$= .49 vs. .23) (all $p$<.05; Table 5) (Hypothesis 4). Anticipated regret was also more strongly associated with behavior than were perceived severity ($r_+$= .26 vs. .11) and worry ($r_+$= .35 vs. .26) (both $p$<.05), but not perceived likelihood.

## Meta-analysis of means

Ratings of anticipated action regret were lower than ratings of inaction regret ($d$= −1.11, $p$<. 001; $Q$=787, $p$<.001) (Hypothesis 2b). This pattern was present in nine of the ten studies that

examined both anticipated action and inaction regret (all $p<.001$) (Table 6). All of these studies examined vaccination behavior.

## Discussion

### Motivating health behavior

Anticipated regret was associated with a broad array of health behaviors. Anticipated inaction regret was associated with engaging in protective behaviors, while action regret showed the opposite association. The broad pattern of findings was most consistent with the idea that people minimize anticipated regret from action. First, mean anticipated regret was lower for action than inaction, a finding others have hypothesized for regret of more distal outcomes (Gilovich, Medvec, & Kahneman, 1998). Second, associations were somewhat smaller for anticipated action than inaction regret and intentions, though the difference was marginally reliable, and we found no difference for behavior. Third, associations of anticipated action regret with intentions were weaker for less severe behaviors with more distal outcomes; behavior showed the same pattern, though the behavior findings were marginally reliable. We did not find these moderation effects for anticipated inaction regret. Taken together, the findings suggest that anticipated inaction regret is more strongly felt than action regret in the domain of health and has more reliable associations with behavioral intentions and perhaps health behaviors.

A key component of regret management theory is avoiding self-blame, with less regret anticipated for justifiable decisions (Zeelenberg, & Pieters, 2007). The result was straightforward for mean levels of anticipated regret: people anticipated less regret of an action that is widely believed to protect health (getting vaccinated) than of an inaction that the medical establishment roundly condemns (forgoing vaccination). In the context of health behavior, inaction often defies medical authority, thereby leaving the decision maker more vulnerable to self-blame.

The consequences of avoiding self-blame appear to be more complex when it comes to anticipated action regret motivating health behaviors. While actions may seem more controllable (Knobe, 2003) and thus more naturally fit the schema of eliciting self-blame, actions may also elicit the belief that resulting harms are more controllable (Feldman, Myamoto, & Loftus, 1999). In this way, anticipated regret may be less reliably motivating when it concerns action than inaction, if people perceive consequences of action to be less preordained and more amenable to remediation. Another possibility is that feeling culpable for action may make feelings about those actions especially subject to defensive processing to protect one’s sense of self-worth (Croyle, Sun, & Hart, 1997; Kessels, Ruiter, & Jansma, 2010; Kunda, 1987). The result would be a greater minimizing of the anticipated regret of action than of inaction. Future research can help to tease apart these accounts that rely on perceived responsibility.

Emphasizing the consequences of inaction may benefit interventions that focus on anticipated regret as a way to change health behavior. In our own intervention work, we have used anticipated regret of harms from not vaccinating to prompt HPV vaccination (Golden et al., 2014). However, as initial pilot work suggested direct appeals to anticipated regret might

elicit reactance, we developed education materials with a quote from a local parent that allowed us to incorporate the construct indirectly ("And I'd feel awful if [my kids] got sick because I didn't get them vaccinated"). Other regret-based interventions include so-called regret lotteries in which people learn whether they would have won a prize in the lottery, whether or not they sign up for it (Zeelenberg & Pieters, 2004). In the health context, people have used variants of regret lotteries to encourage health risk assessments among employees (Haisley, Volpp, Pellathy, & Loewenstein, 2012). Similar regret-based interventions encourage weight loss (Volpp et al., 2008) and may increase medication adherence in some patients (Kimmel et al., 2012). Others have suggested leveraging anticipated regret to encourage appropriate use of mammography screening (Rosenbaum, 2014). Finally, some studies have shown that merely asking anticipated regret questions can increase health behaviors such as cervical cancer screening (Sandberg, & Conner, 2009).

### Other risk appraisals and anticipated negative emotions

Anticipated regret generally yielded larger associations than other anticipated negative emotions and risk appraisals. Substantial interest has built for adding emotion to supplement the largely cognitive expectancy value models of behavior (Mellers, Schwartz, & Ritov, 1999; Loewenstein, et al., 2001). Expectancy value models have their roots in utility theories that posit that the expected size and value of future outcomes guide behavior (Edwards, 1954). Arguing that anticipated emotions are already included in utility theories (Over, 2004) may be an oversimplification. One descriptive approach has been to note the similarity of anticipated regret to constructs already in models, such as the idea of loss aversion in prospect theory (Anderson, 2003; Kahneman & Tversky, 1979). Another approach has been to build descriptive evidence for adding the construct to the models, such as to the theory of reasoned action/planned behavior, as anticipated regret is conceptually distinct from other model components and explains additional variance in behavior above and beyond them (Sandberg & Conner, 2008; Sheeran & Orbell, 1999). Unfortunately, efforts to add anticipated regret, for example, to the these models do not appear to have changed the way that many researchers use them or teach them in training programs (e.g., Glanz, Rimer, & Viswanath, 2008). The research findings also did not prompt the inclusion of anticipated regret in updates to the reasoned action approach (Fishbein & Ajzen, 2010).

Our findings suggest that anticipated regret of action may be different than other anticipated negative emotions, perhaps because regret is specific to decisions or because it has an explicit cognitive component. We found stronger associations of intentions and behavior with anticipated regret of action when measured without other anticipated emotions. This finding is important because more than half of the studies in our review, especially those informed by the theories of planned behavior or reasoned action, named the construct anticipated regret, but they often used measures that incorporate this construct along with other anticipated negative emotions. Past research suggests that different emotions have different functions and impacts (Keltner, Ellsworth, & Edwards, 1993; Lerner, Gonzalez, Small, & Fischhoff, 2003), and now our meta-analysis shows that in some circumstances anticipated regret shows stronger associations than other anticipated emotions. By including studies that assessed other anticipated emotions, some of our effect sizes likely underestimate the true effect of anticipated regret on health behavior. Future studies should

more directly by compare measures of anticipated regret alone to measures of anticipated negative emotions excluding regret. Future studies should also better characterize and distinguish between the expectation of regret and emotions such an appraisal generates.

## Limitations

The literature that we reviewed had several limitations. Analyses identified several moderators of the association of anticipated regret and behavior or intentions, but stratified pooled effect sizes remained heterogeneous suggesting the presence of moderators that remain to be identified. While moderator analyses in meta-analysis can yield spurious findings, we are encouraged by the consistency of findings across our analyses. The correlational designs widely used in the studies precludes strong causal inference (Brewer, Weinstein, Cuite, & Herrington 2004; Weinstein & Nicolich, 1993). Longitudinal studies yielded similar associations to (or in one case larger than) cross-sectional studies, which increased our confidence that anticipated regret precedes behavior. With the exception of the vaccination literature, studies of health promotion typically only measured inaction regret, whereas studies of risk behaviors typically only measured action regret. Anticipated action regret was absent in the medical screening literature; studies on screening only measured inaction regret. With rising attention to the potential harms of medical screening (Harris et al., 2014; Rosenbaum, 2014), examining both anticipated action and inaction regret in this context may be fruitful.

Limitations of our meta-analysis are that we did not examine studies of solely other risk appraisals or anticipated negative emotions other than regret; the generalizability of our findings to studies not included in our meta-analysis remains to be established. Few studies were available to test certain hypotheses. For example, only 4 studies examined influence of both anticipated regret and worry on behavioral outcomes. Also, some moderation analyses were limited by small cell sizes when stratifying by action and inaction regret. Our comparison of mean anticipated regret of action and inaction relied solely on studies of vaccination; the generalizability of these finding beyond vaccination is unknown.

## Implications for measurement and health behavior models

The field should consider adopting common methods for measuring anticipated regret. We propose that standard measures of anticipated regret 1) specify a negative consequence of the action or inaction; 2) assess regret of the action or inaction but not the health consequence; 3) examine only anticipated regret without also assessing other expected negative emotions; 4) have separate subscales for action and inaction; and 5) include multiple items in each subscale, if possible. Here is an example of an item that meets the first three criteria: “Imagine that you had an abnormal Pap test, but the HPV vaccine might have prevented it. How much would you regret that you did not get the HPV vaccine?” Identifying multiple negative consequences of action or of inaction can facilitate developing multiple item scales. Using multi-item scales that mix various negative emotions but incorrectly label them as anticipated regret, and using single item measures, underestimates the impact of anticipated regret.

While interest in anticipated regret has accelerated in past years, none of the leading theories of health behavior yet include this important construct. We believe it is now time for anticipated regret to be a standard variable assessed in studies of health behavior (Bell, 1983). The literature on anticipated regret and the theories of planned behavior and reasoned action have supported such action for at least 15 years (Sandberg & Conner, 2008; Sheeran & Orbell, 1999), though debate continues (Fishbein & Ajzen, 2010). Other expectancy value models, such as the health belief model (Janz & Becker, 1984), may benefit similarly from including anticipated regret (Bell, 1983). At the very least, studies relying on these models should also assess and make use of anticipated regret in their conceptualization of the health behavior. Anticipated regret had stronger associations with health behaviors and intentions than several other risk appraisals including perceived severity, which is central to most expectancy value models. Including anticipated regret in these models would raise several interesting questions, such as whether anticipated regret acts only through intentions, whether it could mediate or precede more cognitive constructs such as perceived severity, or whether it moderates the intentions-behavior association (Sheeran & Orbell, 1999). Answering questions like these represents a next stage of maturation in research on anticipated regret and health behavior models.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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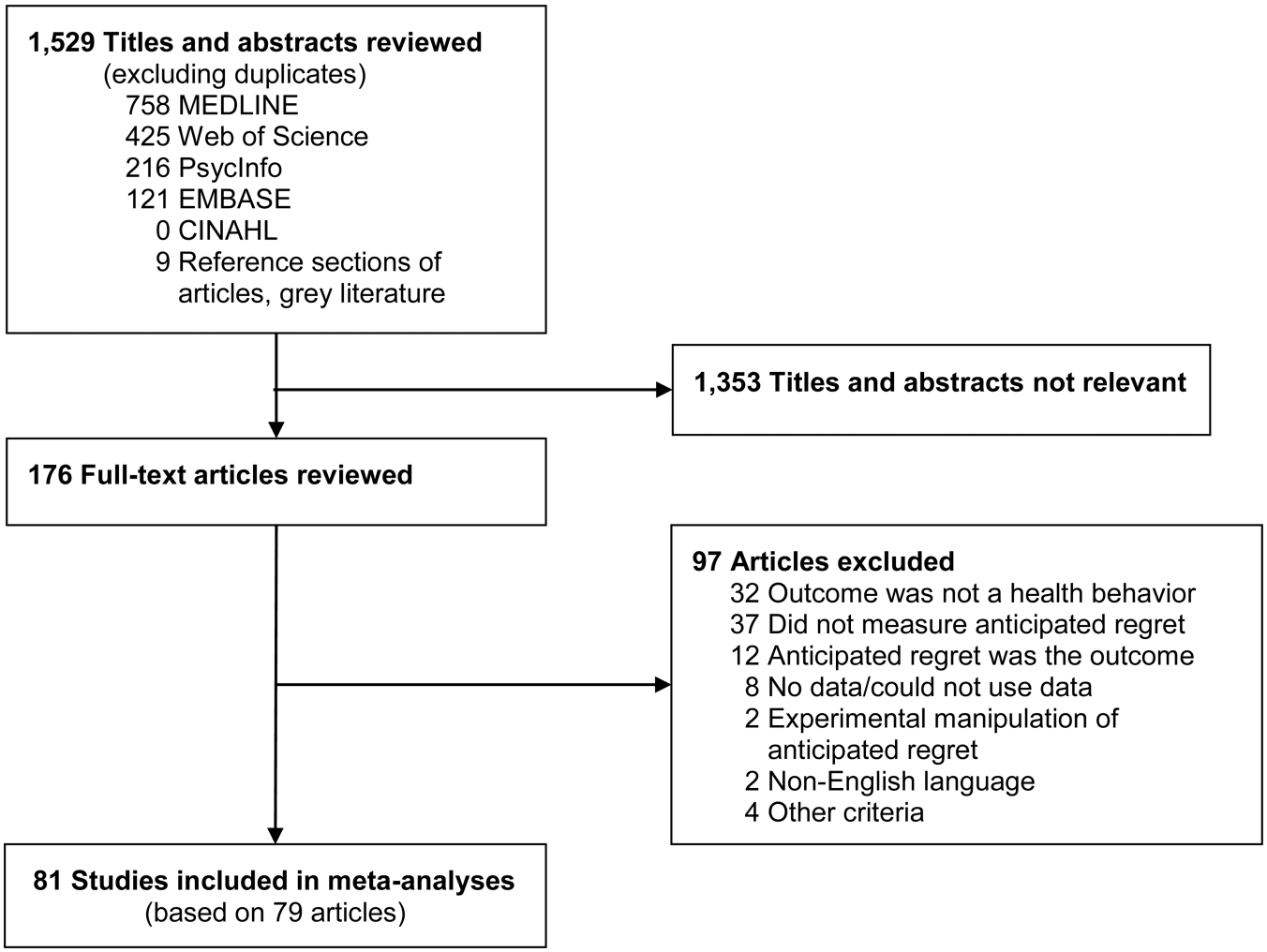


**Figure 1.**
Flow diagram

## Table 1

Hypothesized relationships between anticipated regret and health behavior

| Anticipated Regret of | |
|---|---|
| **Action** | **Inaction** |
| Discourages health behavior | Encourages health behavior |
| *Example*: anticipated regret of vaccination (if it led to side effects) discourages vaccination. | *Example*: anticipated regret of not getting the flu vaccine (if the person later got the flu) encourages vaccination. |
| Discourages risk behavior | Encourages risk behavior |
| *Example*: anticipated regret of smoking (if it caused cancer) discourages smoking. | *Example*: anticipated regret of not trying cigarettes (if it led to being shunned by friends) encourages trying cigarettes. |

**Table 2**

Pooled effect sizes for anticipated regret by health behavior category

| Health behaviour category | | Outcome Intentions | | | | Outcome Behavior | | |
|---|---|---|---|---|---|---|---|---|
| | *k* | $r_+$ (95% CI) | *Q* | Difference in $r_+$ *p* | *k* | $r_+$ (95% CI) | *Q* | Difference in $r_+$ *p* |
| Vaccination (ref) | 24 | .46 (.38, .54)** | 534** | -- | 18 | .27 (.19, .36)** | 377** | -- |
| Cancer screening | 10 | .54 (.49, .58)** | 37** | .10 | 4 | .17 (−.02, .34) | 28** | .29 |
| Safe sex/condom use | 10 | .50 (.42, .58)** | 168** | .50 | 2 | .23 (.15, .30)** | <1 | .44 |
| Speeding/unsafe driving | 9 | .50 (.37, .60)** | 185** | .66 | 4 | .45 (.34, .55)** | 10* | .01 |
| Smoking | 7 | .47 (.42, .51)** | 14* | .94 | 5 | .22 (.13, .31)** | 21** | .39 |
| Physical activity | 7 | .55 (.52, .58)** | 3 | .03 | 4 | .46 (.40, .52)** | 1 | <.001 |
| Alcohol/drug use | 6 | .57 (.43, .69)** | 53** | .19 | 3 | .27 (.13, .40)** | 5 | .97 |
| Healthy eating/weight maintenance | 3 | .44 (.09, .69)* | 60** | .89 | 4 | .22 (.10, .33)** | 13* | .44 |
| Skin cancer prevention | 2 | .42 (.13, .65)* | 22** | .78 | 2 | .35 (.04, .60)* | 21** | .61 |
| Other | 3 | .48 (−.08,.81) | 110** | .93 | 2 | .28 (.12, .42)* | 2 | .98 |

*Note*. Analyses combined action and inaction regret, reversing sign for action regret. *p* values compare effect sizes for health behavior category to vaccination (reference group). Other behaviors included for the intention outcome are looking after one's health (*k*=1), oral contraception use (*k*=1) and glaucoma screening (*k*=1). Other behaviors included for the behavior outcome are looking after one's health (*k*=1) and oral contraception use (*k*=1).

* *p*<.05,

** *p*<.001

**Table 3**

Pooled effect sizes for anticipated regret

| Predictor Anticipated Regret | Outcome Intentions | | | | Outcome Behavior | | | |
|---|---|---|---|---|---|---|---|---|
| | *k* | $r_+$ (95% CI) | *Q* | Difference in $r_+$ *p* | *k* | $r_+$ (95% CI) | *Q* | Difference in $r_+$ *p* |
| Action | 28 | −.45 (−.51, −.38)** | 562** | -- | 19 | −.28 (−.36, −.19)** | 328** | -- |
| Inaction | 52 | .52 (.48, .56)** | 894** | .06 | 29 | .29 (.23, .35)** | 344** | <.76 |

*Note*. Comparison reverses the sign for action regret. Higher scores indicated more anticipated regret.

* $p<.05$;

** $p<.001$

**Table 4**

Pooled effect sizes for anticipated regret by moderators

| Moderator | Predictor Anticipated Regret | Outcome Intentions $k$ | Outcome Intentions $r_+$ | Difference in $r_+$ $p$ | Outcome Behavior $k$ | Outcome Behavior $r_+$ | Difference in $r_+$ $p$ |
|---|---|---|---|---|---|---|---|
| **Consequence** | | | | | | | |
| Disease | Action | 16 | −.36** | -- | 7 | −.22** | -- |
| Death | Action | 12 | −.55** | <.001 | 12 | −.37** | .06 |
| Disease | Inaction | 42 | .52** | -- | 25 | .31** | -- |
| Death | Inaction | 11 | .53** | .82 | 4 | .17 | .13 |
| **Delay to Consequence** | | | | | | | |
| Shorter | Action | 13 | −.53** | -- | 7 | −.37** | -- |
| Longer | Action | 15 | −.37** | .003 | 12 | −.22** | .06 |
| Shorter | Inaction | 13 | .46** | -- | 3 | .22** | -- |
| Longer | Inaction | 40 | .54** | .15 | 26 | .30** | .11 |
| **Frequency of Behavior** | | | | | | | |
| Infrequent | Action | 9 | −.29** | -- | 6 | −.18* | -- |
| Frequent | Action | 19 | −.52** | <.001 | 13 | −.32** | .09 |
| Infrequent | Inaction | 26 | .56** | -- | 16 | .28** | -- |
| Frequent | Inaction | 27 | .48** | .05 | 13 | .30** | .78 |
| **Type of Behavior** | | | | | | | |
| Health behavior | Action | 9 | −.29** | -- | 6 | −.18* | -- |
| Risk behavior | Action | 19 | −.52** | <.001 | 13 | −.32** | .09 |
| Health behavior | Inaction | 50 | .53** | -- | 28 | .30** | -- |
| Risk behavior | Inaction | 3 | .31 | .41 | 1 | .20* | .28 |
| **Measurement of AR** | | | | | | | |
| Multiple items, AR° | Action | 3 | −.64** | -- | 3 | −.50** | -- |
| Single item, AR° | Action | 9 | −.29** | <.001 | 7 | −.17* | <.001 |
| Multiple items, AR+ | Action | 15 | −.50** | .002 | 7 | −.30** | .005 |

| Moderator | Predictor Anticipated Regret | Outcome Intentions $k$ | Outcome Intentions $r_+$ | Difference in $r_+$ $p$ | Outcome Behavior $k$ | Outcome Behavior $r_+$ | Difference in $r_+$ $p$ |
|---|---|---|---|---|---|---|---|
| Multiple items, AR° | Inaction | 8 | .58** | -- | 4 | .36* | -- |
| Single item, AR° | Inaction | 12 | .45** | .04 | 11 | .26** | .50 |
| Multiple items, AR+ | Inaction | 31 | .54** | .68 | 13 | .32** | .78 |

*Note:* No studies measured anticipated negative emotion with a single item, as our meta-analysis included only studies that measured anticipated regret. AR° = anticipated regret only. AR+ = anticipated regret and other negative emotions.

* $p<.05$;

** $p<.001$

**Table 5**

Comparison of pooled effect sizes for anticipated regret and other risk appraisals

| Risk Belief | Outcome Intentions | | | Difference in $r_+$ | Outcome Behavior | | | Difference in $r_+$ |
|---|---|---|---|---|---|---|---|---|
| | *k* | $r_+$ (95% CI) | *Q* | *p* | *k* | $r_+$ (95% CI) | *Q* | *p* |
| Perceived likelihood | 15 | .15 (−.01, .29) | 810** | -- | 12 | .17 (.03, .30)* | 399** | -- |
| Anticipated regret | 15 | .47 (.40, .54)** | 254** | .002 | 12 | .28 (.20, .36)** | 165** | .15 |
| Perceived severity | 14 | .17 (.05, .28)* | 279** | -- | 11 | .11 (.06, .16)** | 33** | -- |
| Anticipated regret | 14 | .50 (.41, .59)** | 293** | <.001 | 11 | .26 (.18, .34)** | 109** | <.001 |
| Worry | 7 | .23 (.12,.34)** | 81** | -- | 4 | .26 (.16, .36)** | 21** | -- |
| Anticipated regret | 7 | .49 (.36, .61)** | 162** | .004 | 4 | .35 (.20, .48)** | 42** | .04 |

*Note*. Analyses only included studies that assessed both anticipated regret and at least one other risk appraisal. Analyses combined action and inaction regret, reversing sign for action regret.

* $p<.05$,

** $p<.001$

## Table 6

Mean anticipated regret of action and inaction

| Study | *N* | Action Mean (SD) | Inaction Mean (SD) | *p* |
|---|---|---|---|---|
| Brewer, 2012 | 567 | 2.8 (1.2) | 3.6 (1.8) | <.001 |
| Chapman, 2006 | 428 | 2.3 (1.4) | 3.1 (1.5) | <.001 |
| Liao, 2013 | 507 | 2.0 (1.0) | 1.7 (0.8) | <.001 |
| McRee, 2014 | 543 | 2.0 (0.9) | 3.4 (0.9) | <.001 |
| Morison, 2010 | 243 | 3.6 (1.4) | 5.4 (1.0) | <.001 |
| Reiter, 2011 (parents) | 535 | 2.7 (1.1) | 3.2 (1.0) | <.001 |
| Reiter, 2011 (sons) | 412 | 2.8 (1.1) | 3.1 (1.0) | <.001 |
| Reiter, 2014 | 428 | 2.1 (0.9) | 3.4 (0.8) | <.001 |
| Wroe, 2004 | 190 | 42.3 (32.5) | 89.5 (25.1) | <.001 |
| Wroe, 2005 | 108 | 44.2 (29.0) | 84.4 (24.5) | <.001 |
| Ziarnowski, 2009 | 783 | 2.7 (1.2) | 3.6 (0.8) | <.001 |

*Note*. Ten studies assessed both anticipated regret of action and inaction; all studies concerned vaccination. Higher scores indicated more anticipated regret. Studies used 5-point response scales, except for Morison (6-point response scale) and Wroe et al. (100-point response scale).