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Article in *International Journal of Dental Hygiene* · January 2019

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The role of psychological theories in oral health interventions: A systematic review and meta-analysis

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This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/idh.12386

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Abstract

Objective: In the present study, we attempted to assess how psychological theories (Health Belief Model (HBM), Theory of Planned Behavior (TPB), Social Cognitive Theory (SCT), Clinical Theories (CT) and Other Theories (OT)) influence oral health interventions.

Methods: Pubmed, Scopus, Cochrane, and Web of Knowledge databases from the years 2000 to 2017, were searched. We defined psychological theories based on five subgroups: A) HBM, B) TPB, C) SCT, E) CT and F) OT.

Results: From 156 identified studies, 19 studies based on PICO were included. Our finding indicated that the Standardized Mean Difference (SMD) of the HBM was 0.37 (95% CI; 0.24, 0.51), which was statistically significant in improving oral health. The SMD of SCT was not significant 0.05 (95% CI; -0.33, 0.44) on improving oral health. The SMD of the TPB was significant 1.66 (95% CI; 1.06, 2.27) on improving oral health. The SMD of CT size -4.6 (95% CI; -6.49, -2.71) and OT 2.93 (95% CI; 1.55, 4.32) revealed significant differences on improving oral health.

Conclusion: The current meta-analysis showed that in general, psychological interventions that used OT, CT, HBM, and TPB were effective in enhancing oral health status, and interventions that used SCT did not have an effect on improving oral health status. Oral health care providers who work with patients to take methods and improve behaviors that are related to appropriate oral health need to comprehend their applicability and strengths.

Keywords: Psychological theories; Oral Health; Interventions; Meta-Analysis

Introduction

According to the World Health Organization's definition, oral health is "being free from oral diseases, pain, sores, tooth decay or loss, and other defects in the mouth"¹. Furthermore, oral health is an essential component of general health and quality of life^{2, 3}. Oral health is considered as a multi-faceted phenomenon, including the ability to speak, smile, smell, taste, touch, chew, and swallow, as well as the ability to express a range of emotions through facial expressions with confidence and without pain, discomfort, and disease of the craniofacial complex. Moreover, oral health is influenced by the values and attitudes of individuals and communities and reflects the physiological, social and psychological attributes that are essential to the quality of life. Additionally, oral health is influenced by the individual's changing experiences, perceptions, expectations, and ability to adapt to circumstances¹. One of the most critical issues of public health around the world is oral disorders such as dental caries, periodontal diseases, and tooth loss. Oral diseases are associated with co-morbidities like cardiovascular disease, Alzheimer's disease, respiratory infection, and diabetes⁴⁻⁶. About 20-25% of the world population directly suffer from one of these oral health diseases, and 4-10 % of health expenditures worldwide are dedicated to oral health treatments⁷. These critical public health issues (oral health) have far-reaching repercussions on public health and quality of life of people^{3, 8 9}. The first step for expanding intervention is to analyze the health problems by recognizing the determinants associated with the problem and behaviors related to health¹⁰. The hypothesis was that by altering the determinants of behavior, health behavior might change (the causal working of behavior), therefore this may promote the health effects¹¹. Among these determinants, the most significant modifiable determinant of behavior is psychosocial factors¹². Therefore, theory-based interventions were recognized to be reliable approaches in promoting health education¹³⁻¹⁵. Theories of health behavior were claimed to be the adequate approaches in adjusting patient's behavior and improving their

collaboration, as well as shaping a framework for practice, monitor and assess the model^{1, 15-}
¹⁸. Since then other theories had applied for both acute and chronic health conditions. Health Belief Model, Locus of Control, Self-Efficacy, Stages of Change, and the theory of Reasoned Action are the most common theories in oral health. ¹⁹. Nonetheless, an evidence-based theory is yet lacking to promote oral health. The available evidence seems to suggest that psychological theories of behavior regulation may lead to improved oral health and its relevant behaviors. Previous systemic reviews, support psychological interventions in the improvement of oral health behavior(s)²⁰. Another systematic review also indicated that psychological interventions did not significantly affect the development of gingivitis and plaque²¹. Studies done had a low quality in presenting results and even only the effect of psychological interventions on improving the behavior and clinical indexes of the mouth and teeth, such as (gum inflammation and tooth decay), had been addressed. In the present study, we attempted to explain the psychological theories by their type (HBM, TPB, SCT, CT, and OT) which were used in oral health interventions. Additionally, oral health care providers who work with patients to take methods and improve behaviors that are related to appropriate oral health need to comprehend their applicability and strengths. Also, we covered the proposals of previous studies by analyzing psychological interventions based on different age groups (children, school children, adolescents, and adults). Therefore, in the present study, we attempted to assess how psychological theories (HBM, TPB, SCT, CT, and OT) influence oral health interventions. The research question states:

- 1) what are the association between psychological theories in oral health interventions?
- 2) Which of the psychological theories are more effective in oral hygiene interventions?
- 3) Psychological theories are more effective in which age groups and how many months after the follow-up?

Materials and Methods:

This study is performed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA) guidelines as described previously^{2, 8, 22}. Registered in PROSPERO (CRD42018084308). The corresponding author did the systematic review for this article.

Search strategy

The systematic review and meta-analysis were conducted with the purpose of evaluating the effectiveness of psychological interventions based on health education and promotion theories. Pubmed, Scopus, Cochrane and Web of Knowledge databases from the years 2000 to 2017, were searched for the MESH and non-MESH term keywords based on the "And," "OR" operators. Table 1 represents the search strategy.

Inclusion criteria based on PICO:

Since there was not any general framework that supports all the required elements and characterizes research gaps we used PICO (population, intervention, comparison, outcomes) that is the most common method. And also the categorization of the causes to clarify how to remove the gap is essential. Accordingly, we used a framework that contains both the characterization of the gap using PICOS elements (also including setting) and addressing of the cause(s) of the gap existence²³

Population: all of the population groups including children, school children, student, and adults were considered.

Intervention: psychological interventions were conducted based on theories that led to improving oral health.

Comparator: participants who did not receive any theories based on psychological interventions.

Outcomes: Psychological theories which improve long-term and short-term outcomes such as knowledge, attitude, behavior, tooth decay, plaque, and bleeding gums.

Studies: Randomized control trial studies, cluster randomized controlled trial, pre-tests and post-tests, quasi-experimental studies.

Exclusion criteria

The studies which were conducted assystematic reviews and meta-analysis and the qualitative and secondary studies and also non-English studies and those which their full texts were not available to authors were excluded from the review.

Selection studies

All the mentioned databases were reviewed based on the title, abstract and full text, independently by the two authors (B.A. and M.S). The same two researchers reviewed and assessed papers independently by applying a standardized data collection form. Any conflict of ideas among reviewers was sorted out through a discussion with other authors Y.M, and J.H Microsoft Excel software was used to extract the data. Researchers extracted the data independently concerning elements of each paper, such as the surname of the first author, year of publication, and other characteristics like the participant, study design, sample size,

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follow up the month. The selection method is shown in Figure 1. Qualitative assessment of the studies was performed by the Habbu's checklist which includes 19 items²⁴. The maximum score gained was 19. The goals of each study, the nature of the interventions, the characteristics and number of participants and the outcomes of each intervention was documented by a qualitative review. Studies that achieved a validity score of 10, were included in our study. We concerned health education in our systematic review, so we considered all studies as variables due to the outcome measures, the control groups were not essential to apply, randomization was not optimal, and hence the scores lower than 10 was considered for inclusion of studies. The scores for each study were calculated, and those with lower than the minimum score of 10 were excluded from this review (the maximum score was 19). Table 2 and 3 represents the attributes used for the qualitative assessments.

Outcome measure

To develop 'theory-based' instead of 'theory-inspired' interventions, and to recognize the theoretical fundamentals for effective interventions, having the knowledge of the relationship between the approaches of behavioral change and mechanisms of action is required. Primary researches to identify this has been implemented in both primary research and evidence syntheses²⁵. Theory-based or behavior change methods are specified as general techniques or processes that have been proved to have effects to alter some behavior determinants of at-risk group members or environmental decision-makers^{26, 27}. 'Theory based' means that the method has the principle of behavioral and social science theories²⁷ and occasionally several theories supply the evidence for a method. The manner of the mechanism of operation and also the explanation and investigation of the causal link between the application of the method and behavior change is determined by the theory. We defined psychological theories based on five subgroups: A) HBM, B) TPB, C) SCT, E) CT and F) OT.

Statistical analysis

Firstly, the dissimilarity index between studies was determined by the heterogeneity test (Q-Cochran). Since the heterogeneity of subgroups was higher than 50%, the Random Effect Model was used for the computation of the SMD. SMD which is an important effect size was applied in the meta-analysis. In the present study, the conditions under which SMD effect sizes based on different measures of the same construct were directly comparable were studied. Secondly, 19 studies were selected for the systematic review and meta-analysis. Thirdly, for presenting the pooled effect, a forest plot was applied. Also to review the publication bias, the funnel plot was used. Finally, categorized forest plot and in each of them the participant and follow-up subgroups. A) HBM, B) TPB, C) SCT, E) CT, F) OT, G) age of participant subgroups and H) the follow-up periods after the intervention. Meta-analysis of the data was done using STATA V.12 software.

Results:

According to the search strategy, a total of 9786 articles published between 2000 to 2017 were identified. The number of 5342 studies were from PubMed, 1300 Scopus, 1478 Web of Knowledge and 1666 Cochrane. Following the removal of 4,265 duplicate records, a further 5,373 of the remaining 5,529 studies were removed for the following reasons:

- The studies did not include a psychological theory
- Qualitative studies, secondary analysis, review articles
- Studies that were only an abstract
- Studies that did not report Mean and SD for case and control

156 studies were reviewed in full text for the eligibility check, and finally, 19 articles were entered into the Meta-Analysis²⁸⁻⁴⁶ (Table4). Our finding indicated that the SMD of HBM was 0.37 (95% CI; 0.24, 0.51) (Figure 2). The SMD of SCT showed no significant 0.05 (95% CI; -0.33, 0.44) (Figure3). The SMD of TPB was significant 1.66 (95% CI; 1.06, 2.27) (Figure4). The SMD of CT -4.60 (95% CI; -6.49, -2.71) (Figure5) and OT 2.93(95% CI; 1.55, 4.32) (Figure6) revealed significant differences. The subgroup analysis conducted for each theory.

Our findings showed that the SMD of HBM in subgroups of participants, including children, students and adults were 0.49 (95% CI; 0.17,0.81), 0.53 (95% CI; 0.21,0.85), and 0.19 (95% CI; 0.14,0.24) respectively and statistically significant. (figureS1)

HBM in subgroups of follow-up, including 1 month, 1-3 month and >6 month also had significant SMD which were 0.55 (95% CI; 0.29, 0.82), 0.41 (95% CI; 0.11, 0.71), 0.19 (95% CI; 0.14, 0.24) respectively (figureS2).

The SMD of SCT in subgroups of participants, including children, students and adults were 1.96 (95% CI; 1.72, 2.21), 0.1 (95% CI; -0.12,0.32), -0.15 (95% CI; -0.57,0.27) (figureS3) which were only significant in the children subgroup. The SMD of SCT in the follow-up, subgroups were 1 month 1.88 (95% CI; 1.13, 2.63), 1-3 months 0.31 (95% CI; -0.10, 0.71) 3-6 months -0.4 (95% CI; -1.56,0.76) and >6 months -1.55 (95% CI; -1.95, -1.15) (figureS4).

This theory had the most impact on one month subgroup and also the negative effect on >6months subgroup and was not significant in that subgroup.

Another finding showed that the TPB in the participant subgroups that the SMD were 3.28 (95% CI; 2.17, 4.4), 0.21 (95% CI; -0.24, 0.65) and 1.16 (95% CI; 0.85, 1.46) (figureS5). This theory was only significant in children subgroup.

The SMD for TPB in follow-up subgroups were 1 month 0.97 (95% CI; 0.5, 1.43), 1-3 months 0.00 (95% CI; -0.16, 0.16), 3-6 months 0.7 (95% CI; 0.31, 1.08) and > 6 months 3.28 (2.17, 4.4) (figureS6)

Besides, results of the present study suggested that the clinical theory in participant subgroups, including the adults had the significant the SMD -4.6 (95% CI; -6.49, -2.71) (figureS7). In the follow-up subgroups, this theory had significant SMD in subgroups of 1 month and 1-3 months -1.83 (95% CI; -2.45, -1.22) and -6.70 (95% CI; -9.19, -4.21) (figureS8).

We observed that the SMD for OT in participant subgroups, including school children and adults were 0.53 (95% CI; 0.35, 0.70) and 4.22 (95% CI; 2.11, 6.33). The other theories had the most impact on adults that were statistically significant (figureS9).

In follow-up subgroups of 1-3 months, the SMD of OT was 4.22 (95% CI; 2.11, 6.33). (figureS10).

There was no publication bias based on the Funnel plot. (figureS11). Since based on funnel plot the distribution of most of the articles is not oriented and for most of them is uniform, there was no publication bias in our study. As shown in figure18, lowest and the highest the effect size in the adult groups was observed in the United States (> 6 month: 0.18) and Australia (1-3 month:5.19); Children groups in the United Kingdom (1 month: 0.4) and Belgium (> 6 month: 3.28); respectively. In the school children groups, lowest and the highest mean difference was observed in the one month and 1-3 month in the United Kingdom; and finally, in the student groups in India (1-3 month: 0.06) and United States (1 month: 0.53), respectively (Figure S12).

Discussion:

The present systematic and meta-analytic review of 19 unique articles aim to identify the effectiveness of psychological theories in oral health interventions. The finding of this study showed that psychological theories based on HBM are effective in improving oral health behaviors. The results of other studies are consistent with our findings. For example in Solhi's study on the application of the HBM in oral health education, after education based on HBM, all the oral health perceptions increased ($P < .05$)⁴⁷. In another study, on the effect of a school-based oral health education program on Iranian children, the results showed the secondary outcomes were changes in oral hygiene and community periodontal indices and in HBM components. The comprehensive group reported higher scores for all HBM constructs after intervention at the first follow up⁴⁸. Similarly, in Tippanart's study on the evaluation of a multi-level oral health intervention, theoretical constructs from the self-efficacy, HBM and some other theories were used to guide intervention development and measurement⁴⁹. Similarly, a systematic review also showed the HBM is effective in improving adherence to

oral hygiene instructions amongst adults with periodontal disease⁵⁰. According to our findings, the HBM predicts that individuals will be more likely to adhere to oral health recommendations. One of the reasons may be that if they feel susceptible to oral diseases, think oral diseases are severe diseases, perceive barriers to oral health behavior as lower than perceived benefits, and have higher self-efficacy for action⁵¹. The effect of this theory after six months follow up the lowest difference was observed between the case and control groups. One of the reasons may be the individuality of HBM theory and beliefs may change over time. These findings of the current study are consistent with those of Ghaffari et al. 's study⁸. Overall, we can conclude that among cross-sectional studies, there is a strong relation between suitable oral health and HBM stages^{52, 53}. However, in longitudinal studies, the appropriate predictive values in following HBM basics are not found⁵⁴⁻⁵⁶. The reason may be due to the fact that when measuring health beliefs cross-sectionally, people believe in the importance of condition and worth of intervention after taking a behavior. The most interesting finding was that psychological intervention based on TPB is effective in improving oral health behaviors. Also, we found that as the duration of follow-up increases, the effect of TPB increases too. TPB was proposed by Icek Ajzen as an attempt to anticipate how humans were perceived to perform several behaviors under the influence of intention. According to this theory, the intention is the immediate prediction. This theory supposes that attitude toward the behavior, subjective norm, and perceived behavioral control influence behavioral intention⁵⁷. TPB has been successfully performed to provide a better comprehension and better specification about the health-related behaviors⁵⁸. Alexandrina and colleagues revealed that intention was positively correlated with attitude, subjective norms, perceived behavioral control, oral health knowledge, and current oral health behaviors⁵⁹. The result of the Daniel study revealed that attitude was the strongest predictor of brushing behavior and followed by oral health knowledge, and perceived behavior control, subjective

norms⁶⁰. According to Ebrahimpour et al³⁴ after the intervention based on TPB, the mean scores of knowledge, attitude, perceived behavioral control, subjective norms and behavioral intention in the intervention group showed a significant increase compared to the control group ($P \leq 0.05$). Similarity the result of Buunk-Werkhoven the TPB variables emerged as significant predictors of oral health behavior⁶¹. The result of Christina et al. support this point that the use of an expanded TPB for dental checkup intention and behavior, and, most notably, provide support for the use of subjective norm-based messages to prompt dental checkups. Findings of all of the studies posted that attitude, perceived behavioral control, and subjective norms are predictors of intention to improve oral health behaviors. To design and provide behavior change interventions, we should relate this theory to communication theories. In this way, the TPB and extend the form of TPB can complement the use of other theories of change and thereby improve health behavior research and practice¹⁷. The use of the TPB framework permitted health educators to design interventions and identify factors associated with evidence-based practice on oral health. Specialists (health educators, dentists,) must concentrate on improving attitudes and subjective norms and perceived behavior control for removing barriers to daily oral health care. A possible explanation for this may be that this theory has more influence in predicting behaviors which are under the control of people, for example, daily oral health routines that are consistent goals. Factors that are not under the control of individuals such as fatigue or environmental variation may lead rapidly to alter purposes, hence the outcomes and behavior change. This theory has the evidence to have efficiency in young adults' oral health, and according to it, the social expectations of the group was effective in their oral hygiene behavior^{62, 63}. Another possible explanation for this is that any changes in the environment of students such as moving to student dormitory may change intentions and behavior, although they had been learned the concepts and were stable at their practicing oral hygiene at home. Student life fatigue also

might affect nightly oral health practices¹⁹. Surprisingly, we found that the psychological interventions that used SCT did not affect oral hygiene and were not statistically significant.

Studies have emphasized that customized interventions based on SCT may enhance self-reported oral health behaviors and decrease plaque and gingival status⁶⁴. However, the findings of the current study do not support the previous research⁶⁵⁻⁶⁷. According to the qualitative analysis of dental attitudes, dental attitudes and behaviors are influenced by cognitive experiences, supportive and emotional dimensions, and childhood experiences⁶⁵.

One of the determinant factors of oral health and oral hygiene among elderly patients and diabetes patients was discovered to be dental self-efficacy^{66, 67}. There are several possible explanations for this result. It seems possible that this result is due to most of the studies being focused on individual aspects of cognitive, social theory and neglected another environmental aspect of the cognitive social theory. Also, this inconsistency may be due to length the time. It is proved that self-efficacy is consistent with improvements in oral hygiene, but the advantages may have the short-time effect. After six months the efficiency, oral hygiene and dental self-efficacy of periodontal patients were ameliorated⁶⁸. The current study found that with an increment of age the effect of this theory decreases. Another important finding was that using other theories such as (Range-frequency Theory, Information and Communication Technology, and Wilson and Cleary's model) have a positive effect on oral health interventions and were statistically significant. Also, using these theories has more impact in older ages. This finding of the current study is consistent with those of Reisine et al. who found children who were at higher risk for developing dental caries had mothers with more external Locus of Control (LOC)⁶⁹. This also accords with our earlier observations, which showed that the locale of control was predictive for children's dental health. Our result indicated that the effect of CT on the improvement of oral health. These theories were effective on clinical indicators such as dental plaque, gum inflammation

and gum bleeding. The present study covered almost the principal medical databases (such as PubMed, Scopus, Cochrane) and published papers for 17 years. In addition, the research has surveyed the different psychological theories used in oral hygiene for the first time. This leads that dental practitioners can regulate the preparation of care that is suitable to fulfill the requirements of patients and support their skills, and capability to preserve their oral health. This research investigates beneficial to inform the performing of individual clinicians. However, there have been some limitations in this study that need to be acknowledged and considered in future researchers; First, the available educational contents were not uniform. Second, statistical measures that reported in studies (OR, RR and mean difference) were various. Third, since most of the interventions based on psychological theories used a self-made questionnaire, the mean difference reported high or low and with wide CI that we had to remove these studies. Fourth, We selected the random effects model because of the heterogeneity among studies. The cause of this heterogeneity may have been the different operationalization of the variables, mixed gender, various cultures and various specifications of the outcomes across the used studies. Since most of the studies showed outcomes for mixed gender, testing the moderation of psychosocial factors with oral health behaviour by gender of contributors was not feasible. In addition to these improvements, the future studies should embrace the goal of measuring oral health behavior. Moreover, more interventional studies based on psychological theories should be performed in order to be more confident about their effectiveness.

Conclusions:

The current meta-analysis showed that in general, psychological interventions that used other theories, clinical theories, HBM, and TPB were effective in enhancing oral health status, and interventions that used SCT did not have an effect on improving oral health status. Additionally, various health models in oral health behavior modification proved to be effective and applicable in health behavior researches. Several models concentrated on the healthy self-responsibility of people such as the Health Belief Model, Transtheoretical Model and Stages of Change, Theory of Reasoned Action, Self-Efficacy, LOC, and Sense of Coherence. Oral health care providers who work with patients to take methods and improve behaviors that are related to appropriate oral health need to comprehend their applicability and strengths.

Clinical relevance

The scientific rationale for the study

Previous meta-analyses done had a low quality in presenting results and also only the effect of psychological interventions on improving the behavior and clinical indexes of the mouth and teeth, such as (gum inflammation and tooth decay), had been addressed. In the present study, we have been trying to explain the psychological theories by their type (Health Belief Model, Theory of Planned Behavior, Social Cognitive Theory, and Clinical Theories) which were used in oral health interventions.

Principal findings

The current meta-analysis showed that in general, psychological interventions that used other theories, clinical theories, HBM, and TPB were effective in enhancing oral health status, and interventions that used SCT did not have an effect on improving oral health status.

Practical implications

Oral health care providers who work with patients to take methods and improve behaviors that are related to appropriate oral health need to comprehend their applicability and strengths.

Conflicts of interest:

The authors declare that there are no conflicts of interest

Acknowledgments:

Acknowledgment

The authors gratefully acknowledge the Faculty of Health, Baqiyatallah University of Medical Sciences, Tehran, Iran.

Authors contributions:

Study design: BA. Database searched, data extraction and data synthesis: BA, JH,NN, MLand YM. Drafting the manuscript: BA, HSN, and ML. Critical revision of the manuscript:BA.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Figure legends

Figure1: PRISMA flow diagram of numbers of publications

Figure 2: Forrest plot of Health belief model. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure 3: Forrest plot of Social cognitive theory. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure 4: Forrest plot of Theory of planned behavior. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure 5: Forrest plot of Clinical theories. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure 6: Forrest plot of Other theories. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S1: Forrest plot of Health belief model based on participants. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S2: Forrest plot of Health belief model based on follow up. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S3: Forrest plot of Social cognitive theory based on participants. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S4: Forrest plot of Social cognitive theory based on follow up. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S5: Forrest plot of Theory of planned behavior based on participants. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S6: Forrest plot of Theory of planned behavior based on follow up. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S7: Forrest plot of Clinical theories based on participants. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S8: Forrest plot of Clinical theories based on follow up. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S9: Forrest plot of Other theories based on participants. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S10: Forrest plot of Other theories based on follow up. Random effects model meta-analysis. Studies sorted by standardized mean difference.

Figure S11. Funnel plot of publication bias.

Figure S12. Distribution of mean difference of psychological theories in the various countries investigated in the world.







