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Author note

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Abstract

Objective**:** The Health Action Process Approach (HAPA) is a social-cognitive model specifying motivational and volitional determinants of health behavior. A meta-analysis of studies applying the HAPA in health behavior contexts was conducted to estimate the size and variability of correlations among model constructs, test model predictions, and test effects of past behavior and moderators (behavior type, sample type, measurement lag, study quality) on model relations.

Methods**:** A literature search identified 95 studies meeting inclusion criteria with 108 independent samples. Averaged corrected correlations among HAPA constructs and multivariate tests of model predictions were computed using conventional meta-analysis and meta-analytic structural equation modeling, with separate models estimated in each moderator group.

Results**:** Action and maintenance self-efficacy and outcome expectancies had small-to-medium sized effects on health behavior, with effects of outcome expectancies and action self-efficacy mediated by intentions, and action and coping planning. Effects of risk perceptions and recovery self-efficacy were small by comparison. Past behavior attenuated the intention-behavior relationship. Few variations in model effects were observed across moderator groups. Effects of action self-efficacy on intentions and behavior were larger in studies on physical activity compared to studies on dietary behaviors, whereas effects of volitional self-efficacy on behavior were larger in studies on dietary behaviors.

Conclusions**:** Findings highlight the importance of self-efficacy in predicting health behavior in motivational and volitional action phases. The analysis is expected to catalyze future research including experimental studies targeting change in individual HAPA constructs, and longitudinal research to examine change and reciprocal effects among constructs in the model.

Keywords*:* social cognition; intention; action planning; coping planning; self-efficacy; dual phase models; meta-analytic structural equation modeling; behavior change

Chronic, non-communicable diseases such as cancer, cardiovascular disease, and diabetes account for a substantive proportion of premature deaths, ill health, and reduced quality of life worldwide (WHO, 2014). Epidemiological research has indicated that the deleterious effects of these illnesses can be prevented through participation in health behaviors (Li et al., 2018). This has led health promotion organizations to advocate long-term illness prevention through population-level behavior change (OSBBR, 2016; WHO, 2014). However, development of effective behavior change interventions necessitates identification of potentially modifiable behavioral determinants that can be targeted by intervention content (Johnson & Acabchuk, 2018). Researchers have applied theories of motivation and behaviors from psychology and behavioral science to identify these determinants in order to inform the content of behavior-change interventions (Rothman et al., 2015).

Prominent among these theories is the health action process approach (HAPA; Schwarzer, 2008), a social cognitive model that identifies the motivational and volitional determinants of health behavior and related processes. The HAPA is a dual-phase model that identifies the determinants of the initiation and maintenance of health behavior (see Figure 1 for a schematic representation of the model). Behavioral intention is a pivotal construct in the model that reflects the extent to which individuals will invest effort in enacting a given health behavior in future. Intention is conceptualized as the most proximal predictor of future behavior. The model differentiates between two distinct stages or phases each comprising sets of constructs and processes that determine behavioral enactment: a motivational phase and a volitional phase. The motivational phase encompasses three sets of social cognitive constructs implicated in intention formation: outcome expectancies, action self-efficacy, and risk perceptions. Outcome expectancies reflect beliefs about whether or not engaging in the behavior will result in desired outcomes, action self-efficacy represents beliefs in capacity to perform the behavior, and risk perceptions are beliefs regarding personal risk or susceptibility to particular conditions or outcomes. Research has identified positive relations between these factors and intentions, particularly outcome expectancies and action self-efficacy (e.g., Bierbauer et al., 2017; Hattar, Pal, & Hagger, 2016; Maher & Conroy, 2016).

However, research has consistently demonstrated modest intention-behavior relations, suggesting that a substantive proportion of individuals who form intentions fail to enact them (Orbell & Sheeran, 1998). Accordingly, the HAPA incorporates two components that operate in the volitional phase involved in the enactment of intentions: self-efficacy and planning. Maintenance or coping self-efficacy reflects an individual's beliefs in their capability to cope with barriers that might derail the intended action. Similarly, recovery self-efficacy reflects an individual's capacity to overcome setbacks and recover from failed attempts to enact the target behavior. Maintenance and recovery self-efficacy are proposed to have direct effects on behavior, and are also expected to be related to each other, and to action self-efficacy. The forms of self-efficacy in the HAPA are, therefore, phase-specific, with action self-efficacy relevant to intention formation, and maintenance and recovery self-efficacy implicated in the enactment and maintenance of behavior.

Individuals also need to furnish their intentions with preparatory strategies that assist in their implementation. An important strategy that determines intention enactment is planning. The HAPA identifies two forms of planning relevant to behavioral enactment: action and coping planning. Action planning assists individuals in identifying salient cues that lead to action. Consistent with previous theory and research (e.g., Heckhausen & Gollwitzer, 1987), identifying salient cues relating to the situation (when, where) and sequence of actions (how) will lead to more effective recall of intentions, and more efficient, automatic behavioral enactment. Coping planning entails identification of barriers that might derail intended actions, and generation of plans to manage or overcome them. Action and coping planning are proposed to mediate the intention-behavior relationship in the HAPA; individuals enact their intentions by identifying cues to action and managing contingencies that may derail actions.

Research has supported the predicted pattern of relations among the HAPA constructs across multiple health behaviors (Schwarzer & Luszczynska, 2015; Schwarzer et al., 2007). In terms of the motivational phase, action self-efficacy and outcome expectancies are consistently related to intentions with small-to-medium effect sizes, while risk perceptions have smaller effects. With respect to the volitional phase, maintenance and recovery self-efficacy, and action and coping planning, are consistently related to behavioral enactment, alongside intentions. Further, planning constructs have been shown to mediate the intention-behavior relationship across multiple behaviors (e.g., Teng & Mak, 2011; Zhou et al., 2015). In addition, the HAPA has been used to guide behavioral interventions aimed at changing individual (e.g., Lippke, Schwarzer, Ziegelmann, Scholz, & Schüz, 2010; Payaprom, Bennett, Alabaster, & Tantipong, 2011) or multiple (e.g., Duan, Wienert, Hu, Si, & Lippke, 2017; Lhakhang, Lippke, Knoll, & Schwarzer, 2015) constructs from the HAPA, and their effectiveness is supported in randomized controlled trials.

While the extant research has generally supported the predicted effects among HAPA constructs, substantive variability in the effect sizes across studies has been identified (e.g., Teng & Mak, 2011; Yeager, Shoji, Luszczynska, & Benight, 2018), and null effects observed for some of the predicted effects (e.g., Barg et al., 2012; Hattar et al., 2016; Maher & Conroy, 2016). Although observed variations could reflect true variability in model effects, it could also be attributed to methodological artefacts. The aim of the current study was to synthesize effects among HAPA constructs, and their variability, in studies applying the model in health behavior research using meta-analytic techniques to correct for bias. The present study also aimed to test model predictions using meta-analytic structural equation modeling (Cheung & Hong, 2017; Hagger, Polet, & Lintunen, 2018). In addition, the extent to which past behavior attenuated model effects was also examined, consistent with previous research (Hagger, Chan, Protogerou, & Chatzisarantis, 2016). Effects of five candidate moderators on model relations were also tested: type of behavior, type of sample (student vs. non-student and clinical vs. non-clinical), time lag between measures of HAPA constructs and behavior, and study quality. Effects among HAPA constructs and behavior were expected to be attenuated in studies with longer time lag, as longer lag increases the likelihood that new information will arise that affects model relations. Effects among HAPA constructs were expected to be larger in student samples, because such samples reflect a homogenous group. No specific predictions were made for the moderation of model effects in studies on samples from clinical and non-clinical populations. Finally, model effects were expected to be larger in studies of acceptable quality due to increased precision and lower measurement error.

Method

Search Strategy

The meta-analysis was pre-registered on the Prospero database of systematic reviews: http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42016043081. Five electronic databases (PsycINFO, Medline, EMBASE via Ovid; Web of Science; and Scopus) were systematically searched to identify studies published from 1992 to August 2016. The search terms were developed by the authors based on four key variables of the HAPA (self-efficacy, intention, planning, and behavior). The following search strings were used: health action process approach*; OR self-efficacy* AND intention* AND planning*; OR Schwarzer*. Additional studies were identified by manually searching reference lists of published reviews of the HAPA and through direct contact with research groups currently conducting, or known to have previously conducted, research on the HAPA.

Characteristics of Included Studies

Studies were included if they measured at least four of the key variables that characterize the HAPA: self-efficacy, intention, planning, and health behaviors. Specifically, only studies that measured at least one type of self-efficacy (action, maintenance, or recovery self-efficacy), one type of planning (action or coping planning), intention, and health behavior were included in the analysis. These inclusion criteria were applied to studies regardless of whether or not the study identified the HAPA as a theoretical basis. In line with McEachan and colleagues (2016), health behavior was defined as "behaviors which impact or have the potential to impact upon the health of an individual in a positive or negative way " (p. 593). Articles identified in the initial search after removal of duplicates (k = 3,775) were subjected to a title and abstract screen for eligibility by two members of the research team. The resulting subset of studies was then subjected to full-text review against inclusion criteria to produce a final set of included studies ($k = 95$). A PRISMA flow diagram (Moher, Liberati, Tetzlaff, Altman, & the PRISMA Group, 2009) of the study search, screening, and selection process is presented in Appendix A (supplemental materials). Studies using the same data set were consolidated (see Appendix B, supplemental materials). In addition, some studies used multiple data sets and were treated as separate studies resulting in a final sample of 108 studies (see Appendix B, supplemental materials). A full list of included studies is available in Appendix C.

Effect Size Data Extraction and Classification of Constructs

Relevant effect size data for computing sample-weighted averaged correlations among HAPA constructs were extracted from included studies by two members of the research team using a pre-defined coding scheme. The majority of studies identified were correlational in design with few intervention or correlational studies targeting change in individual HAPA components. The zero-order bivariate correlation coefficient was therefore identified as the appropriate effect size metric for the analysis. For experimental studies, data from the control group were used. Data extraction was verified by two additional members of the research team. Study characteristics (mean age and range, gender composition, population from which the sample was drawn) are summarized in Appendix D (supplemental materials). Full characteristics of studies are provided in a table available on the project website: https://osf.io/5nfqs/.

Moderator coding

Studies were coded according to the candidate moderator variables: type of behavior, sample type, lag between measures of HAPA constructs and health behavior, and study quality (moderator coding is summarized in the study characteristics table in Appendix D. With respect to the behavior type moderator, only two behaviors were the target outcome behavior with sufficient frequency across studies to conduct a moderator analysis ($k \geq 10$): physical activity and dietary behaviors. Studies consistently targeting other behaviors numbered relatively few by comparison with insufficient numbers to define moderator groups. Studies were also coded according to the population from which they drew their sample, with samples coded as student and non-student, and clinical and non-clinical. Student samples were defined as studies drawing their sample exclusively or predominantly from high school, undergraduate, or post-graduate student populations. Non-student samples comprised samples from clinical and general populations. Clinical samples were defined as studies on samples of participants with clinically-diagnosed conditions (e.g., diabetes, obesity, cardiac). Non-clinical samples comprised samples from non-clinical populations. Time lag was defined as time, in weeks, between measures of the HAPA constructs and follow-up measures of behavior. Consistent with previous research, studies with a time lag of four weeks or fewer were classified as 'proximal' and studies with a lag greater than 4 weeks were classified as 'distal' (McEachan et al., 2016). This dichotomized variable was used in subsequent moderator analyses.

Study quality was assessed using a 16-item checklist developed for correlational research (Hagger, Koch, Chatzisarantis, & Orbell, 2017). Studies meeting stipulated quality standards on each item were assigned a score of 1 and those not meeting standards, or provided insufficient information for evaluation, were assigned a score of 0. Studies attaining a quality score of 9 or greater were considered of 'acceptable' quality, while studies attaining scores less than 9 were considered of 'questionable' quality. The dichotomous study quality variable was used in the moderator analysis. The checklist criteria, item descriptions, and scoring method are presented in Appendix E (supplemental materials) and quality scores for each study are presented in Appendix F (supplemental materials).

Effects of study design (experimental vs. correlational) and type of behavioral measure (self-report vs. objective) were also candidate moderators, but there were too few studies adopting factorial designs to test the isolated effects of an experimental manipulation on individual HAPA constructs, and too few studies adopted non-self-report measures of behavior to compute meaningful moderator groups.

In addition, coding other sample characteristics such as age or ethnicity into moderator variables was not possible due to high variability in the characteristic across studies or insufficient data.

Data Analysis

Relations among constructs in model tests were estimated using meta-analytic structural equation modeling using the MASEM package (Cheung & Hong, 2017) in R. Meta-analytic structural equation modeling is a two-stage approach to testing a network of structural relations in a proposed model using synthesized correlations from meta-analysis. In the first stage, correlation matrices among constructs of the proposed model from each study included in the analysis are transformed to account for study-specific random effects, enabling them to be analyzed as covariance matrices in a structural equation model. Parameter estimates (intercepts) produced in the first stage represent the zero-order bias-corrected correlations among constructs across studies with 95% confidence intervals. The analysis also yields statistical tests to evaluate homogeneity in each model parameter: Cochran's (1952) Q, the τ^2 statistic, and I^2 statistic and its 95% confidence interval. Statistically significant Q and τ^2 values with I^2 values exceeding 25% with wide confidence intervals are considered indicative of substantive heterogeneity. Conventional fixed- and random-effects meta-analytic estimates and homogeneity statistics for each correlation were also computed using the metafor packag in R for comparison.

In the second stage of the analysis, a model representing predicted relations among study variables is fitted to the covariance matrix from the first stage. The proposed process model specified effects among past behavior, motivational self-efficacy, volitional self-efficacy, intention, action planning, coping planning, and health behavior according to the HAPA (see Figure 1). For comparison, a model testing the predictions of the HAPA excluding past behavior was also estimated. As goodness-of-fit chi-square values for models in large sample sizes are likely to be statistically significant, model fit was evaluated using multiple goodness-of-fit indices: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the standardized root mean square of the residuals, and the root mean error of approximation (RMSEA). A non-significant chi-square value, CFI and TLI values that approach or exceed .90, a SRMSR value of less than .08, and a RMSEA value of .05 or less indicate good fit of the model with the data (Hu & Bentler, 1999). Effects among model constructs were evaluated based on the likelihood-based confidence intervals about model parameter estimates. Differences in the effect sizes of the parameter estimates across the models including and excluding past behavior were tested using 95% confidence intervals of the difference in the parameter estimates across the models (Schenker & Gentleman, 2001). To the extent that the interval does not include zero, a statistically significant difference in the parameter estimates across models is confirmed. A formal test of difference is also provided using Welch's *t*-test. Both tests require the use of Wald confidence intervals based on symmetric standard errors

Effects of candidate moderator variables on the proposed relations among constructs in the HAPA were tested by estimating of the model separately in each moderator group. As before, multiple goodness-of-fit indices were adopted to evaluate the adequacy of the model in each moderator group. Differences in model parameter estimates across moderator groups were tested using Schenker and Gentleman's (2001) standard method and Welch's *t*-test.

Assessment of bias. The potential effect of selective reporting bias on relations among model constructs in the current sample of studies was evaluated using regression analyses based on 'funnel' plots of effect size on estimates of precision (Egger, Smith, Schneider, & Minder, 1997). Two methods are used: the precision effect test (PET) and the precision effect estimate with standard error (PEESE). PET and PEESE estimates for each effect size were computed, with accompanying *t*-tests for bias and significance tests of the corrected effect from zero, using the PETPEESE function in R (Carter, Schonbrodt, Gervais, & Hilgard, 2017). Raw data, analysis scripts, and output for all analyses are available on the project website: https://osf.io/5nfqs/

Results

Zero-order correlations

Averaged bias-corrected correlations among HAPA constructs from first stage of the MASEM analysis Table 1 with variability and homogeneity statistics. Estimates were statistically significant with moderate-to-high levels of heterogeneity. The only exceptions were effects for risk perceptions, for which confidence intervals about the effect size included the value of zero for relations with past behavior, behavior, action self-efficacy, and recovery self-efficacy. Constructs with largest bias-corrected averaged correlations with intentions were action self-efficacy (*r* = .418), action planning (*r* = .398), and outcome expectancies (*r* = .349). Intention (*r* = .304), action planning (*r* = .305), and, unsurprisingly, past behavior (*r* = .447) had the largest correlations with health behavior. Results of conventional fixed- and random-effects meta-analyses and bias statistics using funnel plot-based regression techniques are presented in Appendix G (supplemental materials). A majority of the effect sizes exhibited statistically significant bias statistics. Given that PET estimates for all effect sizes were statistically significant, the PEESE estimate was taken as the bias-adjusted effect size, consistent with the PET-PEESE approach (Stanley & Doucouliagos, 2014). Although the bias-adjusted PEESE estimates generally yielded smaller effect size estimates, they did not alter conclusions with respect the overall effect sizes or difference from zero. Furthermore, precision of the bias estimates may be affected by substantive levels of heterogeneity (Carter et al., 2017). These estimates should be indicative of potential bias rather than providing conclusive evidence for small study bias.

Testing the HAPA

HAPA hypotheses were tested by fitting the proposed model to the parameter estimates derived from the first stage of the meta-analytic structural equation modeling analysis. Specifically, a model testing HAPA predictions illustrated in Figure 1 was estimated. In addition, a model that included past behavior as a predictor of all constructs in the model was estimated, based on recommendations from previous research to account for potential habitual or non-conscious effects (e.g., Gardner, 2014; Hagger et al., 2015). Goodness-of-fit and overall homogeneity statistics for the models are presented in Table 2. Both models exhibited acceptable model fit according to the multiple criteria adopted.

Homogeneity statistics indicated substantial overall heterogeneity in model parameters with estimates from the first stage of the analysis. Standardized parameter estimates and confidence intervals for the direct and indirect effects of the proposed models are presented in Table 3 with test statistics comparing differences in parameters for the models that included and excluded past behavior.

Focusing on direct effects in model excluding past behavior, action self-efficacy, outcome expectancies, and risk perceptions were statistically significant predictors of intention, although effect sizes for action self-efficacy and outcome expectancies were substantially larger. Action self-efficacy was a significant predictor of maintenance self-efficacy. Intention significantly predicted action planning, coping planning, and behavior, although effects of the planning constructs were small by comparison. Maintenance self-efficacy also significantly predicted action and coping planning. Maintenance self-efficacy was a predictor of behavior, but recovery self-efficacy was not.

Focusing on the indirect effects, there were significant indirect effects of intention and maintenance self-efficacy on health behavior mediated by action and coping planning. Action self-efficacy also predicted health behavior through intentions, planning, and maintenance self-efficacy. A substantive proportion of the effect of action self-efficacy on behavior was through maintenance self-efficacy. Specifically, the mediation proportion statistic, which provides ratio of the total effect to a mediated effect, indicated that just over half of the total effect of action self-efficacy on behavior could be attributed to the indirect effect through maintenance self-efficacy (P_M = .620). By contrast, the indirect effects of intention on behavior through the planning constructs was relatively modest compared to the direct effect (P_M = .226). There were also indirect effects of outcome expectancies and risk perceptions on health behavior. Overall the model accounted for a significant non-zero proportion of the variance in intentions (R^2 = .261) and behavior (R^2 = .175).

Turning to the model including past behavior, past behavior was a statistically significant predictor of all model variables, risk perceptions excepted. Inclusion of past behavior resulted in a significant attenuation of the direct effects of intentions on behavior, and maintenance self-efficacy on recovery self-efficacy. This also translated into smaller indirect effects of intention and action self-efficacy on behavior. There was no further attenuation of HAPA effects in the model as a result of the inclusion of past behavior, although it should be noted that the confidence intervals for the effects of action and coping planning on intentions encompassed zero when past behavior was included in the model. Inclusion of past behavior resulted in modest increases in explained variance in intentions (R^2 = .284) and behavior (R^2 = .278).

Truncated Model and Moderator Analyses

Truncated model. The large number of constructs in the full model of the HAPA tested in the current study increased the probability that few or no tests of model effects would be available in some groups of studies defined by the moderator variables precluding comparisons. As a consequence, a truncated model was estimated in which the number of constructs in the HAPA was reduced without compromising its integrity and predictive validity. Given the relatively modest contribution of the risk perceptions construct in predicting intentions and behavior observed in the test of the full model, as well as observations from primary research, risk perceptions was dropped from the truncated model. In addition, given the strong correlations observed between the maintenance and recovery self-efficacy constructs, and their joint role in the volitional phase of the model, these constructs were consolidated into a single volitional self-efficacy construct. Maintenance self-efficacy was prioritized in cases where studies measured both variables. The truncated model is illustrated in Figure 2.

Model fit and parameter estimates from the analysis of the truncated model were consistent with those from the full model. Goodness-of-fit indexes indicated good fit of the model with the data across studies for the model that excluded and the model that included past behavior (Table 2). Model parameter estimates and comparisons are presented in Appendix H (supplemental materials). In terms of direct effects, action self-efficacy and outcome expectancies predicted intentions. Intentions predicted health behavior, and action and coping planning, with the latter effects small in size. Action self-efficacy predicted volitional self-efficacy, and volitional self-efficacy predicted health behavior, and action and coping planning. With respect to indirect effects, there were indirect effects of intention and volitional self-efficacy on behavior though action and coping planning. Action self-efficacy also predicted behavior through volitional self-efficacy, intentions, and planning. Outcome expectancies also predicted behavior through intention and planning. A substantive proportion of the indirect effect of action self-efficacy on health behavior operated through volitional self-efficacy (P_M = .538), whereas the effect of intentions on health behavior through the planning constructs accounted for a relatively modest proportion of the total effect (P_M = .242). Overall, the model explained significant variance in intentions (R^2 = .271) and health behavior (R^2 = .171). Inclusion of past behavior in the model resulted in significant attenuation of intention-behavior relationship, as well as indirect effects of action self-efficacy on behavior, and total effects of volitional self-efficacy and intention on behavior. Explained variance was only slightly higher for intentions (R^2 = .283), but much greater for behavior (R^2 = .281).

Moderator analyses. Effects of moderators were tested by estimating the truncated model in groups of studies defined by levels of the behavior type, measurement lag, sample type, and study quality moderator variables. The models all exhibited adequate fit with the data based on multiple criteria (Table 2). Standardized parameter estimates and comparisons across moderator groups are presented in Appendix I (supplemental materials). Estimation of the model in groups of studies with dietary behavior and physical activity as the target behavior yielded few differences in effects. Effects of action self-efficacy on intentions were larger in the physical activity sample relative to the dietary behavior sample, while effects of volitional self-efficacy on behavior were larger in the dietary sample (see Table I1, Appendix I). This translated to larger indirect effects of action self-efficacy on behavior via intention and action and coping planning in studies on physical activity, while the total effect of volitional self-efficacy on behavior was larger in the dietary behavior group.

Time lag between measures of HAPA constructs and behavior was also tested as a moderator. Measurement lag was expected to attenuate model effects with increasing lag. However, results revealed no statistically significant differences in effects with time lag (see Table I2, Appendix I).

Findings indicate relative consistency in the size of the model effects regardless of whether the behavior is proximal or distal to the measures of model constructs.

Finally, two further methodological moderators of model effects were evaluated: sample type and study quality (see Tables I3-I5, Appendix I). Effects of action self-efficacy and outcome expectancies on intention, and volitional self-efficacy on coping planning, were larger in studies on non-student samples. However, these effects did not translate into larger indirect and total effects of action self-efficacy, volitional self-efficacy, and outcome expectancies on behavior. Effects of action self-efficacy on intentions, and of intentions on coping planning, were larger in studies on clinical samples compared to studies on non-clinical samples. In contrast, effects of action self-efficacy on volitional self-efficacy, and of intention on behavior, were smaller in studies on clinical samples compared to non-clinical samples. However, these differences were not reflected in the indirect effects of intentions or action self-efficacy on behavior. Larger effects of action self-efficacy on intentions, and of intentions on coping planning, were observed in the analysis on studies adjudged to be of acceptable quality. However, the effect of volitional self-efficacy on coping planning was larger in studies classified as having questionable quality. This translated into larger indirect effects of action self-efficacy on behavior, although the total effect of volitional self-efficacy on behavior did not differ across groups.

Discussion

Results of the present meta-analysis revealed positive, non-zero bias-corrected correlations among HAPA constructs and past behavior across studies with small-to-medium effect sizes. Effects of the risk perceptions and recovery self-efficacy constructs were the only exceptions, with small effect sizes and confidence intervals encompassing zero. Most of the corrected correlations exhibited substantive heterogeneity. Meta-analytic structural equation modeling revealed that action self-efficacy had the largest effects on health behavior through intentions and maintenance self-efficacy. Action and coping planning predicted behavior and mediated effects of intentions and maintenance self-efficacy on behavior, although the direct effect of intentions and maintenance self-efficacy were substantively larger than the planning-mediated effects. Outcome expectancies also predicted behavior through intentions, while effects of risk perceptions were small. The effect of recovery self-efficacy on behavior was also small and encompassed zero. Inclusion of past behavior resulted in significant attenuation of the intention-behavior relationship and the indirect effect of action self-efficacy on behavior. Examination of moderators revealed that effects of action self-efficacy on intentions and behavior were larger in samples with physical activity as the target behavior, while effects of volitional self-efficacy were larger in samples focusing on dietary behavior. Analysis of effects of study quality and sample type did not lead to meaningful differences in the prediction of behavior. Measurement lag did not moderate any model effects.

Current research provides support for both the motivational and volitional components of the HAPA, particularly the stage-specific self-efficacy constructs, on health behavior. Results corroborate primary research applying the model in multiple health behaviors (Schwarzer & Luszczynska, 2015). Importantly, findings indicate that action self-efficacy, individuals' judgements of their capacity to perform the future behavior, and overcome potential barriers to do so, has a pervasive effect on health behavior. Findings also illustrate that alignment of intentions with these beliefs is a key mechanism by which action self-efficacy predicts health behavior, consistent with the motivational phase. In addition, that maintenance self-efficacy was identified to have a large direct effect on health behavior highlights the importance of volitional components to behavioral enactment.

By comparison, effects of recovery self-efficacy were modest. However, it must be stressed that recovery self-efficacy is only likely to be relevant in situations where individuals experience a behavioral lapse from which they need to recover. Future research comparing the role of recovery self-efficacy in determining behavior in specific contexts where behavioral lapses are likely (e.g., situations where there is high opportunity to participate in rewarding, counter-intentional behavioral options) may demonstrate the context-specific value of this construct. Taken together, results support the segregation of self-efficacy into phase-specific types, particularly action and maintenance self-efficacy, a key feature of the HAPA. Findings also indicate interplay between the self-efficacy components of the motivational and volitional phases. Action self-efficacy was a consistent predictor of maintenance self-efficacy, and maintenance self-efficacy mediated action self-efficacy effects on behavior, illustrating that individuals' estimates of their capacity to engage in health behavior in future align closely with their estimates to maintain that behavior. However, it is important to note that few studies tested effects of these constructs on behavioral maintenance. Future research should examine effects of the self-efficacy constructs, particularly the volitional components, on long-term persistence.

Although action and coping planning predicted behavior, and mediated effects of intentions and maintenance self-efficacy on health behavior, findings indicated that these effects tended to be relatively small across studies relative to the direct effects of intentions and maintenance self-efficacy. This was particularly the case when accounting for the effects of past behavior. These findings are consistent with previous HAPA research that did not support the planning-mediated path (e.g., Barg et al., 2012; Ernsting, Gellert, Schneider, & Lippke, 2013). Although effective planning seems to be implicated in the mechanism by which intentions relate to behavior, effects are modest and other processes may be involved. One possibility is that individuals may not need to consciously form plans in order to enact their behavior, and that the motivational orientation captured by intentions is sufficient to initiate previously-developed behavioral schema or scripts for action.

Another possibility is that planning is a condition under which intentions are converted into action, consistent with theory and research that suggests plans serve to moderate the intention-behavior relationship (Hagger, Luszczynska, et al., 2016; Heckhausen & Gollwitzer, 1987). Finally, a recent perspective is that the indirect effect of intentions on behavior via planning is a function of self-efficacy in the volitional phase (Yeager et al., 2018). These alternative pathways were not tested in the current analysis. Systematic tests of these moderation and mediation effects across populations and behaviors are needed to develop an evidence base for these proposed mechanisms. In addition, the potential for constructs representing the presence of existing behavioral 'scripts', developed through previous experience with the behavior, to mediate the effect of intentions on behavior as an alternative to the planning-mediated path should be explored. Constructs such as implicit attitudes and motives may represent these constructs, and have been shown to predict intentions and behavior in health contexts (e.g., Hagger, Trost, Keech, Chan, & Hamilton, 2017), but have not, to date, been tested as mediators of the intention-behavior relationship alongside planning.

A further important finding in the current research is the substantially smaller effects of risk perceptions on intentions and, indirectly, on behavior across studies applying the HAPA. These findings suggest that risk perceptions play only a relatively minor role in determining health-related behavior. This is consistent with previous research suggesting that beliefs relating to participation in the behavior itself, such as attitudes, outcome expectancies, and self-efficacy, are more pervasive determinants of health behavior than risk perceptions (Hagger, Hardcastle, et al., 2016; Hattar et al., 2016). One important potential moderator may be type of behavior. Risk perceptions are unlikely to have a pervasive influence on health-related behavior unless the behavior has a clear, explicit, and proximal link to reduced risk (e.g., taking prophylactic medication, safety behaviors, vaccination) or are pertinent to an 'at risk' population (e.g., cardiac rehabilitation patients). Such a link may be less apparent for behaviors such as healthy eating or physical activity in healthy populations. Given the preponderance of studies on diet and physical activity in the current sample, the small effects of risk perceptions are unsurprising. In addition, given research suggesting that effects of risk perceptions on intentions and behavior are dependent on individuals' self-efficacy to act to minimize risk (Kok, Peters, Kessels, ten Hoor, & Ruiter, 2018), testing the interactive effects of self-efficacy and risk perceptions on health behavior may provide further insight into the process by which risk perceptions determine action.

The current analysis identified relatively few effects of moderator variables on relations among the HAPA constructs. Most pervasive was the effect of behavior type, with larger effects of action self-efficacy on intentions and, indirectly, behavior in studies with physical activity as the target behavior, and larger effects of volitional self-efficacy on behavior in studies with dietary behaviors as the target behavior. These findings indicate variation in the factors that contribute to enacting these behaviors. Physical activity tends to be a behavior that is predominantly enacted on the basis of motivational factors and intentions, whereas dietary behaviors, particularly those requiring individuals to avoid tempting, palatable foods, are also likely to be subject to desires and affective responses. This is consistent with research demonstrating direct effects of affective attitudes for dietary behaviors compared to physical activity (Lawton, Conner, & McEachan, 2009). Volitional self-efficacy, as the capacity to overcome barriers and manage contingencies that may derail behavior is, therefore, more likely to be an important correlate of these behaviors. In contrast, behaviors like physical activity are less subject to impulse-related desires that draw attention away from the goal-directed behavior.

Another moderator effect of note was the smaller effect of intentions on behavior in clinical samples relative to non-clinical samples. This finding suggests that individuals with clinical conditions have greater difficulty in enacting their intentions. Although this was not corroborated by differences in the contribution of volitional constructs to behavior, it may be that the differences in intentions across the samples may be due to the moderating effects of perceived behavioral control and volitional constructs in the model such as action planning and volitional self-efficacy. For example, the smaller effects of intentions in clinical samples may be due to lower perceived behavioral control over behavior among patients. Similarly, patients in clinical samples with better plans or higher volitional self-efficacy may have larger intention-behavior effects than those with poorer plans and lower self-efficacy. Exploring these interaction effects is an important avenue for future research.

Past behavior had a number of salient effects in the current analysis. Past behavior predicted all constructs and attenuated the size of the intention-behavior effect. Research has suggested that past behavior models habits and previous decision making. For example, research adopting social cognitive models has demonstrated that measures of habit mediate past behavior effects (van Bree et al., 2015), and it has been suggested that social cognitive variables mediate effects of past behavior on subsequent behavior (Ajzen, 2002). Mediation of past behavior effects on future behavior by constructs from social cognitive approaches like the HAPA represent the extent to which individuals have formed those beliefs and act on them. The mediation of past behavior also illustrates how well the model functions as a means to explain behavioral stability over time. Considering that past behavior is often a substantive predictor of future behavior (Hagger, Chan, et al., 2016), the absence of mediation of past behavior on subsequent behavior by model constructs may render a model redundant as an effective means to explain behavior, and as a means to guide interventions that may be effective in changing behavior. Current findings support the relevance of the HAPA in this regard as there were substantive non-zero indirect effects of past behavior in subsequent behavior through the HAPA constructs.

However, it is important to note that the substantive residual effect of past behavior means that it remains an important predictor of future behavior, and that the overall variance in behavior accounted for by the model is relatively modest. Nevertheless, it is also important to consider that past behavior is also a function of the social cognitive constructs identified in the HAPA, so there is a need to account for those determinants in order to assess the unique effects of past behavior on subsequent behavior.There is also a need to identify potential mediators that explain the residual effect of past behavior on future behavior in the HAPA. Likely candidates may be self-reports of habit and measures of implicit beliefs, which represent the automatic, non-conscious processes that lead to behavior independent of the more conscious, deliberative processes represented by the belief-based constructs (Hagger, Chan, et al., 2016; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017; van Bree et al., 2015).

What practical recommendations arise from current findings? Results point to the value of self-efficacy as an influential correlate of intentions and health behavior. Two forms of self-efficacy had pervasive effects on behavior in the current analysis: action and maintenance self-efficacy. Interventions may, therefore, seek to apply strategies that target change in these constructs self-efficacy. Strategies such as providing opportunities to experience, or reflect on, past success with the behaviour, developing skills to effectively set appropriate goals and monitor goal progress, provision of appropriate feedback on progress, enhancing skills to manage setbacks, and providing appropriate actual or self models to provide vicarious experience of success with the behavior, such as through imagery, would be appropriate self-efficacy enhancing strategies (Bandura, 2004; Conroy & Hagger, 2018). These suggestions come with the caveat that effects of these constructs on behavior in the current analysis were relatively modest, and that the current study focused on behavioral prediction rather than behavior change. In addition, although the current analysis indicates that interventions based on planning and risk perceptions may not have desired effects in promoting health behavior, we did not test the potential interactive effects of planning and intention, and risk perceptions and self-efficacy, on health behavior. Ruling out these constructs as potential intervention targets may be premature.

Strengths of the current analysis include application of a rigorous hypothesis-testing framework to estimate the size and variability of relations among HAPA constructs, and test its predictions, across multiple studies in health contexts, the use of appropriate synthesis and model testing analytic procedures, and the testing of salient moderator variables. However, several limitations should be noted. First, all data from the current sample of studies were treated as correlational in design. Although a number of data sets included in the present analysis adopted experimental or intervention designs, the manipulations or intervention conditions targeted change in multiple constructs within the model. Very few studies reported experimental or intervention conditions that targeted change in isolated constructs within the HAPA (Lippke et al., 2010; Luszczynska et al., 2016), which precluded generation of effect sizes among HAPA constructs derived from experimental or intervention designs. This clearly points to the imperative of future experimental or intervention studies adopting factorial designs, which apply strategies that target change in individual components of the HAPA. It indicates that inference of causal relations among HAPA constructs cannot be inferred from the current analysis, and that the direction of the paths tested in the current models are inferred from theory rather than the data.

Current findings are based on data focusing on prediction rather than change. Even though inclusion of past behavior provides useful information on the effectiveness of the HAPA in accounting for behavior stability, future research should adopt cross-lagged panel designs, which would permit the modeling of change in behavior as a function of change in HAPA constructs (c.f., Jacobs, Hagger, Streukens, De Bourdeaudhuij, & Claes, 2011; Scholz, Nagy, Ghner, Luszczynska, & Kliegel, 2009). It would also allow for the testing of specific directional and reciprocal effects among study variables.

Although the current analysis tested a model comprising the core components of the HAPA, few studies included measures of action control. Action control is a further volitional construct included in the extended model, which reflects individuals' use of self-regulatory skills such as self-monitoring to regulate their behavior. Although researchers are increasingly including action control as a determinant of behavior in HAPA tests, very few of the included studies comprised measures of the construct (k = 10), and the number of studies reporting relations between action control and some of the other HAPA constructs was small, and in some cases zero, precluding the inclusion of this construct in the model test. As research incorporating this construct accumulates, sufficient data may be available in the future to include this construct in meta-analytic tests of the model.

It is important to note that substantial heterogeneity was observed in the parameter estimates of the models across studies. Although these estimates provide evidence of non-zero effect sizes, they are not highly precise as estimates of the true effect size. In addition, current moderator analyses did not resolve the heterogeneity. As the body of research testing the HAPA in health contexts expands, future research syntheses may be able to test effects of additional moderators on model relations. For example, intentions may be an important moderator of model effects. Higher intentions may lead to larger effects of motivational constructs on behavior, whereas lower intentions may lead to larger effects of volitional constructs. Similarly, planning may moderate the effects of intentions on health behavior, and risk perceptions may moderate effects of self-efficacy on health behavior. However, high within-study variability in these continuous moderators, and the use of different measures of these constructs across studies, precluded precise coding of moderator groups. In addition, few studies reported tests of interaction effects among continuous moderators in the model, and those that did neglected to report the necessary effect size data to test the interactions. As more studies testing interactions using continuous moderators become available, future syntheses of moderator effects using continuous variables will become feasible.

That the literature search in the current review was restricted to English-language items is a further limitation. Such a restriction may constitute a further source of bias in the findings. However, there is evidence to suggest that such restrictions do not pose a threat to the validity of conclusions drawn (Morrison et al., 2012). Nevertheless, we acknowledge this as a potential limitation and suggest that future research syntheses adopt search strategies without language restriction.

The current study is the first to provide comprehensive cumulative estimates of the effect sizes and variability among constructs of the HAPA in studies in health contexts. The current analysis makes a unique contribution to knowledge by testing model predictions using synthesized relations among model constructs, and examining effects of past behavior and candidate moderators on relations in the model. Findings provide important information on the HAPA constructs that most reliably predict intentions and behavior across health behaviors, and the processes involved. For example, results indicate that action and maintenance self-efficacy have pervasive effects on health behavior, and that effects of action self-efficacy are indirect through intentions and planning. Current findings have utility in that they provide researchers with information on the key processes to target when applying the model to predict health behavior, and contribute to the evidence base of constructs that may be targets in behavior change interventions. The current analysis is also expected to set the agenda for future research to address gaps in knowledge in the application of the HAPA to health behaviors. Future research should test causal effects among model constructs by targeting change in individual HAPA components, adopt panel designs to model change and reciprocal effects, and test additional mechanisms such as the interactive effects of risk perceptions and self-efficacy, and planning and intentions, on health behavior.

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Table 1

Zero-Order Parameter Estimates from Meta-Analytic Structural Equation Modeling (Stage 1) of the Full Model of Health Action Process Approach with Heterogeneity and Bias Statistics

Effect	Intercept	SE	Intercept CI_{95}		I^2	τ^2	Effect	Intercept	SE	Intercept CI_{95}		I^2	τ^2
			LL	UL						LL	UL		
PB-Behavior	.447	.057	.336	.558	.870	.023	ASE-CP	.313	.025	.263	.362	.812	.014**
PB-ASE	.247	.018	.212	.282	.821	.015***	MSE-RSE	.484	.026	.433	.534	.762	.011*
PB-MSE	.223	.024	.175	.270	.815	.015**	MSE-OE	.254	.019	.217	.291	.719	.009**
PB-RSE	.220	.025	.171	.270	.771	.011*	MSE-RP	.063	.028	.008	.118	.865	.022**
PB-OE	.157	.020	.117	.196	.785	.012**	MSE-Intention	.307	.019	.269	.346	.814	.014***
PB-RP	-.041	.029	-.099	.016	.884	.026***	MSE-AP	.378	.022	.335	.421	.856	.019***
PB-Intention	.306	.022	.262	.350	.912	.031***	MSE-CP	.400	.029	.343	.456	.773	.011*
PB-AP	.247	.019	.210	.284	.862	.020***	RSE-OE	.237	.019	.200	.275	.685	.007*
PB-CP	.265	.028	.211	.320	.785	.012*	RSE-RP	.046	.026	-.006	.097	.825	.016**
Behavior-ASE	.275	.018	.241	.310	.860	.019***	RSE-Intention	.299	.018	.263	.336	.719	.009**
Behavior-MSE	.283	.024	.237	.330	.837	.017***	RSE-AP	.337	.024	.291	.384	.842	.018***
Behavior-RSE	.248	.030	.189	.307	.882	.025***	RSE-CP	.333	.035	.264	.402	.803	.014*
Behavior-OE	.146	.019	.108	.183	.834	.017***	OE-RP	.142	.026	.092	.192	.914	.036***
Behavior-RP	.020	.024	-.027	.066	.875	.024***	OE-Intention	.349	.017	.315	.383	.839	.016***
Behavior-Intention	.304	.018	.268	.340	.888	.023***	OE-AP	.264	.011	.242	.286	.584	.005***
Behavior-AP	.305	.017	.271	.339	.872	.020***	OE-CP	.233	.018	.198	.269	.494	.003
Behavior-CP	.294	.021	.252	.336	.684	.007*	RP-Intention	.119	.020	.080	.159	.864	.021***
ASE-MSE	.403	.020	.364	.442	.790	.012***	RP-AP	.051	.018	.016	.086	.820	.015***
ASE-RSE	.329	.024	.282	.377	.824	.016**	RP-CP	.074	.035	.005	.144	.848	.019*
ASE-OE	.314	.016	.282	.346	.809	.013***	Intention-AP	.398	.015	.368	.428	.890	.020***
ASE-RP	.033	.022	-.010	.075	.876	.024***	Intention-CP	.323	.022	.280	.365	.766	.011**
ASE-Intention	.418	.017	.385	.452	.899	.023***	AP-CP	.568	.026	.518	.618	.830	.016**
ASE-AP	.336	.015	.306	.366	.855	.017***							

Note. MASEM = Meta-analytic structural equation modeling; Intercept = Zero-order parameter estimate from MASEM analysis corrected for sampling error; CI_{95} = 95% confidence interval of intercept; LL = Lower limit of 95% confidence interval; UL = Upper limit of 95% confidence interval; SE = Standard error; I^2 = Higgins and Thompson's (2002) I^2 statistic for parameter estimate; τ^2 = Estimated variance in population; Q = Cochran's Q statistic from conventional analyses; r^{+}_{PET} = Effect size estimate corrected for bias using the precision-effect estimate technique; PB = Past behavior; ASE = Action self-efficacy; MSE = Maintenance self-efficacy; RSE = Recovery self-efficacy; OE = Outcome expectancies; RP = Risk perceptions; AP = Action planning; CP = Coping planning.

$^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Table 2

Fit Indexes and Overall Homogeneity Statistics for Meta-Analytic Structural Equation Models

Model	*N*	*k*	Goodness-of-fit			Fit indexes						Homogeneity of effects		
			χ^2	df	*p*	CFI	TLI	SRMR	RMSEA	RMSEA CI_{95}		*Q*	df	*p*
										LL	UL			
Full model	32231	108	256.635	17	<.001	0.959	0.913	.053	.021	.019	.023	10876.980	1834	<.001
Full model including past behavior	32231	108	200.082	17	<.001	0.972	0.927	.041	.018	.016	.021	13243.940	2206	<.001
Truncated model	32231	108	167.793	7	<.001	0.969	0.907	.046	.027	.023	.030	7777.116	1297	<.001
Truncated model including past behavior	32231	108	142.832	7	<.001	0.977	0.907	.037	.025	.021	.028	9893.215	1617	<.001
Moderator: Behavior type[a]														
Dietary behaviors	8459	23	31.769	7	<.001	0.977	0.932	.048	.021	.014	.028	1392.810	218	<.001
Physical activity	10842	41	105.970	7	<.001	0.959	0.878	.054	.036	.030	.042	2772.342	542	<.001
Moderator: Measurement lag[a]														
Distal	17776	68	106.241	7	<.001	0.972	0.914	.043	.028	.024	.033	4994.158	878	<.001
Proximal	7913	21	53.328	7	<.001	0.968	0.903	.052	.029	.022	.036	1639.715	245	<.001
Moderator: Sample type[a]														
Student	8465	28	58.594	7	<.001	0.969	0.907	.046	.046	.023	.037	1395.471	313	<.001
Non-student	23766	80	130.306	7	<.001	0.968	0.903	.049	.027	.023	.031	6261.272	963	<.001
Clinical	7096	34	113.199	7	<.001	0.947	0.842	.053	.046	.039	.054	1481.528	473	<.001
Non-clinical	25135	74	81.936	7	<.001	0.978	0.933	.044	.021	.017	.025	5894.146	803	<.001
Moderator: Methodological quality[a]														
Acceptable	19319	73	150.981	7	<.001	0.963	0.889	.048	.033	.028	.037	4747.752	933	<.001
Questionable	12912	35	45.265	7	<.001	0.975	0.924	.047	.021	.015	.027	2863.965	343	<.001

Note. [a]Moderator analyses are conducted on truncated model excluding past behavior. *N* = Total sample size across studies contributing to model; *k* = Number of studies contributing to estimated model; χ^2 = Model goodness-of-fit chi-square relative to independence (totally free) model; df = Degrees of freedom; CFI = Comparative fit index; TLI = Tucker-Lewis Index; SRMR = Standardized root mean square residual; RMSEA = Root mean square error of approximation; RMSEA CI_{95} = 95% confidence intervals of RMSEA; LL = Lower limit of the RMSEA 95% confidence interval; UL = Upper limit of the RMSEA 95% confidence interval; *Q* = Cochran's *Q* test of homogeneity of model effects.

Table 3

Standardized Parameter Estimates for Direct and Indirect Effects in Meta-Analytic Path Analyses of the Full Model of the Health Action Process Approach Including and Excluding Past Behavior

Effect	Model excluding past behavior			Model including past behavior			Model comparisons				
	β	LB CI_{95}		β	LB CI_{95}		$β_{diff}$[a]	CI_{95}		t[b]	p
		LL	UL		LL	UL		LL	UL		
Direct effects											
ASE→Intention	.333	.294	.373	.295	.251	.338	.038	-.020	.097	1.279	.201
OE→Intention	.265	.224	.304	.235	.192	.277	.030	-.029	.088	1.002	.316
RP→Intention	.066	.025	.108	.079	.036	.122	-.013	-.073	.047	-0.427	.669
ASE→MSE	.522	.491	.552	.480	.444	.516	.042	-.006	.089	1.725	.085
Intention→AP	.335	.300	.370	.305	.266	.343	.030	-.021	.082	1.147	.251
Intention→CP	.236	.187	.284	.194	.139	.248	.042	-.031	.114	1.122	.262
Intention→Behavior	.182	.135	.228	.100	.039	.157	.082	.007	.157	2.154	.031
MSE→AP	.336	.295	.377	.314	.271	.356	.022	-.037	.081	0.741	.459
MSE→CP	.369	.314	.423	.343	.285	.401	.025	-.055	.105	0.619	.536
AP→Behavior	.087	.019	.153	.066	-.007	.137	.021	-.077	.118	0.420	.675
CP→Behavior	.099	.026	.172	.051	-.033	.131	.048	-.061	.157	0.869	.385
MSE→Behavior	.144	.044	.244	.166	.069	.264	-.022	-.162	.117	-0.314	.754
MSE→RSE	.611	.571	.650	.539	.493	.586	.071	.010	.132	2.288	.022
RSE→Behavior	.064	-.039	.165	-.017	-.126	.089	.081	-.066	.228	1.075	.282
PB→ASE	–	–	–	.253	.219	.287	–	–	–	–	–
PB→OE	–	–	–	.211	.173	.248	–	–	–	–	–
PB→RP	–	–	–	-.018	-.069	.032	–	–	–	–	–
PB→Intention	–	–	–	.179	.129	.229	–	–	–	–	–
PB→MSE	–	–	–	.063	.010	.117	–	–	–	–	–
PB→RSE	–	–	–	.189	.130	.245	–	–	–	–	–
PB→AP	–	–	–	.123	.074	.170	–	–	–	–	–
PB→CP	–	–	–	.163	.097	.227	–	–	–	–	–
PB→Behavior	–	–	–	.365	.235	.495	–	–	–	–	–
Indirect effects											
Intention→AP→Behavior	.029	.006	.052	.020	-.002	.043	.009	-.023	.041	0.559	.576
Intention→CP→Behavior	.023	.006	.042	.010	-.006	.028	.014	-.011	.038	1.101	.271
MSE→AP→Behavior	.029	.006	.052	.021	-.002	.044	.008	-.023	.040	0.526	.599
MSE→CP→Behavior	.037	.010	.064	.018	-.011	.046	.019	-.020	.058	0.968	.333

MSE→RSE→Behavior	.039	-.024	.101	-.009	-.069	.048	.048	-.036	.133	1.118	.263
ASE→MSE→Behavior	.075	.023	.128	.080	.033	.128	-.005	-.075	.066	-0.132	.895
ASE→Intention→Behavior	.061	.044	.079	.029	.011	.048	.031	.006	.057	2.420	.016
ASE→Intention→Planning→Behavior	.018	.011	.025	.009	.003	.015	.009	.000	.017	1.943	.052
ASE→MSE→Planning→Behavior	.034	.023	.047	.018	.007	.030	.016	.000	.032	1.907	.057
ASE→MSE→RSE→Behavior	.020	-.012	.053	-.004	-.033	.023	.025	-.018	.067	1.142	.253
OE→Intention→Planning→Behavior	.014	.009	.020	.007	.003	.012	.007	.000	.014	1.905	.057
RP→Intention→Planning→Behavior	.003	.001	.006	.002	.001	.005	.001	-.002	.004	0.682	.496
Sums of indirect effects											
Intention→Behavior[c]	.053	.034	.072	.030	.012	.049	.023	-.004	.049	1.681	.093
MSE→Behavior[d]	.066	.044	.089	.038	.014	.062	.028	-.005	.060	1.674	.094
ASE→Behavior[e]	.078	.062	.096	.038	.020	.058	.040	.014	.066	3.057	.002
ASE→Behavior[f]	.208	.187	.230	.132	.103	.161	.076	.040	.112	4.157	.000
PB→Behavior[g]	–	–	–	.065	.034	.092	–	–	–	–	–
Total effects											
MSE→Behavior[h]	.210	.118	.302	.204	.115	.294	.005	-.122	.133	0.081	.936
Intention→Behavior[i]	.235	.192	.276	.130	.070	.186	.105	.033	.177	2.865	.004
PB→Behavior[j]	–	–	–	.430	.319	.542	–	–	–	–	–
Correlations											
ASE↔OE	.388	.360	.416	.320	.288	.353	.068	.025	.111	3.089	.002
ASE↔RP	.050	.013	.088	.058	.016	.100	-.008	-.064	.049	-0.274	.784
OE↔RP	.141	.092	.191	.146	.095	.197	-.004	-.076	.067	-0.121	.904
AP↔CP	.299	.245	.353	.290	.236	.344	.009	-.067	.085	0.231	.818
MSE↔Intention	.095	.061	.130	.088	.049	.126	.008	-.044	.059	0.293	.770

Note. β = Standardized path coefficient; LB CI_{95} = Likelihood based 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; CI_{95} = Conventional 95% confidence interval; β_{diff} = Difference in standardized path coefficient; ASE = Action self-efficacy; OE = Outcome expectancies; RP = Risk perceptions; MSE = Maintenance self-efficacy; AP = Action planning; CP = Coping planning; RSE = Recovery self-efficacy; PB = Past behavior. [a]Model comparisons using Schenker and Gentleman's (2001) 'standard method' based on confidence intervals about the mean difference derived from Wald standard errors; [b]Test of difference in coefficients across models using Welch's *t*-test based on Wald standard errors; [c]Sum of indirect effects of intention on behavior through action and coping planning; [d]Sum of indirect effects of MSE on behavior through all variables; [e]Sum of indirect effects of ASE on behavior through intention, AP, and CP; [f]Sum of indirect effects of ASE on behavior through intention, AP, CP, MSE, and RSE; [g]Sum of indirect effects of PB on behavior; [h]Total effect of MSE on behavior; [i]Total effect of intention on behavior; [j]Total effect of past behavior on behavior.

Figure 1. The health action process approach.

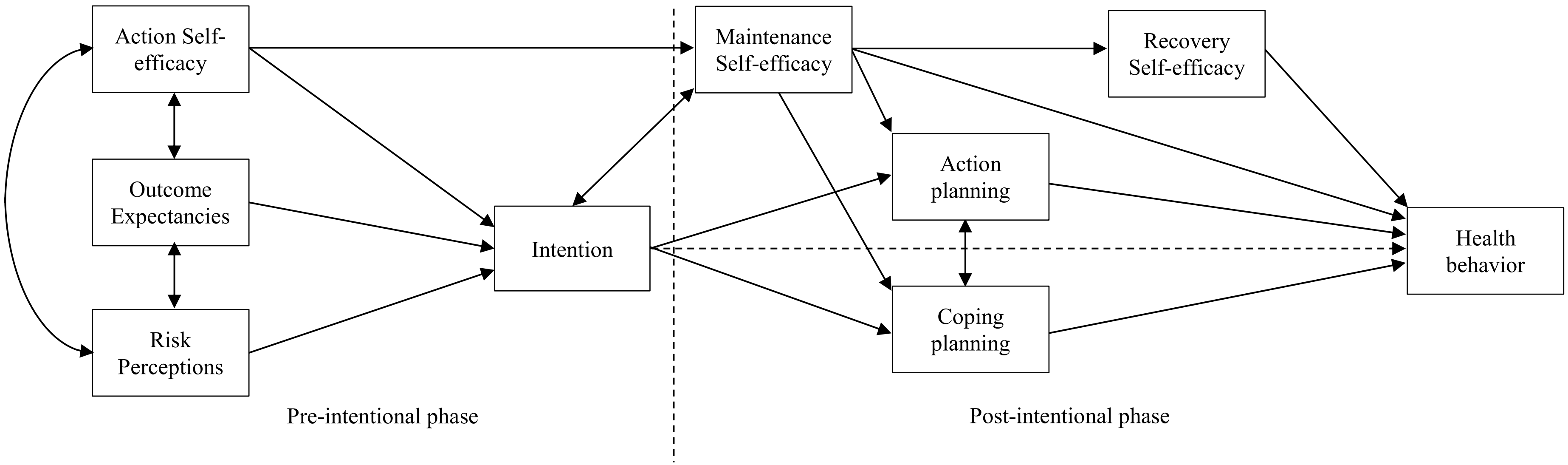
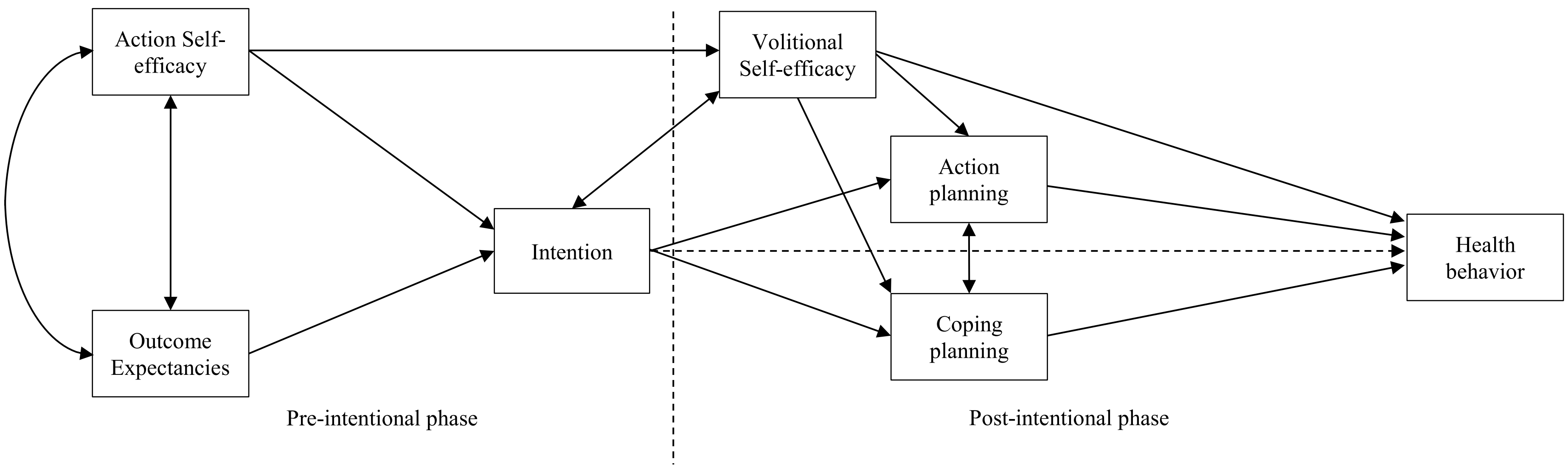
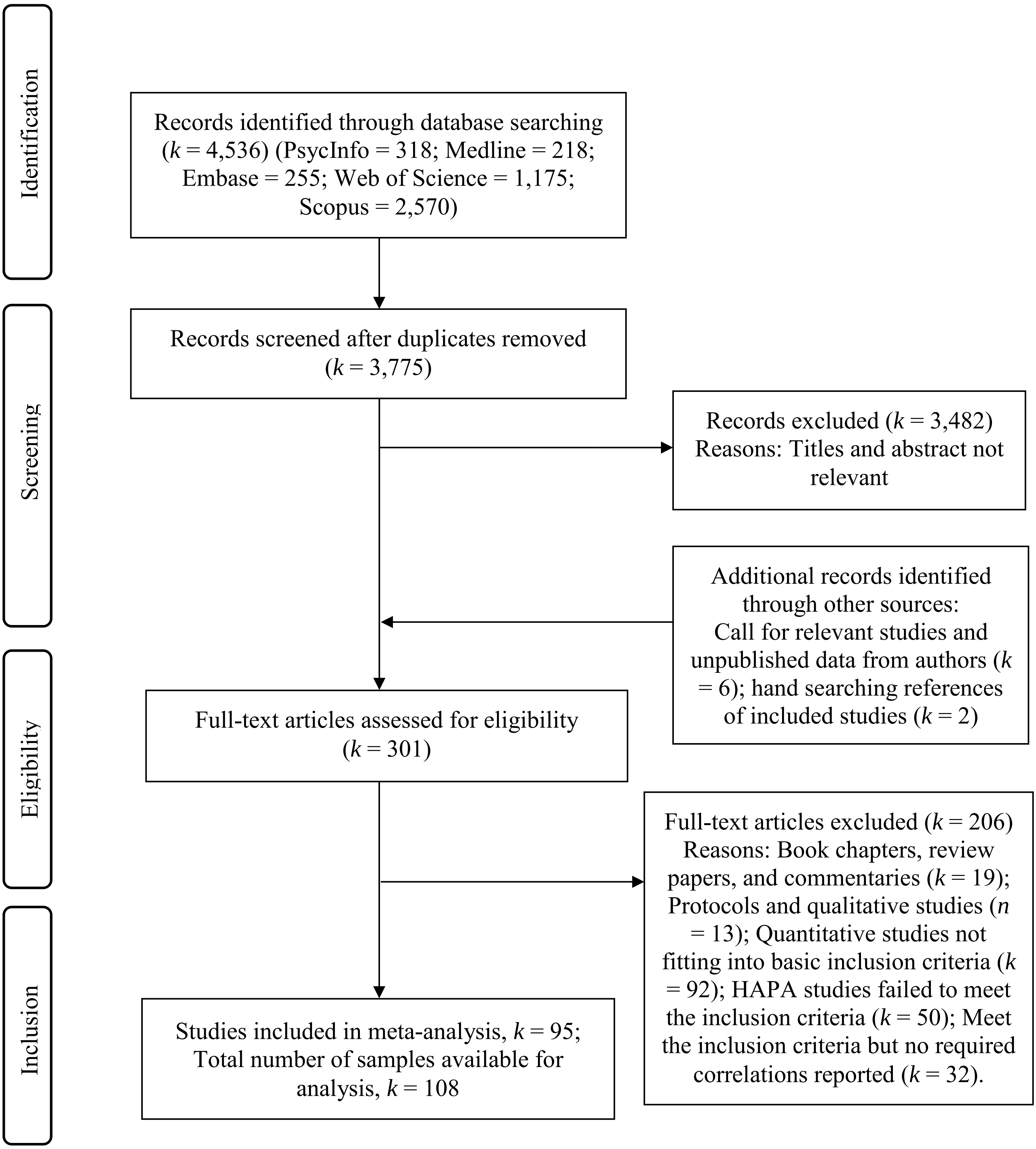


Figure 2. Truncated model of the health action process approach.



Appendix A: PRISMA flow diagram for study search and inclusion strategy



Appendix B: Multiple and overlapping studies

Table B1
Studies Included in Meta-Analysis with Multiple Studies/Samples/Behaviors

Reference	Number of studies/samples/behaviors
1. Duan, Y. P., Wienert, J., Hu, C., Si, G. Y., & Lippke, S. (2017). Web-based intervention for physical activity and fruit and vegetable intake among Chinese university students: a randomized controlled trial. *Journal of Medical Internet Research*, *19*: e106. doi: 10.2196/jmir.7152	1 study/2 behaviors [a]
2. Fleig, L., Küper, C., Lippke, S., Schwarzer, R., & Wiedemann, A. U. (2015). Cross-behavior associations and multiple health behavior change: A longitudinal study on physical activity and fruit and vegetable intake. *Journal of Health Psychology*, *20*, 525-534. doi: 10.1177/1359105315574951	1 study/2 behaviors [a]
3. Fleig, L., Ngo, J., Roman, B., Ntzani, E., Satta, P., Warner, L. M., ... & Brandi, M. L. (2015). Beyond single behaviour theory: Adding cross‐behaviour cognitions to the health action process approach. *British Journal of Health Psychology*, *20*, 824-841. doi: 10.1111/bjhp.12144	2 samples/2 behaviors [a]
4. Gutiérrez‐Doña, B., Lippke, S., Renner, B., Kwon, S., & Schwarzer, R. (2009). Self-efficacy and planning predict dietary behaviors in Costa Rican and South Korean women: Two moderated mediation analyses. *Applied Psychology: Health and Well-Being*, *1*, 91-104. doi:10.1111/j.1758-0854.2008.01001.x	2 studies/1 behavior
5. Hankonen, N., Absetz, P., Kinnunen, M., Haukkala, A., & Jallinoja, P. (2013). Toward identifying a broader range of social cognitive determinants of dietary intentions and behaviors. *Applied Psychology: Health and Well-Being*, *5*, 118-135. doi:10.1111/j.1758-0854.2012.01081.x	2 samples/2 behaviors [b]
6. Jakul, L. (2013). Maintenance of a healthy lifestyle: Differences in the obese and non-obese (Unpublished doctoral dissertation). University of Manitoba, Winnipeg.	2 samples/2 behaviors [a]
7. Jones, F., Abraham, C., Harris, P., Schulz, J., & Chrispin, C. (2001). From knowledge to action regulation: Modeling the cognitive prerequisites of sun screen use in Australian and UK samples. *Psychology & Health*, *16*, 191-206. doi: 10.1080/08870440108405499	2 samples/1 behavior
8. Krämer, L. V., Helmes, A. W., Seelig, H., Fuchs, R., & Bengel, J. (2014). Correlates of reduced exercise behaviour in depression: The role of motivational and volitional deficits. *Psychology & Health*, *29*, 1206-1225. doi: 10.1080/08870446.2014.918978	2 samples/1 behavior

9. Luszczynska, A., Cao, D. S., Mallach, N., Pietron, K., Mazurkiewicz, M., & Schwarzer, R. (2010). Intentions, planning, and self-efficacy predict physical activity in Chinese and Polish adolescents: Two moderated mediation analyses. *International Journal of Clinical and Health Psychology, 10*, 265-278.	2 studies/1 behavior
10. Luszczynska, A., Horodyska, K., Zarychta, K., Liszewska, N., Knoll, N., & Scholz, U. (2016). Planning and self-efficacy interventions encouraging replacing energy-dense foods intake with fruit and vegetable: A longitudinal experimental study. *Psychology & Health, 31*, 40-64. doi:10.1080/08870446.2015.1070156	1 study/2 behaviors [c]
11. Parschau, L., Fleig, L., Warner, L. M., Pomp, S., Barz, M., Knoll, N., . . . Lippke, S. (2014). Positive exercise experience facilitates behavior change via self-efficacy. *Health Education & Behavior, 41*, 414-422. doi: 10.1177/1090198114529132	2 studies/1 behavior
12. Scholz, U., Nagy, G., Gohner, W., Luszczynska, A., & Kliegel, M. (2009). Changes in self-regulatory cognitions as predictors of changes in smoking and nutrition behaviour. *Psychology & Health, 24*, 545-561. doi: 10.1080/08870440801902519	2 studies/2 behaviors[d]
13. Schwarzer, R., & Luszczynska, A. (2008). How to overcome health-compromising behaviors: The health action process approach. *European Psychologist, 13*, 141-151. doi: 10.1027/1016-9040.13.2.141	2 studies/2 behaviors[d]
14. Schwarzer, R., Schüz, B., Ziegelmann, J. P., Lippke, S., Luszczynska, A., & Scholz, U. (2007). Adoption and maintenance of four health behaviors: Theory-guided longitudinal studies on dental flossing, seat belt use, dietary behavior, and physical activity. *Annals of Behavioral Medicine, 33*, 156-166. doi: 10.1007/BF02879897	4 studies/4 behaviors[e]
15. Schwarzer, R., Luszczynska, A., Ziegelmann, J. P., Scholz, U., & Lippke, S. (2008). Social-cognitive predictors of physical exercise adherence: Three longitudinal studies in rehabilitation. *Health Psychology, 27*, S54-S63. doi: 10.1037/0278-6133.27.1%28Suppl.%29.S54	3 studies/1 behavior
16. Schwarzer, R., Richert, J., Kreausukon, P., Remme, L., Wiedemann, A. U., & Reuter, T. (2010). Translating intentions into nutrition behaviors via planning requires self-efficacy: Evidence from Thailand and Germany. *International Journal of Psychology, 45*, 260-268. doi: 10.1080/00207591003674479	2 studies/2 behaviors[f]
17. Steca, P., Pancani, L., Greco, A., D'Addario, M., Magrin, M. E., Miglioretti, M., . . . Zanettini, R. (2015). Changes in dietary behavior among coronary and hypertensive patients: A longitudinal	2 samples/1 behavior

investigation using the Health Action Process Approach. *Applied Psychology: Health and Well-Being, 7*, 316-339. doi: 10.1111/aphw.12050	
18. Steca, P., Pancani, L., Cesana, F., Fattirolli, F., Giannattasio, C., Greco, A., . . . Franzelli, C. (2017). Changes in physical activity among coronary and hypertensive patients: A longitudinal study using the Health Action Process Approach. *Psychology & Health, 32*, 361-380. doi: 10.1080/08870446.2016.1273353	2 samples/1 behavior
19. Szczepanska, W. K., Scholz, U., Liszewska, N., & Luszczynska, A. (2013). Social and cognitive predictors of fruit and vegetable intake among adolescents: The context of changes in body weight. *Journal of Health Psychology, 18*, 667-679. doi: 10.1177/1359105312437434	2 studies/1 behavior
20. Ziegelmann, J. P., & Lippke, S. (2007). Planning and strategy use in health behavior change: A life span view. *International Journal of Behavioral Medicine, 14*, 30-39. doi: 10.1007/BF02999225	2 samples/1 behavior

Note. [a]Physical activity and dietary behaviors; [b]Fruit and vegetable intake and fast food consumption; [c]Fruit and vegetable intake and energy-dense foods intake; [d]Smoking and dietary behaviors; [e]Dental flossing, seat belt use, dietary behavior, and physical activity; [f]Fruit and vegetable intake and eating a low-fat diet.

Table B2

Studies Included in Meta-Analysis with Overlapping Samples

Studies	Group name[a]
1. Chiu, C. Y. (2009). Testing Schwarzer' Health Action Process Approach (HAPA) model of health promotion for people with multiple sclerosis: A path analytic approach (Unpublished doctoral dissertation). University of Wisconsin-Madison, Madison, Wisconsin. 2. Chiu, C. Y., Lynch, R. T., Chan, F., & Berven, N. L. (2011). The Health Action Process Approach as a motivational model for physical activity self-management for people with multiple sclerosis: A path analysis. *Rehabilitation Psychology*, *56*, 171-181. doi: 10.1037/a0024583	Chiu (2009); Chiu et al. (2011)
3. Chow, S. (2008). Food safety behaviours: Application of health model (Unpublished bachelor dissertation). The University of Sydney, Sydney, Australia. 4. Chow, S., & Mullan, B. (2010). Predicting food hygiene. An investigation of social factors and past behaviour in an extended model of the Health Action Process Approach. *Appetite, 54*, 126-133. doi: 10.1016/j.appet.2009.09.018	Chow (2008); Chow & Mullan (2010)
5. Ghisi, G. L. M. (2014) Patient education in cardiac rehabilitation: the role of knowledge on behavior change and its mediators (Unpublished doctoral dissertation). University of Toronto, Toronto. 6. Ghisi, G. L. M., Grace, S. L., Thomas, S., Vieira, A. M., Costa, I. Z., & Oh, P. (2015a). Knowledge and exercise behavior maintenance in cardiac rehabilitation patients receiving educational interventions. *Heart & Lung*, *44*, 474-480. doi: 10.1016/j.hrtlng.2015.09.004 7. Ghisi, G. L. M., Grace, S. L., Thomas, S., & Oh, P. (2015b). Behavior determinants among cardiac rehabilitation patients receiving educational interventions: an application of the health action process approach. *Patient Education and Counseling*, *98*, 612-621. doi: 10.1016/j.pec.2015.01.006	Ghisi (2014); Ghisi et al. (2015a); Ghisi et al. (2015b)
8. Hankonen, N., Absetz, P., Kinnunen, M., Haukkala, A., & Jallinoja, P. (2013). Toward identifying a broader range of social cognitive determinants of dietary intentions and behaviors. *Applied Psychology: Health and Well-Being*, *5*, 118-135. doi:10.1111/j.1758-0854.2012.01081.x 9. Hankonen, N., Kinnunen, M., Absetz, P., & Jallinoja, P. (2014). Why do people high in self-control eat more healthily? Social cognitions as mediators. *Annals of Behavioral Medicine*, *47*, 242-248. doi: 10.1007/s12160-013-9535-1	Hankonen et al. (2013); Hankonen et al. (2014)
10. Harman, B. (2014). Social cognitive variables related to physical activity following total knee arthroplasty: An application of the Health Action Process Approach (Unpublished master dissertation). AUT University, Auckland, New Zealand.	Harman (2014); Harman et al. (2015)

11. Harman, B., Bassett, S., & Lewis, G. (2015). Can the health action process approach explain physical activity following total knee arthroplasty? *Physiotherapy*, 101, eS531-eS532. doi: 10.1016/j.physio.2015.03.3339	
12. Johnson, E. T. (2013). Applying the health action process approach model to predict physical activity in African Americans living with HIV/AIDS: A hierarchical regression analysis (Unpublished master dissertation). University of Wisconsin-Madison, Madison, Wisconsin. 13. Johnson, E. T., Lynch, R. T., Chan, F., Bezyak, J., & Mahr, M. (2015). Expanding the health action and process approach to predict physical activity in African Americans with HIV/AIDS: A hierarchical regression analysis. *Rehabilitation Counseling Bulletin, 59*, 30-42. doi: 10.1177/0034355215573794	Johnson (2013); Johnson et al. (2015)

Note. [a]Summary name used to refer to the group of overlapping studies in the study characteristics table presented in Appendix D.

Appendix C: Studies included in meta-analysis

Araújo-Soares, V., McIntyre, T., MacLennan, G., & Sniehotta, F. F. (2009). Development and exploratory cluster-randomised opportunistic trial of a theory-based intervention to enhance physical activity among adolescents. *Psychology and Health*, *24*, 805-822. doi: 10.1080/08870440802040707

Arbour-Nicitopoulos, K. P., Duncan, M., Remington, G., Cairney, J., & Faulkner, G. E. (2014). Development and reliability testing of a health action process approach inventory for physical activity participation among individuals with schizophrenia. *Frontiers in Psychiatry*, *5*, 68. doi: 10.3389/fpsyt.2014.00068

Barg, C. J., Latimer, A. E., Pomery, E. A., Rivers, S. E., Rench, T. A., Prapavessis, H., & Salovey, P. (2012). Examining predictors of physical activity among inactive middle-aged women: An application of the health action process approach. *Psychology & Health, 27, 829-845*. doi: 10.1080/08870446.2011.609595

Bassett-Gunter, R., & Chang, A. (2016). Self-regulatory self-efficacy, action control, and planning: There's an app for that! *Telemedicine and e-Health*, *22*, 325-331. doi: 10.1089/tmj.2015.0061

Berli, C., Loretini, P., Radtke, T., Hornung, R., & Scholz, U. (2014). Predicting physical activity in adolescents: The role of compensatory health beliefs within the Health Action Process Approach. *Psychology & Health*, *29*, 458-474. doi: 10.1080/08870446.2013.865028

Bonner, J. E. (2011). Social-cognitive predictors of physical activity initiation in type 2 diabetes following diabetes self-management education: Application of the Health Action Process Approach (Unpublished doctoral dissertation). University of Louisville, Louisville, Kentucky.

Burkert, S., Knoll, N., Scholz, U., Roigas, J., & Gralla, O. (2012). Self-regulation following prostatectomy: Phase-specific self-efficacy beliefs for pelvic-floor exercise. *British Journal of Health Psychology*, *17*, 273-293. doi: 10.1111/j.2044-8287.2011.02037.x

Carvalho, T., & Alvarez, M. J. (2015). Preparing for male condom use: The importance of volitional predictors. *International Journal of Sexual Health*, *27*, 303-315. doi: 10.1080/19317611.2014.982264

Chiu, C. Y. (2009). Testing Schwarzer' Health Action Process Approach (HAPA) model of health promotion for people with multiple sclerosis: A path analytic approach (Unpublished doctoral dissertation). University of Wisconsin-Madison, Madison, Wisconsin.

Chiu, C. Y., Lynch, R. T., Chan, F., & Berven, N. L. (2011). The Health Action Process Approach as a motivational model for physical activity self-management for people with multiple sclerosis: A path analysis. *Rehabilitation Psychology*, *56*, 171-181. doi: 10.1037/a0024583

Chiu, C. Y., Lynch, R. T., Chan, F., & Rose, L. (2012). The health action process approach as a motivational model of dietary self-management for people with multiple sclerosis: A path analysis. *Rehabilitation Counseling Bulletin*, *56*, 48-61. doi: 10.1177/0034355212440888

Chow, S., & Mullan, B. (2010). Predicting food hygiene. An investigation of social factors and past behaviour in an extended model of the Health Action Process Approach. *Appetite*, *54*, 126-133. doi: 10.1016/j.appet.2009.09.018

Chow, S. (2008). Food safety behaviours: Application of health model (Unpublished bachelor dissertation). The University of Sydney, Sydney, Australia.

Craciun, C., Schüz, N., Lippke, S., & Schwarzer, R. (2012). A mediator model of sunscreen use: A longitudinal analysis of social-cognitive predictors and mediators. *International Journal of Behavioral Medicine*, *19*, 65-72. doi: 10.1007/s12529-011-9153-x

Crawford, D. A. (2016). Examining the health action process approach model for predicting physical activity in people with back pain (Unpublished doctoral dissertation). The University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma.

Duan, Y. P., Wienert, J., Hu, C., Si, G. Y., & Lippke, S. (2017). Web-based intervention for physical activity and fruit and vegetable intake among Chinese university students: a randomized controlled trial. *Journal of Medical Internet Research*, *19*: e106. doi: 10.2196/jmir.7152

Ernsting, A., Gellert, P., Schneider, M., & Lippke, S. (2013a). A mediator model to predict workplace influenza vaccination behaviour–an application of the health action process approach. *Psychology & Health*, *28*, 579-592. doi: 10.1080/08870446.2012.753072

Ernsting, A., Schwarzer, R., Lippke, S., & Schneider, M. (2013b). ‘I do not need a flu shot because I lead a healthy lifestyle’: Compensatory health beliefs make vaccination less likely. *Journal of Health Psychology*, *18*, 825-836. doi: 10.1177/1359105312455076

Fleig, L., Küper, C., Lippke, S., Schwarzer, R., & Wiedemann, A. U. (2015a). Cross-behavior associations and multiple health behavior change: A longitudinal study on physical activity and fruit and vegetable intake. *Journal of Health Psychology*, *20*, 525-534. doi: 10.1177/1359105315574951

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Appendix D: Study characteristics

Table D1

Summary Characteristics and Moderator Coding of Studies Included in Meta-Analysis

Study	N	Mean age of sample in years (SD)	Age range	Gender (% female)	Behavior[b]	Sample type[c]		Study design[d]	Behavior measure[e]	Model[f]	Time lag[g]	HAPA variables measured
						Student vs. non-student	Clinical vs. non-clinical					
Araujo-Soares et al. (2009)	157	12.04 (0.95)	-	52.2	PA	ST	NC	PR	SR	TPB + Planning	DST	PB, INT, MSE, AP, CP
Arbour-Nicitopoulos et al. (2014)	26	41.5 (13.45)	19-64	61.54	PA	NS	CL	PR	SR	HAPA	PRX	PB, RP, OE, ASE, INT, AP, CP, MSE, RSE, AC
Barg et al. (2012)	175	51.97 (7.64)	40-65	100	PA	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, AP, MSE
Bassett-Gunter & Chang (2016)	103	23.6	18-	54	PA	NS	NC	CS	SR	HAPA	-	PB, ASE, INT, MSE, RSE, AP, AC
Berli et al. (2014)	430	14.55 (0.98)	12-17	46.28	PA	ST	NC	PR	SR	HAPA	PRX	RP, OE, ASE, INT, AP AC
Bonner (2011)	152	53.9 (11.6)	21-	73.15	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, AP
Burkert et al. (2012)	112	62.8 (6.0)	-	-	MISC[a]	NS	CL	PR	SR	HAPA	DST	ASE, INT, MSE, RSE, AP
Carvalho & Alvarez (2015)	203	19.0 (1.70)	18-25	0	CU	NS	NC	PR	SR	HAPA	PRX	PB, OE, ASE, INT, MSE, AP, CP
Caudroit et al. (2011)	120	65.38 (5.63)	53-83	65.83	PA	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, AP, CP
Chiu (2009); Chiu et al. (2011)	195	47.35 (10.01)	19-67	87.18	PA	NS	CL	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, MSE, AP, CP, AC
Chiu et al. (2012)	209	47.39 (10.12)	19-67	86.60	DB	NS	CL	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, MSE, RSE, AP, CP
Chow (2008); Chow & Mullan (2010)	259	19.9	-	78.38	HB	ST	NC	PR	SR	HAPA	PRX	PB, RP, OE, ASE, INT, MSE, RSE, AP
Craciun et al. (2012)	154	21.46 (4.47)	18-48	92.86	SU	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, AP

Crawford (2015)	350	37.4 (12.0)	21-64	74	PA	NS	NC	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, MSE, RSE, AP
Duan et al. (2017)	54	19.54 (1.13)	17-23	59.3	DB	ST	NC	EX	SR	HAPA	DST	RP, OE, ASE, INT, AP, CP
Ernsting et al. (2013a)	823	40 (9)	18-69	51.40	MISC[b]	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, AP
Ernsting et al. (2013b)	851	40 (10)	18-69	46.42	MISC[b]	NS	NC	EX	SR	HAPA	DST	PB, OE, ASE, INT, AP
Fleig et al. (2015a)	1002	37.2 (11.4)	18-78	77.35	DB	NS	NC	PR	SR	HAPA	PRX	ASE, INT, AP
Fleig et al. (2015b) EU	416	34.6	17-	-	DB	NS	NC	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, AP, AC
Fleig et al. (2015b) GER	351	42.3	17-	-	DB	NS	NC	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, AP, AC
Fleig et al. (2016)	10	66.23 (3.98)	-	100	MISC[c]	NS	NC	PR	OJ	NST	DST	ASE, INT, AP, CP, AC
Gaston & Prapavessis (2014)	20	31.75 (4.68)	-	100	PA	NS	NC	EX	SR+OJ	PMT + Planning	PRX	PB, RP, ASE, INT, AP, CP
Gerber et al. (2011)	210	17.43 (1.19)	15-20	71.43	PA	ST	NC	PR	SR	TPB + Planning	DST	PB, OE, ASE, INT, AP, CP
Ghisi (2014); Ghisi et al. (2015a); Ghisi et al. (2015b)	160	63.58 (11.66)	-	23.1	PA	NS	CL	EX	SR	HAPA	DST	RP, OE, ASE, INT, MSE, AP, CP
Godinho et al. (2014)	203	22.19 (5.33)	18-50	85.22	DB	ST	NC	PR	SR	HAPA	PRX	PB, OE, ASE, INT, CP
Gutierrez-Dona et al. (2009) Study1	245	40 (9.3)	19-62	100	DB	NS	NC	CS	SR	NST	-	PB, ASE, INT, CP
Gutierrez-Dona et al. (2009) Study2	358	36 (18.97)	17-90	100	DB	NS	NC	PR	SR	NST	DST	PB, ASE, INT, CP
Hankonen et al. (2013); Hankonen et al. (2014)	679	20 (0.84)	19-28	0	DB	NS	NC	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, AP, CP
Harman (2014); Harman et al. (2015)	54	68 (8)	47-85	46.30	PA	NS	CL	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, MSE, RSE, AP, CP
Hattar et al. (2016)	68	41.10 (12.10)	18-65	-	PA	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, AP
Jakul (2013) Normal	183	18	-	65	DB	ST	NC	PR	SR	HAPA	DST	PB, OE, INT, RSE, AP
Jakul (2013) Overweight	191	18	-	65.5	DB	ST	NC	PR	SR	HAPA	DST	PB, OE, INT, RSE, AP
Johnson (2013); Johnson et al. (2015)	110	46.07 (11.02)	18-	52.73	PA	NS	CL	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, MSE, RSE, AP

Jones et al. (2001) Australian sample	113	-	-	53.98	SU	NS	NC	CS	SR	TPB + Planning	-	PB, RP, ASE, INT, AP
Jones et al. (2001) UK sample	376	-	-	60.90	SU	NS	NC	CS	SR	TPB + Planning	-	PB, RP, ASE, INT, AP
Koring et al.(2012)	290	41.9 (14.3)	19-76	77.10	PA	NS	NC	PR	SR	NST	PRX	PB, ASE, INT, AP
Krämer et al. (2014) No depression	56	47.7 (15.4)	-	48.20	PA	NS	CL	PR	SR	HAPA	DST	OE, ASE, INT, MSE, AP, CP
Krämer et al. (2014) Depression	56	44.3 (13.4)	-	60.70	PA	NS	NC	PR	SR	HAPA	DST	OE, ASE, INT, MSE, AP, CP
Lhakhang et al. (2014)	111	21.4 (1.4)	18-26	51.35	DB	ST	NC	EX	SR	HAPA	DST	PB, ASE, INT, MSE, AP, CP
Lhakhang et al. (2015)	112	21.45 (1.42)	-	50.89	HB	ST	NC	EX	SR	HAPA	DST	PB, ASE, INT, MSE, AP, CP
Lippke (2010a)	366	48.6 (10.5)	19-76	54.4	PA	NS	CL	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, MSE, AP
Lippke (2010b)	84	37.80 (9.41)	21-64	89.29	PA	NS	NC	EX	SR	HAPA	DST	PB, RP, OE, INT, RSE, AP
Lippke et al. (2004)	59	-	15-80	62.28	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, AP
Lippke et al. (2005)	423	45.56 (11.71)	15-80	62	PA	NS	CL	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, AP
Lippke et al. (2009)	812	36.69 (12.20)	16-78	74.4	PA	NS	NC	PR	SR	HAPA	PRX	PB, INT, RSE, AP
Luszczynska & Schwarzer (2003)	418	23.19 (5.61)	18-49	100	MISC[d]	ST	NC	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, RSE, AP
Luszczynska (2004)	173	24.01 (5.41)	18-49	100	MISC[d]	ST	NC	EX	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, RSE, AP
Luszczynska (2007)	200	29.1 (9.01)	18-60	64	DB	NS	NC	EX	SR	NST	DST	PB, ASE, INT, AP
Luszczynska & Cieslak (2009)	130	54.25 (6.85)	39-67	36	DB	NS	CL	PR	SR	NST	DST	PB, INT, MSE, AP
Luszczynska (2010) Study1	534	13.8 (1.40)	12-18	54	PA	ST	NC	PR	SR	NST	PRX	PB, INT, RSE, AP
Luszczynska (2010) Study2	620	16.46 (0.61)	15-19	62	PA	ST	NC	PR	SR	NST	DST	PB, INT, MSE, AP
Luszczynska (2016)	181	16.35 (0.79)	13-18	58	DB	ST	NC	EX	SR	NST	DST	PB, ASE, INT, RSE, AP

MacPhail et al. (2014)	42	71.21 (11.72)	-	52.38	DB	NS	CL	EX	SR	HAPA	PRX	PB, RP, OE, ASE, INT, MSE, RSE, AP, CP
Matterne et al. (2011)	117	-	-	-	SU	NS	CL	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, RSE, AP, CP
Miller et al. (2016)	33	50.8 (8.1)	-	78.79	DB	NS	CL	EX	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, RSE, AP
Mullan et al (2010)	109	19.5 (2.43)	17-35	77.98	HB	ST	NC	PR	SR	HAPA	PRX	PB, RP, OE, ASE, INT, MSE, RSE, AP
Mullan et al (2013)	102	19.5 (2.5)	17-35	77.45	DB	ST	NC	PR	SR	HAPA	PRX	RP, OE, ASE, INT, MSE, RSE, AP
Namadian et al. (2016)	411	65.5 (9.7)	-	57.42	PA	NS	CL	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, AC
Ochsner et al. (2014)	106	40.67 (10.03)	19-72	27.36	SM	NS	NC	PR	SR+OJ	HAPA	DST	INT, RSE, AP, CP
Parschau et al. (2014a)	484	42.3 (11.3)	18-75	67.77	PA	NS	NC	CS	SR	HAPA	-	PB, RP, OE, ASE, INT, MSE, RSE, AP, CP
Parschau et al. (2014b) Study1	350	41 (12.8)	16-90	63.7	PA	NS	NC	PR	SR	HAPA	DST	PB, ASE, INT, MSE, AP
Parschau et al. (2014b) Study2	275	50 (9.3)	19-76	56	PA	NS	CL	PR	SR	HAPA	DST	PB, ASE, INT, MSE, AP
Paxton (2016)	304	54.0 (10.1)	-	100	PA	NS	CL	CS	SR	HAPA	-	OE, ASE, INT, MSE, RSE, AP, CP
Payaprom et al. (2011)	102	56.24 (5.86)	46-65	66.67	MISC[b]	NS	CL	EX	SR	HAPA	PRX	RP, OE, ASE, INT, AP
Radtke et al. (2012)	385	17.80 (1.65)	-	50.39	SM	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, RSE, AP
Radtke et al. (2014)	75	31.95 (12.40)	19-66	100	DB	NS	NC	CS	SR	HAPA	-	PB, RP, OE, INT, MSE, AP, AC
Ranby (2009)	160	63 (10)	35-85	100	PA	NS	NC	CS	SR	HAPA	-	PB, ASE, INT, MSE, AP
Renner et al. (2007)	697	32.0 (17.5)	16-90	51.36	PA	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, RSE, AP, CP
Reuter et al. (2010)	853	37.4 (12.62)	18-78	77.5	DB	NS	NC	PR	SR	NST	PRX	PB, ASE, INT, MSE, RSE, AP
Reyes Fernandez et al.(2016)	307	21.82 (3.89)	-	61	HB	ST	NC	PR	SR	HAPA	DST	PB, OE, ASE, INT, AP, CP, AC
Richert et al. (2010)	411	43 (6.2)	20-59	19.46	DB	NS	NC	PR	SR	NST	PRX	PB, ASE, INT, AP

Sager (2011)	114	14.47 (1.33)	13-19	50.88	DF	ST	NC	EX	SR	HAPA	DST	PB, RP, OE, ASE, INT, AP
Scholz et al. (2005)	211	59 (10.02)	31-86	21.07	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, RSE, AP
Scholz et al. (2008)	354	37 (9.90)	16-64	81.4	PA	NS	NC	PR	SR	HAPA	DST	PB, RP, OE, INT, MSE, AP
Scholz et al. (2009) Dietary	344	44.25 (12.40)	18-79	82.09	DB	NS	NC	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, AP, CP, AC
Scholz et al. (2009) Smoking	235	32.09 (11.60)	-	51.47	SM	NS	NC	PR	SR	HAPA	PRX	PB, RP, OE, ASE, INT, AP, AC
Scholz et al. (2013a)	72	52.08 (12.85)	20-79	68.06	DB	NS	NC	EX	SR	HAPA	DST	PB, INT, RSE, AP, CP, AC
Scholz et al. (2013b)	190	52.34 (11.56)	20-78	67.86	DB	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, AP, AC
Schuz et al. (2006)	157	25.3	18-51	79.62	DF	ST	NC	PR	SR	SCT + Planning	DST	PB, RP, OE, ASE, INT, AP, CP
Schuz et al. (2016)	93	15.73 (0.66)	15-18	55.13	SU	ST	NC	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, AP
Schwarzer & Luszczynska (2008) Low-fat Diet	116	54.57 (10.01)	31-79	39.7	DB	NS	CL	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, RSE, AP
Schwarzer & Luszczynska (2008) Smoking	166	18.56 (0.87)	18-21	41.2	SM	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, RSE, AP
Schwarzer et al. (2007) Exercise	365	37.01 (9.99)	16-64	81.4	PA	NS	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, RSE, AP
Schwarzer et al. (2007) FV intake	700	37.68 (12.31)	16-78	72.8	DB	NS	NC	PR	SR	HAPA	PRX	RP, OE, ASE, INT, RSE, AP
Schwarzer et al. (2007) Seatbelt	298	18.35 (1.06)	16-21	44.5	MISC[e]	ST	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, RSE, AP
Schwarzer et al. (2007) Flossing	157	25.29 (7.03)	16-51	79.61	DF	ST	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, RSE, AP
Schwarzer et al. (2008) Study 1	353	58.8 (9.96)	31-82	21	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, RSE, AP
Schwarzer et al. (2008) Study 2	114	54.3 (6.9)	39-67	36	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, RSE, AP
Schwarzer et al. (2008) Study 3	368	47.4 (11.7)	18-80	62	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, RSE, AP
Schwarzer et al. (2010) FV intake	1140	37.3 (12.5)	16-77	81	DB	NS	NC	PR	SR	NST	PRX	PB, INT, MSE, AP
Schwarzer et al. (2010) Low-fat diet	1718	20 (1.4)	17-30	46.62	DB	ST	NC	CS	SR	NST	-	PB, INT, MSE, AP
Sniehotta et al. (2005)	307	59 (9.98)	31-82	20.20	PA	NS	CL	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, AP, AC

Steca et al. (2015) Coronary patient	231	57.09 (7.92)	-	16	DB	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, AP
Steca et al. (2015) Hypertensive patient	228	54.71 (10.78)	-	43.50	DB	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, AP
Steca et al. (2017) Coronary patient	189	57.3 (8.0)	35-75	17.46	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, AP
Steca et al. (2017) Hypertensive patients	169	54.9 (10.1)	21-75	43.79	PA	NS	CL	PR	SR	HAPA	DST	PB, RP, OE, ASE, INT, MSE, AP
Szczepanska et al. (2013) Study 1	502	14.93 (1.31)	12-18	51	DB	ST	NC	CS	SR	SCT+HAPA	-	PB, ASE, INT, AP
Szczepanska et al. (2013) Study 2	668	16.21 (0.92)	13-18	57.2	DB	ST	NC	PR	SR	SCT +HAPA	DST	PB, ASE, INT, AP
Teng & Mak (2011)	276	28.49 (8.19)	-	0	CU	NS	NC	PR	SR	HAPA	PRX	PB, RP, OE, ASE, INT, MSE, RSE, AP, CP
Van Osch et al. (2008)	436	36.4 (5.17)	-	77	SU	NS	NC	PR	SR	I-change + HBM + TPB	DST	RP, ASE, INT, AP
Van Osch et al. (2010)	434	47.8 (16)	-	53.3	DB	NS	NC	PR	SR	NST	DST	PB, ASE, INT, AP
Van Stralen et al. (2011)	578	64 (8.2)	-	-	PA	NS	NC	EX	SR	NST	DST	ASE, INT, AP, CP
Zhou et al. (2013)	240	19.60 (1.48)	-	43.75	DB	ST	NC	PR	SR	HAPA	DST	RP, OE, ASE, INT, MSE, AP
Zhou et al. (2016)	164	25.10 (4.72)	18-64	73.8	MISC[f]	ST	NC	PR	SR	HAPA	PRX	RP, OE, ASE, INT, MSE, AP, CP, AC
Ziegelmann et al. (2006a)	286	45.7 (12.0)	18-80	62.5	PA	NS	CL	PR	SR	NST	DST	ASE, INT, AP, CP
Ziegelmann et al. (2006b)	370	48.2 (11.7)	-	62.2	PA	NS	CL	PR	SR	HAPA	DST	RP, OE, ASE, INT, AP
Ziegelmann & Lippke (2007) Elderly	169	58.0 (5.8)	50-80	52.7	PA	NS	CL	PR	SR	HAPA	DST	RP, OE, ASE, INT, RSE, AP, CP
Ziegelmann & Lippke (2007) Young	199	38.5 (7.0)	19-48	69.8	PA	NS	CL	PR	SR	HAPA	DST	RP, OE, ASE, INT, RSE, AP, CP

Note. [a]Pelvic floor exercises; [b]Influenza vaccine; [c]Fall prevention in older adults; [d]Breast self-examination; [e]Car seatbelt use; [f]Use of anti-dust facemask; CU = Condom use; DB = Dietary behaviors; HB = Hygiene behaviors; MISC = Miscellaneous behavioral category; PA = Physical activity; SM = Smoking; SU = Sun safety behaviors; NS = Non-student sample; ST = Student sample; DST = Distal time lag (> 4 weeks); PR = Proximal time lag (≤ 4 weeks); CS = Cross-sectional design; EX = Experimental design; PR = Prospective design; OJ = Objective measure of behavior; SR = Self-report measure of behavior; HBM = Health belief model; HAPA = Health action process approach; I-Change = I-change model; TPB = Theory of planned behavior; SCT = Social cognitive theory; NST = Not stated; AP = Action planning; ASE = Action self-efficacy; CP = Coping planning; INT = Intention; MSE = Maintenance self-efficacy; OE = Outcome expectancies; PB = Past behavior; RP = Risk perceptions; RSE = Recovery self-efficacy.

Appendix E: Study methodological quality checklist criteria and descriptions

Item	Criterion	Description
1	Research question or objective[a]	Was a specific research question, hypothesis, objective or prediction of the study clearly stated?
2	Study population[a,c]	Was the population clearly specified and defined (e.g., population, condition, location, date and time)?
3	Participation rate[a,c]	Was the participation rate (i.e., proportion of eligible persons invited to participate that agreed to do so) of eligible persons at least 50%?
4	Definition of clinical condition or outcome of interest[b]	Was the target condition and primary outcome clearly defined?
5	Inclusion/exclusion criteria[a,c]	Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?
6	Ethical approval[b]	Was the study approved by a relevant institutional review board or research ethics committee?
7	Participant informed consent	Were participants provided with details of the study prior to data collection and required to provide their consent (e.g., by signing a form)?
8	Sample representative of population[b]†	Was the final sample size representative of the population from which the participants were drawn (characteristics compared between those that remained and drop-outs)? As many of the studies in the current sample relied on self-reported demographic characteristics from returned surveys.
9	Sample size[b,c]	Was the ratio of participants to the number of independent variables appropriate (>=10)?
10	Statistical power analysis[b]	Was a statistical power analysis conducted to establish the target sample size a priori?
11	Study design[b]	Did the study include longitudinal follow-up of outcomes?
12	Follow-up measures[a]†	Were the outcome follow up measures assessed more than once over time? Did the study collect long-term (>4 weeks) follow-up measures of the outcomes?
13	Exposure/independent variable(s)[a,b,c,d]	Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? In the case of self-report measures, study-specific reports of

		reliability (e.g., internal consistency test, test-retest reliability) were expected.
14	Outcome/dependent variable(s)[a,b,c,d]	Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? In the case of self-report measures, study-specific reports of reliability (e.g., internal consistency test, test-retest reliability) were expected. Outcome measures that were objectively determined by clinical procedure or analysis (e.g., glycosylated hemoglobin, HbA1c in diabetics or viral load, CD4 count in HIV patients) or had external validity (e.g., clinic attendance) were scored as valid.
15	Loss to follow-up[a,c]†	Was loss to follow-up after baseline 20% or less?
16	Control for confounding variables[a]	Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposures and outcomes?

Note. †Criterion relevant to longitudinal/prospective studies only; [a]Criterion adopted from National Institutes for Health Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (National Institutes of Health, 2014); [b]Criterion adopted from Oluka et al. (2014); [c]Criterion adopted from Jack et al. (2010); [d]Criterion adopted from Husebo et al. (2012).

Scoring

For each of the 16 criteria, studies are assigned 1 for 'Yes' responses and 0 for No/ Could not be determined / Not applicable / Not reported.

Overall Methodological Quality Score

Simple sum of scores for each criterion to provide score out of 16. A score of nine and above is regarded as acceptable; while a score of eight and below is regarded as questionable.

Sample Study Methodological Quality Checklist

Reference:			
Criteria	**Yes**	**No**	**Other (CD, NR, NA)**
1. Research question or objective			
2. Study population			
3. Participation rate			
4. Definition of clinical condition or outcome of interest			
5. Inclusion/exclusion criteria			
6. Ethical approval			
7. Participant informed consent			
8. Sample representative of population			
9. Sample size			
10. Statistical power analysis			
11. Study design			
12. Follow-up measures			
13. Exposure/independent variable(s)			
14. Outcome/dependent variable(s)			
15. Loss to follow-up			
16. Control for confounding variables			
Overall Rating (Yes = 1, No and Other = 0)			
Total Score:			
Quality Rating (Acceptable = 9-16, Questionable = 0-8):			

Note. CD = Could not be determined; NA = Not applicable; NR = Not reported.

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Appendix F: Study quality assessment

Table F1

Study Quality Assessment

Study	Item																Total
	1	2	3	3	5	6	7	8	9	10	11	12	13	14	15	16	
Araujo-Soare et al. (2009)	Y	Y	NR	Y	Y	NR	NR	Y	Y	N	Y	Y	Y	NR	N	Y	9
Arbour-Nicitopoulos et al. (2014)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	NR	Y	NR	12
Barg et al. (2012)	Y	N	NR	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	Y	Y	Y	13
Bassett-Gunter & Chang (2016)	Y	N	NR	Y	Y	Y	Y	NR	Y	NR	N	NA	Y	NR	NA	N	7
Berli et al. (2014)	Y	Y	NR	Y	NR	NR	NR	Y	Y	NR	Y	N	Y	NR	Y	Y	9
Bonner (2011)	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	Y	Y	Y	NR	N	Y	13
Burkert et al. (2012)	Y	Y	NR	Y	Y	Y	Y	NR	N	NR	Y	Y	Y	Y	Y	Y	12
Carvalho & Alvarez (2015)	Y	Y	NR	Y	NR	CD	Y	Y	Y	NR	Y	N	Y	Y	N	NR	9
Caudroit et al. (2011)	Y	Y	NR	Y	Y	NR	NR	Y	Y	NR	Y	Y	Y	NR	Y	NR	10
Chiu et al. (2011); Chiu (2009)	Y	Y	NR	Y	Y	NR	NR	NR	Y	NR	N	NA	Y	NR	NA	Y	7
Chiu et al. (2012)	Y	Y	NR	Y	Y	NR	NR	NR	Y	NR	N	NA	Y	NR	NA	NR	6
Chow & Mullan (2010); Chow (2008)	Y	N	NR	Y	Y	Y	NR	Y	Y	NR	Y	N	Y	NR	Y	N	9
Craciun et al. (2012)	Y	Y	Y	Y	NR	Y	Y	NR	Y	NR	Y	Y	Y	NR	N	NR	10
Crawford (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	Y	Y	NA	Y	13
Duan et al. (2017)	Y	Y	Y	Y	NR	Y	Y	Y	Y	NR	Y	Y	Y	NR	N	Y	12
Ernsting et al. (2013a)	Y	Y	NR	Y	NR	Y	NR	Y	Y	NR	Y	Y	Y	NR	N	Y	10
Ernsting et al. (2013b)	Y	Y	N	Y	NR	Y	NR	CD	Y	NR	Y	Y	NR	NR	N	Y	8
Fleig et al. (2015a)	Y	N	NR	Y	Y	Y	NR	N	Y	NR	Y	N	Y	NR	N	Y	8
Fleig et al. (2015b)	Y	N	NR	Y	Y	Y	NR	CD	Y	NR	N	NA	Y	Y	NA	Y	8
Fleig et al. (2016)	Y	N	NR	Y	NR	NR	NR	CD	N	NR	Y	Y	NR	NR	Y	NR	5
Gaston & Prapavessis (2014)	Y	Y	NR	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	CD	Y	NA	12
Gerber et al. (2011)	Y	Y	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	NA	N	Y	10
Ghisi et al. (2015a)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NA	Y	NR	13
Ghisi et al. (2015b)	Y	N	NR	Y	Y	Y	Y	Y	Y	Y	Y	Y	NR	NR	Y	Y	12
Godinho et al. (2014)	Y	N	NR	Y	NR	Y	Y	Y	Y	NR	Y	N	Y	NR	Y	Y	10
Gutierrez-Dona et al. (2009) Study1	Y	N	NR	Y	NR	NR	Y	CD	Y	NR	N	NA	Y	Y	NA	NR	6
Gutierrez-Dona et al. (2009) Study2	Y	N	NR	Y	NR	NR	Y	CD	Y	NR	Y	Y	Y	Y	N	Y	9
Hankonen et al. (2013)	Y	Y	Y	Y	NR	Y	Y	Y	Y	NR	Y	Y	Y	NR	N	Y	12
Hankonen et al. (2014)	Y	Y	Y	Y	NR	Y	Y	NR	Y	NR	Y	Y	Y	NR	N	NR	10
Harman (2014); Harman et al. (2015)	Y	Y	NR	Y	Y	Y	Y	CD	N	Y	N	NA	Y	Y	NA	NR	9
Hattar et al. (2016)	Y	N	NR	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14
Jakul (2013)	Y	Y	NR	Y	NR	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14
Johnson et al. (2015); Johnson (2013)	Y	Y	N	Y	Y	Y	Y	NR	Y	NR	N	NA	Y	NA	NA	NR	8
Jones et al. (2001)	Y	N	NR	Y	NR	NR	NR	NR	Y	NR	NA	NA	Y	NR	NA	Y	5
Koring et al.(2012)	Y	Y	NR	Y	NR	NR	Y	CD	Y	NR	Y	Y	Y	Y	N	Y	10

Krämer et al. (2014)	Y	Y	NR	Y	Y	Y	Y	CD	N	NR	Y	N	Y	NR	N	Y	9
Lhakhang et al. (2014)	Y	N	Y	Y	NR	NR	Y	CD	Y	NR	Y	Y	Y	NR	Y	Y	10
Lhakhang et al. (2015)	Y	N	Y	Y	NR	Y	Y	Y	Y	NR	Y	Y	Y	NR	Y	Y	12
Lippke (2010a)	Y	Y	Y	Y	Y	Y	Y	NR	Y	NR	NR	NA	Y	NR	NA	NR	9
Lippke (2010b)	Y	N	N	Y	Y	NR	Y	CD	Y	N	Y	Y	Y	N	N	Y	9
Lippke et al. (2004)	Y	N	Y	Y	Y	NR	Y	Y	Y	NR	Y	Y	Y	NA	Y	NR	11
Lippke et al. (2005)	Y	N	NR	Y	Y	NR	Y	Y	Y	N	Y	Y	NR	NR	N	Y	9
Lippke et al. (2009)	Y	N	NR	Y	Y	NR	Y	Y	Y	NR	Y	N	Y	N	N	Y	9
Luszczynska & Schwarzer (2003)	Y	Y	NR	Y	NR	NR	NR	NR	Y	NR	Y	Y	Y	Y	N	NR	8
Luszczynska (2004)	Y	Y	NR	Y	NR	NR	NR	NR	Y	NR	Y	Y	Y	N	N	NR	7
Luszczynska (2007)	Y	N	Y	Y	Y	NR	NR	Y	Y	NR	Y	N	Y	NR	Y	NR	9
Luszczynska & Cieslak (2009)	Y	Y	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	N	N	Y	Y	10
Luszczynska (2010) Study1	Y	Y	NR	Y	NR	NR	NR	Y	Y	NR	Y	N	Y	N	N	Y	8
Luszczynska (2010) Study2	Y	Y	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	N	Y	10
Luszczynska (2016)	Y	N	Y	Y	Y	NR	Y	N	Y	NR	Y	Y	Y	N	Y	Y	11
MacPhail et al. (2014)	Y	N	Y	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	Y	Y	Y	14
Matterne et al. (2011)	Y	Y	NR	Y	NR	Y	Y	Y	Y	NR	Y	Y	Y	NR	N	Y	11
Miller et al. (2016)	Y	N	NR	Y	Y	Y	Y	Y	N	Y	Y	Y	CD	CD	Y	NR	10
Mullan et al (2010)	Y	N	NR	Y	NR	Y	NR	Y	Y	NR	Y	N	Y	N	Y	Y	9
Mullan et al (2013)	Y	Y	NR	Y	NR	Y	NR	Y	Y	NR	N	NA	Y	N	NA	NR	7
Namadian et al. (2016)	Y	Y	N	Y	Y	Y	NR	NR	Y	NR	N	NA	Y	Y	NA	NR	8
Ochsner et al. (2014)	Y	Y	NR	Y	Y	NR	Y	Y	Y	NR	Y	Y	Y	NR	Y	Y	12
Parschau et al. (2014a)	Y	Y	Y	Y	NR	NR	NR	NR	Y	N	N	NA	Y	N	NA	Y	7
Parschau et al. (2014b) Study 1	Y	N	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	N	Y	9
Parschau et al. (2014b) Study 2	Y	Y	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	N	Y	10
Paxton (2016)	Y	Y	NR	Y	Y	Y	Y	NR	Y	NR	N	NA	Y	NR	NA	Y	9
Payaprom et al. (2011)	Y	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	N	Y	N	Y	Y	13
Radtke et al. (2012)	Y	N	NR	Y	Y	Y	NR	Y	Y	NR	Y	Y	Y	NA	N	NR	9
Radtke et al. (2014)	Y	Y	N	Y	Y	Y	Y	CD	Y	NR	N	NA	N	N	NA	Y	8
Ranby (2009)	Y	N	Y	Y	NR	Y	NR	CD	Y	NR	NA	NA	Y	N	NA	Y	7
Renner et al. (2007)	Y	N	NR	Y	Y	NR	NR	CD	Y	NR	Y	Y	Y	NR	N	NR	7
Reuter et al. (2010)	Y	N	NR	Y	NR	NR	NR	CD	Y	NR	Y	N	Y	N	N	NR	5
Reyes Fernandez et al.(2016)	Y	Y	NR	Y	NR	Y	Y	Y	Y	NR	Y	Y	Y	NR	N	Y	11
Richert et al. (2010)	Y	Y	NR	Y	NR	NR	Y	Y	Y	NR	Y	N	Y	NR	N	NR	8
Sager (2011)	Y	N	NR	Y	NR	NR	NR	Y	Y	NR	Y	Y	Y	NR	NR	NR	7
Scholz et al. (2005)	Y	Y	Y	Y	NR	NR	Y	Y	Y	Y	Y	Y	Y	NR	Y	NR	12
Scholz et al. (2008)	Y	N	NR	Y	NR	NR	NR	Y	Y	NR	Y	Y	Y	NR	N	NR	7
Scholz et al. (2009) Study1	Y	N	N	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	NR	N	NR	8
Scholz et al. (2009) Study2	Y	N	N	Y	Y	NR	Y	Y	Y	NR	Y	N	Y	N	N	NR	8
Scholz et al. (2013a)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NR	NR	Y	Y	13
Scholz et al. (2013b)	Y	N	NR	Y	Y	Y	Y	N	Y	NR	Y	Y	Y	Y	N	Y	11
Schuz et al. (2006)	Y	Y	Y	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	NR	N	Y	11
Schuz et al. (2016)	Y	Y	NR	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	NR	N	NR	11

Schwarzer & Luszczynska (2008) Study1	Y	Y	NR	Y	NR	NR	NR	Y	Y	NR	Y	Y	Y	N	N	NR	8
Schwarzer & Luszczynska (2008) Study2	Y	Y	Y	Y	Y	NR	NR	Y	Y	NR	Y	Y	Y	N	N	NR	10
Schwarzer et al. (2007) Exercise	Y	N	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	Y	N	NR	9
Schwarzer et al. (2007) FV intake	Y	Y	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	Y	Y	NR	11
Schwarzer et al. (2007) Seatbelt	Y	N	Y	Y	NR	NR	Y	Y	Y	NR	Y	N	Y	Y	N	NR	9
Schwarzer et al. (2007) Flossing	Y	N	Y	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	Y	N	NR	10
Schwarzer et al. (2008) Study 1	Y	N	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	N	NR	8
Schwarzer et al. (2008) Study 2	Y	N	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	Y	NR	9
Schwarzer et al. (2008) Study 3	Y	N	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	N	NR	8
Schwarzer et al. (2010) Study 1	Y	Y	NR	Y	NR	NR	Y	NR	Y	N	NA	NA	Y	Y	NA	NR	7
Schwarzer et al. (2010) Study 2	Y	N	NR	Y	NR	NR	NR	Y	Y	NR	Y	N	Y	Y	N	Y	8
Sniehotta et al. (2005)	Y	N	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	Y	N	Y	10
Steca et al. (2015)	Y	Y	NR	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	NR	Y	Y	13
Steca et al. (2017)	Y	Y	NR	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	NR	Y	Y	13
Szczepanska et al. (2013) Study 1	Y	Y	Y	Y	Y	Y	Y	NR	Y	NR	N	NA	Y	Y	NA	NR	10
Szczepanska et al. (2013) Study 2	Y	Y	N	Y	NR	Y	Y	Y	Y	NR	Y	Y	Y	Y	N	NR	11
Teng & Mak (2011)	Y	Y	NR	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	NR	N	NR	11
Van Osch et al. (2008)	Y	N	N	Y	Y	NR	NR	N	Y	NR	Y	Y	Y	NR	N	NR	7
Van Osch et al. (2010)	Y	N	Y	Y	Y	NR	Y	Y	Y	NR	Y	Y	Y	NR	N	Y	11
Van Stralen et al. (2011)	Y	Y	N	Y	Y	Y	Y	NR	Y	Y	Y	Y	Y	NA	N	Y	12
Zhou et al. (2013)	Y	Y	NR	Y	NR	NR	NR	Y	Y	NR	Y	Y	Y	Y	N	NR	9
Zhou et al. (2016)	Y	Y	Y	Y	NR	Y	Y	Y	Y	NR	Y	Y	Y	NR	N	NR	11
Ziegelmann et al. (2006a)	Y	Y	NR	Y	NR	Y	Y	Y	Y	NR	Y	Y	NR	NR	Y	Y	11
Ziegelmann et al. (2006b)	Y	Y	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	N	Y	10
Ziegelmann & Lippke (2007)	Y	N	NR	Y	NR	NR	Y	Y	Y	NR	Y	Y	Y	N	N	Y	9

Note. Y = Checklist item confirmed; N = Checklist item not confirmed; NR = Not reported; NA = Not applicable.

Appendix G: Conventional meta-analysis and bias statistics

Table G1

Zero-Order Parameter Estimates from Conventional Fixed and Random Effects Model Meta-Analysis for Relations Among Constructs from the Health Action Process Approach with Heterogeneity and Bias Statistics

Effect	Meta-analytic models										Bias statistics		
	Random effects							Fixed effects		Q	r^{+}_{PET}	r^{+}_{PEESE}	p-BIAS
	k	r^{+}_{RE}	SE	CI_{95} LL	CI_{95} UL	I^2	τ^2	r^{+}_{FE}	SE				
PB-Behavior	9	.456***	.062	.334	.578	93.646	.030	.567***	.014	88.277***	.762***	.620***	<.001
PB-ASE	62	.249***	.020	.209	.287	86.763	.020	.275***	.007	635.065***	.289***	.278***	.468
PB-MSE	35	.221***	.027	.168	.275	88.125	.020	.300***	.009	344.118***	.431***	.336***	<.001
PB-RSE	28	.231***	.029	.174	.289	83.444	.018	.244***	.011	146.841***	.219***	.233***	.287
PB-OE	43	.160***	.023	.114	.206	83.076	.018	.163***	.009	228.686***	.118***	.159***	.110
PB-RP	37	-.036	.033	-.100	.027	89.622	.033	-.059	.032	340.299***	-.132***	-.078***	.010
PB-Intention	73	.309***	.025	.261	.358	95.217	.040	.445***	.005	2065.519***	.619***	.489***	<.001
PB-AP	70	.205***	.021	.208	.291	91.438	.027	.309***	.006	866.398***	.400***	.330***	<.001
PB-CP	24	.275***	.031	.213	.336	84.101	.018	.287***	.012	164.163***	.235***	.282***	.063
Behavior-ASE	78	.281***	.020	.243	.320	90.254	.025	.349***	.006	1100.185***	.468***	.372***	<.001
Behavior-MSE	41	.291***	.027	.239	.343	88.659	.024	.355***	.008	520.981***	.463***	.377***	<.001
Behavior-RSE	35	.251***	.033	.186	.315	91.115	.032	.292***	.009	363.755***	.319***	.298***	.198
Behavior-OE	60	.149***	.022	.107	.192	85.926	.014	.178***	.008	652.186***	.258***	.197***	<.001
Behavior-RP	53	.020	.026	-.031	.071	89.405	.030	.075***	.008	954.676***	.234***	.112***	<.001
Behavior-Intention	87	.310***	.020	.270	.350	93.144	.031	.404***	.005	1980.034***	.510***	.426***	<.001
Behavior-AP	85	.309***	.019	.271	.347	91.530	.026	.372***	.005	1193.126***	.434***	.387***	<.001
Behavior-CP	30	.302***	.022	.258	.345	71.239	.009	.296***	.011	99.795***	.262***	.296***	.119
ASE-MSE	46	.418***	.025	.370	.466	89.591	.024	.473***	.008	491.112***	.437***	.445***	.030
ASE-RSE	37	.347***	.028	.291	.402	88.814	.025	.376***	.009	335.612***	.296***	.348***	<.001
ASE-OE	70	.323***	.018	.288	.358	85.549	.018	.350***	.007	496.340***	.349***	.340***	.952
ASE-RP	63	.039	.025	-.010	.087	90.361	.033	.064***	.007	862.423***	.136***	.078***	<.001
ASE-Intention	97	.431***	.019	.394	.468	93.788	.031	.489***	.005	1620.567***	.442***	.472***	<.001
ASE-AP	93	.347***	.018	.312	.381	90.861	.024	.397***	.005	1246.204***	.396***	.391***	.983
ASE-CP	34	.337***	.029	.280	.393	87.969	.023	.365***	.010	343.787***	.329***	.350***	.022
MSE-RSE	25	.502***	.032	.440	.564	91.475	.021	.583***	.009	329.934***	.593***	.574***	.568
MSE-OE	41	.267***	.023	.221	.313	80.673	.017	.267***	.010	172.644***	.178***	.229***	<.001

MSE-RP	36	.073*	.033	.009	.137	88.414	.033	.053***	.011	270.841***	-.117***	-.013	<.001
MSE-Intention	53	.322***	.026	.272	.372	91.361	.030	.342***	.007	649.589***	.204***	.285***	<.001
MSE-AP	52	.392***	.026	.341	.443	93.068	.031	.452***	.007	804.879***	.428***	.434***	.048
MSE-CP	22	.414***	.033	.349	.479	87.073	.019	.460***	.011	168.462***	.463***	.458***	.898
RSE-OE	35	.249***	.023	.205	.294	78.079	.013	.251***	.010	159.659***	.174***	.222***	.004
RSE-RP	32	.052	.030	-.006	.110	84.013	.022	.025*	.011	194.598***	-.105***	-.007	<.001
RSE-Intention	42	.316***	.024	.268	.363	86.071	.020	.319***	.009	304.727***	.204***	.274***	<.001
RSE-AP	42	.352***	.029	.294	.409	91.649	.031	.394***	.008	451.906***	.325***	.365***	<.001
RSE-CP	17	.352***	.044	.266	.437	89.193	.026	.376***	.013	147.246***	.326***	.356***	.033
OE-RP	63	.150***	.028	.095	.206	93.218	.046	.175***	.007	1221.224***	.023	.111***	<.001
OE-Intention	73	.356***	.019	.320	.393	88.272	.021	.404***	.006	757.249***	.457***	.416***	.001
OE-AP	71	.268***	.013	.243	.293	68.331	.007	.284***	.007	261.736***	.319***	.292***	.069
OE-CP	27	.249***	.021	.208	.289	62.551	.007	.234***	.012	69.576***	.117***	.198***	<.001
RP-Intention	67	.128***	.023	.820	.173	90.101	.031	.171***	.007	1264.942***	.231***	.181***	.001
RP-AP	65	.056**	.021	.015	.098	86.717	.023	.071***	.007	723.656***	.081***	.064***	.609
RP-CP	21	.083*	.040	.006	.161	85.539	.025	.057***	.014	148.534***	-.058	.033	<.001
Intention-AP	104	.408***	.017	.374	.442	93.114	.027	.463***	.004	1640.774***	.443***	.454***	.031
Intention-CP	38	.347***	.026	.295	.398	85.914	.021	.322***	.009	287.621***	.303***	.340***	<.001
AP-CP	35	.594***	.029	.538	.650	94.177	.025	.653***	.007	569.757***	.557***	.630***	<.001

Note. r^{+}_{RE} = Corrected effect size estimate from conventional random effects meta-analysis model; r^{+}_{FE} = Corrected effect size estimate from conventional fixed effects meta-analysis model; SE = Standard error; CI_{95} = 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; I^2 = Higgins and Thompson's (2002) I^2 statistic for parameter estimate; τ^2 = Estimated variance in population; Q = Cochran's Q statistic from conventional analyses; r^{+}_{PET} = Effect size estimate corrected for bias using the precision-effect estimate technique; r^{+}_{PET} = Effect size estimate corrected for bias using the precision-effect estimate with standard errors technique; p_{BIAS} = Probability value for effect of precision estimate on effect size in regression analyses; PB = Past behavior; ASE = Action self-efficacy; MSE = Maintenance self-efficacy; RSE = Recovery self-efficacy; OE = Outcome expectancies; RP = Risk perceptions; AP = Action planning; CP = Coping planning.

* $p < .05$ ** $p < .01$ *** $p < .001$

Appendix H: Truncated model

Table H1

Standardized Parameter Estimates of Direct and Indirect Effects in Meta-Analytic Path Analyses of the Truncated Model of the Health Action Process Approach Including and Excluding Past Behavior

Effect	Model excluding past behavior			Model including past behavior			Model comparisons				
	β	LB CI_{95}		β	LB CI_{95}		$β_{diff}$[a]	CI_{95}		t[b]	p
		LL	UL		LL	UL		LL	UL		
Direct effects											
ASE→Intention	.350	.311	.388	.315	.273	.357	.035	-.022	.091	1.190	.234
OE→Intention	.281	.244	.319	.259	.219	.298	.023	-.032	.077	0.820	.412
ASE→VSE	.457	.425	.489	.409	.372	.446	.048	-.001	.097	1.926	.054
Intention→AP	.374	.342	.405	.340	.305	.375	.034	-.014	.081	1.388	.165
Intention→CP	.281	.235	.326	.236	.186	.286	.045	-.023	.112	1.290	.197
Intention→Behavior	.197	.151	.243	.120	.062	.175	.077	.004	.150	2.075	.038
VSE→AP	.298	.259	.336	.275	.234	.316	.022	-.034	.079	0.776	.438
VSE→CP	.312	.259	.365	.282	.226	.338	.030	-.047	.107	0.756	.450
AP→Behavior	.087	.018	.154	.070	-.002	.141	.017	-.081	.115	0.333	.739
CP→Behavior	.107	.035	.179	.061	-.020	.140	.046	-.061	.153	0.846	.397
VSE→Behavior	.172	.122	.221	.122	.066	.176	.050	-.024	.124	1.322	.186
PB→ASE	–	–	–	.259	.225	.293	–	–	–	–	–
PB→OE	–	–	–	.200	.162	.237	–	–	–	–	–
PB→Intention	–	–	–	.142	.091	.193	–	–	–	–	–
PB→VSE	–	–	–	.123	.077	.168	–	–	–	–	–
PB→AP	–	–	–	.112	.063	.159	–	–	–	–	–
PB→CP	–	–	–	.154	.089	.218	–	–	–	–	–
PB→Behavior	–	–	–	.366	.242	.490	–	–	–	–	–
Indirect effects											
Intention→AP→Behavior	.032	.007	.058	.024	-.001	.049	.009	-.027	.044	0.478	.633
Intention→CP→Behavior	.030	.010	.051	.014	-.005	.035	.016	-.012	.044	1.094	.274
VSE→AP→Behavior	.026	.005	.046	.019	-.001	.040	.007	-.022	.035	0.454	.650
VSE→CP→Behavior	.034	.011	.057	.017	-.006	.041	.016	-.016	.048	0.996	.319

ASE→VSE→Behavior	.079	.055	.102	.050	.027	.074	.029	-.004	.062	1.699	.089
ASE→Intention→Behavior	.069	.052	.087	.038	.019	.058	.031	.005	.057	2.321	.020
ASE→Intention→Planning→Behavior	.022	.015	.030	.012	.006	.019	.010	.000	.020	1.944	.052
ASE→VSE→Planning→Behavior	.027	.019	.036	.015	.007	.023	.012	.000	.024	2.031	.042
OE→Intention→Planning→Behavior	.018	.012	.024	.010	.005	.016	.008	.000	.016	1.859	.063
Sums of indirect effects											
Intention→Behavior[c]	.063	.043	.083	.038	.019	.059	.024	-.004	.052	1.694	.090
VSE→Behavior[d]	.059	.042	.079	.037	.018	.056	.023	-.004	.049	1.695	.090
ASE→Behavior[e]	.091	.074	.109	.050	.031	.070	.041	.015	.067	3.118	.002
ASE→Behavior[f]	.197	.178	.216	.115	.088	.142	.082	.048	.115	4.814	.000
PB→Behavior[g]	–	–	–	.075	.058	.092	–	–	–	–	–
Total effects											
VSE→Behavior[h]	.231	.189	.274	.159	.106	.209	.073	.006	.139	2.144	.032
Intention→Behavior[i]	.260	.221	.298	.159	.103	.211	.101	.035	.167	3.011	.003
PB→Behavior[j]	–	–	–	.441	.330	.551	–	–	–	–	–
Correlations											
AP↔CP	.317	.263	.371	.310	.256	.363	.008	-.068	.084	0.200	.842
VSE↔Intention	.061	.028	.095	.065	.030	.101	-.004	-.053	.045	-0.158	.874
ASE↔OE	.370	.341	.400	.308	.275	.341	.062	.018	.106	2.761	.006

Note. β = Standardized path coefficient; LB CI_{95} = Likelihood based 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; CI_{95} = Conventional 95% confidence interval; β_{diff} = Difference in standardized path coefficient; ASE = Action self-efficacy; OE = Outcome expectancies; VSE = Volitional self-efficacy; AP = Action planning; CP = Coping planning; PB = Past behavior. [a]Model comparisons using Schenker and Gentleman's (2001) 'standard method' based on confidence intervals about the mean difference derived from Wald standard errors; [b]Test of difference in coefficients across models using Welch's *t*-test based on Wald standard errors; [c]Sum of indirect effects of intention on behavior through action and coping planning; [d]Sum of indirect effects of VSE on behavior through all variables; [e]Sum of indirect effects of ASE on behavior through intention, AP, and CP; [f]Sum of indirect effects of ASE on behavior through intention, AP, CP, and VSE; [g]Sum of indirect effects of PB on behavior; [h]Total effect of VSE on behavior; [i]Total effect of intention on behavior; [j]Total effect of past behavior on behavior.

Appendix I: Results of Moderator Analyses

Table I1

Standardized Parameter Estimates of Direct and Indirect Effects in Meta-Analytic Path Analyses of the Health Action Approach for the Behavior Type Moderator (Physical Activity vs. Dietary Behaviors)

Effect	Moderator group: Physical activity			Moderator group: Dietary behaviors			Model comparisons				
	β	LB CI_{95}		β	LB CI_{95}		$β_{diff}$[a]	CI_{95}		t[b]	p
		LL	UL		LL	UL		LL	UL		
Direct effects											
ASE→Intention	.440	.378	.501	.282	.204	.359	.157	.058	.256	3.107	.002
OE→Intention	.222	.164	.278	.283	.218	.347	-.061	-.147	.025	-1.400	.162
ASE→VSE	.520	.472	.569	.434	.368	.500	.086	.004	.168	2.065	.039
Intention→AP	.361	.314	.408	.356	.292	.417	.006	-.072	.084	0.148	.882
Intention→CP	.259	.194	.323	.304	.192	.413	-.045	-.172	.083	-0.687	.492
Intention→Behavior	.178	.124	.231	.138	.054	.219	.040	-.058	.138	0.805	.421
VSE→AP	.320	.269	.370	.332	.246	.415	-.012	-.110	.086	-0.232	.817
VSE→CP	.351	.277	.424	.309	.190	.426	.042	-.097	.180	0.594	.553
AP→Behavior[c]	.053	-.034	.136	.071	-.078	.220	-.018	-.189	.154	-0.201	.841
CP→Behavior[c]	.146	.031	.261	.093	-.047	.233	.053	-.128	.234	0.575	.566
VSE→Behavior	.159	.096	.220	.310	.188	.433	-.151	-.288	-.014	-2.166	.030
Indirect effects											
Intention→AP→Behavior[c]	.019	-.013	.050	.025	-.028	.078	-.006	-.067	.055	-0.189	.850
Intention→CP→Behavior	.038	.008	.071	.028	-.017	.078	.010	-.044	.063	0.349	.727
VSE→AP→Behavior	.017	-.011	.044	.024	-.011	.072	-.006	-.062	.049	-0.228	.820
VSE→CP→Behavior	.051	.011	.096	.029	-.020	.073	.023	-.036	.081	0.758	.449
ASE→VSE→Behavior	.083	.049	.116	.135	.080	.194	-.052	-.118	.014	-1.546	.122
ASE→Intention→Behavior	.078	.053	.106	.039	.015	.067	.039	.002	.076	2.083	.037
ASE→Intention→Planning→Behavior	.025	.013	.039	.015	.004	.029	.010	-.007	.028	1.122	.262
ASE→VSE→Planning→Behavior	.036	.019	.055	.023	.007	.040	.013	-.010	.036	1.083	.279
OE→Intention→Planning→Behavior	.013	.007	.020	.015	.004	.028	-.002	-.016	.011	-0.359	.720
Sums of indirect effects											

Intention→Behavior[d]	.057	.031	.086	.054	.014	.095	.004	-.044	.051	0.149	.881
VSE→Behavior[e]	.068	.038	.104	.052	.015	.089	.016	-.031	.063	0.665	.506
ASE→Behavior[f]	.103	.079	.130	.054	.031	.082	.049	.013	.086	2.673	.008
ASE→Behavior[g]	.222	.197	.247	.211	.167	.259	.010	-.042	.063	0.391	.696
Total effects											
VSE→Behavior[h]	.227	.179	.275	.362	.260	.465	-.135	-.248	-.022	-2.339	.019
Intention→Behavior[i]	.235	.190	.279	.191	.118	.259	.044	-.039	.127	1.037	.300
Correlations											
AP↔CP	.271	.201	.340	.368	.244	.492	-.098	-.239	.044	-1.348	.178
VSE↔Intention	.006	-.046	.057	.062	-.024	.149	-.056	-.157	.044	-1.093	.274
ASE↔OE	.341	.299	.383	.277	.209	.345	.064	-.016	.144	1.564	.118

Note. β = Standardized path coefficient; LB CI_{95} = Likelihood based 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; CI_{95} = Conventional 95% confidence interval; β_{diff} = Difference in standardized path coefficient; ASE = Action self-efficacy; OE = Outcome expectancies; VSE = Volitional self-efficacy; AP = Action planning; CP = Coping planning. [a]Model comparisons using Schenker and Gentleman's (2001) 'standard method' based on confidence intervals about the mean difference derived from Wald standard errors; [b]Test of difference in coefficients across models using Welch's *t*-test based on Wald standard errors; [c]Likelihood based confidence intervals for these effects for the dietary behaviors moderator group could not be computed, so Wald confidence intervals are reported; [d]Sum of indirect effects of intention on behavior through all variables; [e]Sum of indirect effects of VSE on behavior through all variables; [f]Sum of indirect effects of ASE on behavior through intention, AP, and CP; [g]Sum of indirect effects of ASE on behavior through intention, AP, CP, and VSE; [h]Total effect of VSE on behavior; [i]Total effect of intention on behavior.

Table I2

Standardized Parameter Estimates of Direct and Indirect Effects in Meta-Analytic Path Analyses of the Health Action Approach for the Measurement Lag Moderator (Proximal vs. Distal)

Effect	Moderator group: Proximal			Moderator group: Distal			Model comparisons				
	β	LB CI_{95}		β	LB CI_{95}		β_{diff}[a]	CI_{95}		t[b]	p
		LL	UL		LL	UL		LL	UL		
Direct effects											
ASE→Intention	.281	.172	.388	.390	.345	.435	-.109	-.225	.008	-1.821	.069
OE→Intention	.313	.206	.420	.261	.216	.306	.052	-.063	.167	0.882	.378
ASE→VSE	.481	.433	.529	.439	.400	.477	.042	-.019	.103	1.345	.179
Intention→AP	.343	.249	.436	.352	.315	.387	-.008	-.109	.092	-0.166	.868
Intention→CP	.352	.220	.484	.240	.192	.288	.112	-.029	.252	1.559	.119
Intention→Behavior	.205	.118	.290	.199	.148	.250	.006	-.093	.106	0.119	.905
VSE→AP	.270	.155	.383	.321	.276	.366	-.052	-.174	.071	-0.825	.410
VSE→CP	.245	.117	.370	.318	.249	.386	-.073	-.217	.071	-0.996	.319
AP→Behavior	.149	.023	.270	.080	.004	.152	.070	-.072	.212	0.965	.335
CP→Behavior	.048	-.036	.152	.120	.042	.198	-.072	-.203	.060	-1.068	.286
VSE→Behavior	.222	.120	.322	.149	.093	.204	.073	-.042	.188	1.246	.213
Indirect effects											
Intention→AP→Behavior	.051	.008	.099	.028	.001	.054	.023	-.027	.074	0.901	.367
Intention→CP→Behavior	.017	-.026	.056	.029	.010	.050	-.012	-.054	.030	-0.556	.578
VSE→AP→Behavior	.040	.007	.080	.026	.001	.049	.015	-.027	.056	0.699	.485
VSE→CP→Behavior	.012	-.005	.041	.038	.013	.065	-.026	-.062	.010	-1.430	.153
ASE→VSE→Behavior	.107	.057	.157	.065	.040	.091	.041	-.014	.097	1.455	.146
ASE→Intention→Behavior	.058	.029	.096	.078	.057	.101	-.020	-.060	.020	-0.977	.329
ASE→Intention→Planning→Behavior	.019	.009	.034	.022	.014	.032	-.003	-.018	.012	-0.386	.700
ASE→VSE→Planning→Behavior	.025	.013	.041	.028	.018	.039	-.003	-.020	.014	-0.337	.736
OE→Intention→Planning→Behavior	.021	.011	.036	.015	.009	.022	.007	-.008	.021	0.909	.363
Sums of indirect effects											
Intention→Behavior[c]	.068	.037	.104	.057	.036	.079	.011	-.028	.051	0.575	.565

VSE→Behavior[d]	.052	.028	.083	.064	.042	.088	-.012	-.047	.023	-0.649	.516
ASE→Behavior[e]	.077	.043	.118	.100	.080	.122	-.023	-.066	.020	-1.043	.297
ASE→Behavior[f]	.209	.163	.254	.193	.172	.215	.016	-.035	.066	0.609	.543
Total effects											
VSE→Behavior[g]	.274	.181	.366	.213	.167	.259	.061	-.042	.165	1.165	.244
Intention→Behavior[h]	.274	.198	.349	.256	.213	.299	.018	-.069	.104	0.397	.692
Correlations											
AP↔CP	.368	.272	.464	.294	.229	.358	.075	-.041	.190	1.263	.207
VSE↔Intention	.129	.061	.196	.045	.004	.087	.084	.005	.162	2.076	.038
ASE↔OE	.492	.438	.546	.364	.329	.400	.128	.063	.192	3.890	.000

Note. β = Standardized path coefficient; LB CI_{95} = Likelihood based 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; CI_{95} = Conventional 95% confidence interval; β_{diff} = Difference in standardized path coefficient; ASE = Action self-efficacy; OE = Outcome expectancies; VSE = Volitional self-efficacy; AP = Action planning; CP = Coping planning; PB = Past behavior. [a]Model comparisons using Schenker and Gentleman's (2001) 'standard method' based on confidence intervals about the mean difference derived from Wald standard errors; [b]Test of difference in coefficients across models using Welch's *t*-test based on Wald standard errors; [c]Sum of indirect effects of intention on behavior through all variables; [d]Sum of indirect effects of VSE on behavior through all variables; [e]Sum of indirect effects of ASE on behavior through intention, AP, and CP; [f]Sum of indirect effects of ASE on behavior through intention, AP, CP, and VSE; [g]Total effect of VSE on behavior; [h]Total effect of intention on behavior.

Table I3

Standardized Parameter Estimates of Direct and Indirect Effects in Meta-Analytic Path Analyses of the Health Action Approach for the Sample Type Moderator (Student vs. Non-student)

Effect	Moderator group: Student			Moderator group: Non-student			Model comparisons				
	β	LB CI_{95}		β	LB CI_{95}		β_{diff}[a]	CI_{95}		t[b]	p
		LL	UL		LL	UL		LL	UL		
Direct effects											
ASE→Intention	.253	.188	.317	.382	.337	.428	-.129	-.208	-.050	-3.208	.001
OE→Intention	.369	.305	.433	.251	.207	.294	.118	.041	.195	3.004	.003
ASE→VSE	.414	.358	.470	.472	.435	.510	-.058	-.125	.009	-1.704	.088
Intention→AP	.375	.310	.440	.378	.342	.414	-.003	-.077	.072	-0.068	.946
Intention→CP	.320	.230	.408	.273	.221	.325	.046	-.057	.149	0.878	.380
Intention→Behavior	.216	.149	.283	.190	.132	.247	.027	-.061	.115	0.601	.548
VSE→AP	.279	.187	.369	.302	.259	.344	-.023	-.123	.077	-0.450	.653
VSE→CP	.218	.124	.311	.331	.272	.389	-.113	-.223	-.003	-2.007	.045
AP→Behavior[c]	.068	-.054	.190	.089	.007	.169	-.021	-.167	.125	-0.280	.780
CP→Behavior[c]	.155	.048	.263	.093	.005	.179	.062	-.075	.200	0.888	.375
VSE→Behavior	.192	.126	.257	.169	.106	.231	.023	-.067	.113	0.499	.618
Indirect effects											
Intention→AP→Behavior	.026	-.026	.071	.034	.003	.064	-.008	-.063	.047	-0.287	.774
Intention→CP→Behavior	.050	.015	.080	.025	.001	.050	.024	-.019	.068	1.097	.273
VSE→AP→Behavior	.019	-.020	.053	.027	.002	.051	-.008	-.049	.033	-0.372	.710
VSE→CP→Behavior	.034	.010	.065	.031	.002	.060	.003	-.036	.042	0.159	.874
ASE→VSE→Behavior	.079	.052	.109	.080	.050	.111	.000	-.042	.041	-0.015	.988
ASE→Intention→Behavior	.055	.035	.078	.072	.049	.097	-.018	-.050	.015	-1.071	.284
ASE→Intention→Planning→Behavior	.019	.010	.030	.023	.013	.033	-.003	-.018	.011	-0.486	.627
ASE→VSE→Planning→Behavior	.022	.010	.035	.027	.016	.039	-.005	-.022	.011	-0.637	.524
OE→Intention→Planning→Behavior	.028	.015	.042	.015	.009	.022	.013	-.002	.028	1.691	.091
Sums of indirect effects											
Intention→Behavior[d]	.075	.040	.111	.059	.035	.084	.016	-.026	.058	0.758	.448

VSE→Behavior[e]	.053	.041	.082	.057	.035	.082	-.005	-.040	.031	-0.258	.796
ASE→Behavior[f]	.074	.052	.098	.095	.074	.118	-.021	-.053	.011	-1.290	.197
ASE→Behavior[g]	.175	.148	.203	.202	.178	.226	-.027	-.063	.010	-1.432	.152
Total effects											
VSE→Behavior[h]	.245	.187	.302	.226	.173	.279	.018	-.060	.096	0.460	.645
Intention→Behavior[i]	.292	.239	.344	.248	.200	.296	.043	-.028	.114	1.188	.235
Correlations											
AP↔CP	.361	.236	.485	.304	.245	.362	.057	-.080	.194	0.813	.416
VSE↔Intention	.116	.061	.172	.039	-.001	.079	.078	.009	.146	2.229	.026
ASE↔OE	.408	.356	.459	.361	.326	.395	.047	-.015	.109	1.483	.138

Note. β = Standardized path coefficient; LB CI_{95} = Likelihood based 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; CI_{95} = Conventional 95% confidence interval; β_{diff} = Difference in standardized path coefficient; ASE = Action self-efficacy; OE = Outcome expectancies; VSE = Volitional self-efficacy; AP = Action planning; CP = Coping planning. [a]Model comparisons using Schenker and Gentleman's (2001) 'standard method' based on confidence intervals about the mean difference derived from Wald standard errors; [b]Test of difference in coefficients across models using Welch's *t*-test based on Wald standard errors; [c]Likelihood based confidence intervals for these effects for the student moderator group could not be computed, so Wald confidence intervals are reported; [d]Sum of indirect effects of intention on behavior through all variables; [e]Sum of indirect effects of VSE on behavior through all variables; [f]Sum of indirect effects of ASE on behavior through intention, AP, and CP; [g]Sum of indirect effects of ASE on behavior through intention, AP, CP, and VSE; [h]Total effect of VSE on behavior; [i]Total effect of intention on behavior.

Table I4

Standardized Parameter Estimates of Direct and Indirect Effects in Meta-Analytic Path Analyses of the Health Action Approach for the Sample Type Moderator (Clinical vs. Non-clinical)

Effect	Moderator group: Clinical			Moderator group: Non-clinical			Model comparisons				
	β	LB CI_{95}		β	LB CI_{95}		$β_{diff}$[a]	CI_{95}		*t*[b]	*p*
		LL	UL		LL	UL		LL	UL		
Direct effects											
ASE→Intention	.425	.365	.484	.317	.268	.366	.108	.031	.184	2.747	.006
OE→Intention	.253	.201	.304	.295	.242	.347	-.041	-.115	.032	-1.102	.271
ASE→VSE	.409	.369	.450	.505	.461	.549	-.095	-.155	-.035	-3.118	.002
Intention→AP	.396	.352	.439	.354	.311	.397	.041	-.020	.103	1.316	.188
Intention→CP	.361	.292	.429	.241	.183	.298	.120	.031	.210	2.631	.009
Intention→Behavior	.128	.064	.189	.214	.155	.273	-.086	-.172	-.001	-1.974	.048
VSE→AP	.273	.225	.320	.312	.256	.366	-.039	-.112	.034	-1.042	.298
VSE→CP	.315	.229	.399	.311	.245	.377	.004	-.104	.111	0.069	.945
AP→Behavior[c]	.059	-.052	.158	.092	.004	.177	-.033	-.167	.100	-0.492	.623
CP→Behavior[c]	.173	.011	.336	.094	.014	.173	.079	-.100	.257	0.861	.389
VSE→Behavior	.163	.089	.234	.178	.112	.243	-.015	-.112	.082	-0.297	.766
Indirect effects											
Intention→AP→Behavior	-.021	.023	.063	.001	.033	.063	-.009	-.060	.041	-0.366	.715
Intention→CP→Behavior	.004	.062	.127	.003	.023	.044	.040	-.023	.102	1.244	.213
VSE→AP→Behavior	-.015	.016	.044	.001	.029	.056	-.013	-.051	.026	-0.646	.518
VSE→CP→Behavior	.004	.054	.112	.004	.029	.055	.025	-.032	.082	0.857	.392
ASE→VSE→Behavior	.036	.067	.097	.056	.090	.124	-.023	-.068	.023	-0.990	.322
ASE→Intention→Behavior	.027	.054	.083	.048	.068	.091	-.014	-.049	.022	-0.757	.449
ASE→Intention→Planning→Behavior	.020	.036	.057	.010	.018	.026	.019	-.001	.039	1.866	.062
ASE→VSE→Planning→Behavior	.015	.029	.047	.018	.029	.042	.000	-.020	.019	-0.046	.964
OE→Intention→Planning→Behavior	.012	.022	.034	.009	.016	.025	.005	-.008	.019	0.786	.432
Sums of indirect effects											
Intention→Behavior[d]	.048	.086	.130	.031	.055	.080	.030	-.016	.077	1.274	.203

VSE→Behavior[e]	.036	.070	.113	.036	.058	.082	.012	-.031	.056	0.562	.574
ASE→Behavior[f]	.068	.091	.116	.065	.086	.108	.005	-.027	.037	0.322	.748
ASE→Behavior[g]	.161	.186	.212	.178	.205	.231	-.018	-.055	.019	-0.971	.332
Total effects											
VSE→Behavior[h]	.177	.233	.290	.179	.236	.292	-.002	-.082	.077	-0.058	.954
Intention→Behavior[i]	.169	.214	.257	.218	.270	.320	-.056	-.123	.011	-1.631	.103
Correlations											
AP↔CP	.308	.219	.397	.322	.256	.387	-.013	-.124	.097	-0.236	.813
VSE↔Intention	.014	-.034	.062	.079	.035	.123	-.065	-.130	.000	-1.973	.049
ASE↔OE	.357	.311	.402	.388	.352	.425	-.031	-.089	.027	-1.049	.294

Note. β = Standardized path coefficient; LB CI_{95} = Likelihood based 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; CI_{95} = Conventional 95% confidence interval; β_{diff} = Difference in standardized path coefficient; ASE = Action self-efficacy; OE = Outcome expectancies; VSE = Volitional self-efficacy; AP = Action planning; CP = Coping planning. [a]Model comparisons using Schenker and Gentleman's (2001) 'standard method' based on confidence intervals about the mean difference derived from Wald standard errors; [b]Test of difference in coefficients across models using Welch's *t*-test based on Wald standard errors; [c]Likelihood based confidence intervals for these effects for the student moderator group could not be computed, so Wald confidence intervals are reported; [d]Sum of indirect effects of intention on behavior through all variables; [e]Sum of indirect effects of VSE on behavior through all variables; [f]Sum of indirect effects of ASE on behavior through intention, AP, and CP; [g]Sum of indirect effects of ASE on behavior through intention, AP, CP, and VSE; [h]Total effect of VSE on behavior; [i]Total effect of intention on behavior.

Table I5

Standardized Parameter Estimates of Direct and Indirect Effects in Meta-Analytic Path Analyses of the Health Action Approach for the Study Quality Moderator (Acceptable vs. Questionable)

Effect	Moderator group: Acceptable			Moderator group: Questionable			Model comparisons				
	β	LB CI_{95}		β	LB CI_{95}		$β_{diff}$[a]	CI_{95}		t[b]	p
		LL	UL		LL	UL		LL	UL		
Direct effects											
ASE→Intention	.377	.333	.420	.277	.203	.350	.099	.014	.184	2.293	.022
OE→Intention	.275	.232	.316	.319	.244	.392	-.044	-.129	.041	-1.017	.309
ASE→VSE	.438	.402	.473	.500	.438	.561	-.062	-.133	.009	-1.715	.086
Intention→AP	.368	.332	.403	.387	.325	.450	-.020	-.092	.052	-0.543	.587
Intention→CP	.315	.269	.360	.179	.081	.276	.135	.028	.242	2.472	.013
Intention→Behavior	.178	.127	.229	.257	.155	.361	-.079	-.193	.035	-1.353	.176
VSE→AP	.303	.258	.347	.287	.211	.361	.016	-.071	.103	0.351	.726
VSE→CP	.269	.212	.325	.412	.308	.515	-.143	-.261	-.025	-2.379	.017
AP→Behavior[c]	.101	.027	.173	.025	-.136	.185	.076	-.100	.253	0.849	.396
CP→Behavior[c]	.108	.027	.189	.141	.008	.273	-.032	-.187	.122	-0.410	.682
VSE→Behavior	.158	.102	.214	.197	.097	.294	-.039	-.152	.073	-0.683	.494
Indirect effects											
Intention→AP→Behavior	.037	.010	.064	.010	-.044	.071	.028	-.040	.095	0.799	.424
Intention→CP→Behavior	.034	.009	.061	.025	.001	.056	.009	-.027	.045	0.478	.633
VSE→AP→Behavior	.031	.008	.053	.007	-.044	.053	.024	-.028	.075	0.904	.366
VSE→CP→Behavior[c]	.029	.007	.052	.058	.003	.113	-.029	-.088	.031	-0.952	.341
ASE→VSE→Behavior	.069	.044	.095	.099	.049	.148	-.029	-.085	.026	-1.041	.298
ASE→Intention→Behavior	.067	.047	.089	.071	.041	.108	-.004	-.044	.035	-0.206	.837
ASE→Intention→Planning→Behavior	.027	.018	.037	.010	-.006	.025	.017	.000	.034	1.993	.046
ASE→VSE→Planning→Behavior	.026	.018	.036	.032	.013	.056	-.006	-.029	.016	-0.560	.575
OE→Intention→Planning→Behavior	.020	.013	.027	.011	-.007	.027	.008	-.009	.026	0.952	.341
Sums of indirect effects											
Intention→Behavior[d]	.071	.049	.095	.035	NA	.083	.036	-.018	.091	1.309	.191

VSE→Behavior[e]	.060	.041	.080	.065	.027	.109	-.005	-.049	.039	-0.236	.813
ASE→Behavior[f]	.094	.075	.115	.081	.052	.114	.013	-.024	.050	0.694	.488
ASE→Behavior[g]	.189	.168	.211	.212	.174	.250	-.023	-.066	.021	-1.027	.304
Total effects											
VSE→Behavior[h]	.218	.169	.266	.262	.183	.341	-.045	-.137	.048	-0.942	.346
Intention→Behavior[i]	.249	.207	.291	.292	.210	.372	-.042	-.134	.049	-0.909	.364
Correlations											
AP↔CP	.312	.252	.372	.346	.235	.458	-.035	-.161	.092	-0.534	.593
VSE↔Intention	.065	.028	.102	.066	-.002	.133	-.001	-.078	.076	-0.020	.984
ASE↔OE	.373	.338	.408	.375	.323	.428	-.002	-.065	.061	-0.063	.950

Note. β = Standardized path coefficient; LB CI_{95} = Likelihood based 95% confidence interval; LL = Lower limit of CI_{95}; UL = Upper limit of CI_{95}; CI_{95} = Conventional 95% confidence interval; β_{diff} = Difference in standardized path coefficient; ASE = Action self-efficacy; OE = Outcome expectancies; VSE = Volitional self-efficacy; AP = Action planning; CP = Coping planning. [a]Model comparisons using Schenker and Gentleman's (2001) 'standard method' based on confidence intervals about the mean difference derived from Wald standard errors; [b]Test of difference in coefficients across models using Welch's *t*-test based on Wald standard errors; [c]Likelihood based confidence intervals for these effects for the questionable quality moderator group could not be computed, so Wald confidence intervals are reported; [d]Sum of indirect effects of intention on behavior through all variables; [e]Sum of indirect effects of VSE on behavior through all variables; [f]Sum of indirect effects of ASE on behavior through intention, AP, and CP; [g]Sum of indirect effects of ASE on behavior through intention, AP, CP, and VSE; [h]Total effect of VSE on behavior; [i]Total effect of intention on behavior.