Relationship between cognitive behavioral variables and mental health status among university students: A meta-analysis

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Abstract

Cognitive behavioral therapy is an effective treatment for improving mental health problems among university students. However, intervention components have different effects on mental health problems. This paper is a meta-analysis of the data concerning the relationship between cognitive behavioral variables and mental health status among university students. A total of five electronic databases were reviewed, and 876 articles met the initial selection criteria. Reviewers applied standardized coding schemes to extract the correlational relationship between cognitive behavioral variables and mental health status. A total of 55 articles were included in the meta-analysis. Correlations were found for three cognitive behavioral variables (attention, thought, and behavior) across nine mental health domains (negative affect, positive affect, happiness, social function, stress response, psychological symptom, quality of life, well-being, and general health). Across each cognitive behavioral process and all mental health domains, the estimated mean correlation was medium ($r = .32 - .46$), and varied by the domain of mental health.

Introduction

Mental health problems among university students is an important issue. Auerbach et al. analyzed data on mental health problems of university students in each country using the World Mental Health Surveys [1]. The results indicated that university students suffering from psychiatric disorders were reluctant to attend university and were unable to receive appropriate treatment. Steptoe et al. investigated the extent of depressive symptoms in 17,348 university students between the ages of 17 and 30 in 23 countries [2]. They found that the prevalence of severe depressive symptoms was 38% in university students from East Asia (e.g., Japan, Korea), 13.9% for men and 17.1% for women from Western countries. Therefore, establishing and managing a support system in universities that focuses on mental health problems has become an important issue.

Mental health problems among university students have negative influences on academic performance and social function. Richardson et al. conducted a meta-analysis of 217 studies
that examined the relationship between mental health status and academic performance [3]. This analysis revealed that the intensity of general stress has a negative impact on academic performance. Weissman et al. investigated the influence of depressive and anxiety symptoms on daily life in adolescence and on social life throughout adulthood [4]. This study showed that depressive and anxiety symptoms in adolescence influenced their job turnover rate and the likelihood that they will remain unmarried.

The WHO definition of health emphasizes not only the absence of illness but also positive aspects such as social functioning and well-being [5]. Keyes classified the positive aspects of mental health in terms of hedonia and positive functioning [6]. Specifically, hedonia includes “experiencing positive affect” and “avowing happiness or life satisfaction”; in addition, positive functioning includes “social acceptance,” “social actualization,” “social contribution,” “social coherence,” “social integration,” “personal growth,” “purpose in life,” “autonomy,” “environmental mastery,” “self-acceptance,” and “positive relationships with others.” Furthermore, showing “personal growth,” “purpose in life,” “autonomy,” “environmental mastery,” “self-acceptance,” and “positive relationships with others” are components of well-being [7]. Therefore, in order to measure mental health, it is necessary to assess not only the general health condition including psychological symptoms or stress responses related to mental illness indicated by WHO, but also affective state, happiness, social functioning, and well-being.

Cognitive behavior therapy (CBT) is widely applied as a psychological approach to promote good mental health in university students. Charlesworth et al. examined the effect of relaxation training on state and trait anxiety in 18 college students [8]. The results indicated that relaxation training reduces trait anxiety. Perna et al. (1998) examined the effect of cognitive behavioral stress management program on the mood states in 34 university students [9]. The results showed that cognitive behavioral stress management program reduces dysphoric mood states. Rosenzweig et al. examined the effect of mindfulness training on mood states for 302 university students in their sophomore year [10]. They found that mindfulness training reduces dysphoric mood states. Levin et al. examined the effect of web-based acceptance and commitment therapy on the academic concerns and well-being of 79 college students [11]. The results indicated that acceptance and commitment therapy improved concerns about academic learning and social well-being.

CBT is an effective approach to improve mental health in university students. CBT includes many therapeutic components and outcome measures. Harvey et al. pointed out that there are five cognitive behavioral variables that can be applied to cognitive behavioral therapy (i.e., attention, memory, reasoning, thought, and behavior [12]). Attention includes variables such as selective attention and mindfulness. Memory includes variables such as overgeneral memory and memory distrust. Reasoning includes variables such as interpretation and attribution. Thought includes variables such as rumination and belief. Behavior includes variables such as avoidance and coping. These five variables are not disorder specific, and are applied in the transdiagnostic approach [12]. Conley et al. conducted a systematic review on the effects of psychological interventions for promoting mental health in university students [13]. The results indicated that mindfulness training is more effective than CBT, relaxation training, and meditation. Furthermore, CBT was found to be more effective than relaxation training and meditation.

Each component of psychological approaches to mental health problems of university students has a different effect. The outcome measures of cognitive behavioral variables that affect the mental health problems of university students have not been verified. Less than one in five adolescents who are in need of treatment receive appropriate psychological interventions [14]. To improve access to effective psychological interventions, it may be useful to develop a brief intervention [15]. In this way, the student counseling center at universities can offer
psychological interventions during semester term [16,17]. Identifying cognitive behavioral variables that strongly influence mental health status is important for developing an effective protocol. In the present study, we aim to conduct an analysis to identify cognitive behavioral variables that influence mental health status in university students.

**Method**

**Definition of terms**

First, we defined cognitive behavioral variables according to Harvey et al’s definition [12]. The definition is as follows: (1) attention, (2) memory, (3) reasoning, (4) thought, and (5) behavior. Second, we defined mental health according to WHO’s definition of health and Keyes’s definition of positive aspects of mental health [5,6]. The definition is as follows: (1) negative affect, (2) positive affect, (3) happiness, (4) social function, (5) stress response, (6) psychological symptom, (7) quality of life (QOL), (8) well-being, and (9) general health.

**Search strategy**

We identified relevant articles in multiple electronic databases (PsycINFO, PubMed, and CENTRAL). In addition, we used the SIGLE and PsyEXTRA databases to search grey literature. The search included articles published in English from the earliest date available to June 11, 2019 in each database. The selected search terms were “universities,” “college,” “undergraduate,” “mental processes,” “adaptation, psychological,” “attitude,” “attention,” “psychology,” and “mental health.” After the database search, we also searched the reference sections of the articles for additional sources. Additionally, the Thesaurus of Psychological Index Terms, created by the American Psychological Association, can be used as a type of thesaurus search in PsycINFO. Therefore, we utilized this additional tool when searching PsycINFO to obtain all possible references in addition to the above-mentioned terminologies.

**Inclusion and exclusion criteria**

Studies included for meta-analysis met the following criteria: (1) written in English, (2) samples were specifically college or junior college students, (3) assessed a bivariate relationship between mental health status and cognitive behavioral variables, (4) reported an effect size, or a statistic that can be calculated, measuring the bivariate association between cognitive behavioral variables and mental health status, and (5) published in a peer-reviewed journal. It also included baseline data for intervention studies. Studies were excluded if their samples were psychiatric patients.

**Screening procedures**

Based on the inclusion criteria, two independent raters evaluated “include,” “exclude,” and “unsure” for each article. The value of Kappa indicates fair agreement ($\kappa = .47$) [18]. Of the 876 articles extracted using the electronic search, we rejected 616 articles for which both the raters evaluated “exclude.” This resulted in 260 articles, of which 27 articles received the same “include” evaluation by both raters, 66 articles received the same “unsure” evaluation by both raters, and 167 articles were evaluated as either “include” or “unsure” by either rater. There were 18 duplicates among the 260 articles. Therefore, we searched the reference sections of the 242 articles. As a result of the reference section search, we extracted 38 new articles. Two raters independently read the full texts of the 280 articles and judged whether they should be subject to meta-analysis. The inter-rater disagreement were resolved by discussion between the raters once they reached a consensus. Furthermore, as defined above, cognitive behavioral measures
were categorized as attention, memory, reasoning, thought, or behavior, mental health measures were categorized as negative affect, positive affect, happiness, social function, stress response, psychological symptom, QOL, well-being, or general health. The inter-rater classification differences were resolved by discussions between raters based on the definition and a consensus was reached. A total of 55 articles were selected for the meta-analysis (Table 1). Fig 1 presents the procedure used to extract the articles.

**Meta-analytic procedures**

This study targeted investigations reporting on the bivariate relationship between cognitive behavioral variables and mental health status. Therefore, multivariable measures of association, such as regression coefficients, were excluded because they are not directly comparable to measures of bivariate association [74]. A meta-analysis was conducted for each combination of cognitive behavioral process and mental health status. When multiple outcomes were used in the study, the effect sizes were extracted for each combination of classifications if the combination of classifications was different (e.g., combination of automatic thoughts and positive affect [thought and positive affect], and combination of automatic thoughts and depressive symptoms [thought and psychological symptoms]). When the effect size was reported in the same combination, it was integrated into the research (e.g., combination of automatic thoughts and depressive symptoms [thought and psychological symptoms] and combination of automatic thoughts and anxiety symptoms [thought and psychological symptoms]). To integrate the effect size, we used Fisher’s z scale weighted for sample size. Cohen’s standard definition of small (.10), medium (.30), and large (.50) effect sizes were used to interpret the effect size findings [75]. In a meta-analysis, clinical and statistical heterogeneity are inevitable because subjects and areas differ depending on the study [76]. Therefore, we used the random effect model to calculate the effect size. Furthermore, we calculated $I^2$ [76], and the statistical heterogeneity of the research included in the meta-analysis was confirmed. If we detected a large heterogeneity, then we conducted a subgroup analysis based on the classification of mental health status (i.e., positive affect, negative affect etc.). To confirm publication bias, we examined the symmetry of the funnel plot using a linear regression test [77] and the trim and fill method [78]. For all analyses, we used the R version 3.4.1 [79]. We used the metafor package [80] to integrate effect size and examine the symmetry of the funnel plot.

**Results**

**Characteristics of included studies**

We extracted three categories of cognitive behavioral variables, “attention,” “thought,” and “behavior”, and all categories of mental health based on reading the full-text. The variables of “memory” and “reasoning” were not extracted. Table 1 presents the characteristics of the included studies. Furthermore, Table 2 presents the results of the classification, and Table 3 presents the scales used in each classification.

As Table 2 indicates, “behavior” (29 studies, 48 effect sizes) is the most common cognitive behavioral variable related to mental health status. The second most common is “thought” (23 studies, 33 effect sizes) and the third is “attention” (20 studies, 36 effect sizes). “Psychological symptom” (32 studies, 41 effect sizes) is the most common mental health category related to the cognitive behavioral variables. Psychological symptoms included “depressive symptoms,” “anxiety symptoms,” “pathological worry,” “post-traumatic stress disorder symptoms,” and the like (details are shown in Table 3). The second most common is “stress response” (14 studies, 17 effect sizes) and the third is “negative affect” (13 studies, 17 effect sizes). Table 4 shows the meta-analysis results for each classification.
Table 1. Characteristics of the included studies.

| Study                                      | N   | Nationality                          | Cognitive behavioral variables | Mental health                          |
|--------------------------------------------|-----|--------------------------------------|---------------------------------|----------------------------------------|
| Anderson & Arnould (1989) [19]             | 159 | USA                                  | Thought                         | Negative affect, Psychological symptom |
| Berking et al. (2012) [20]                 | 151 | Germany                              | Attention, Thought, Behavior    | Psychological symptom                  |
| Bettis et al. (2017) [21]                  | 62  | USA                                  | Behavior                        | Stress response, Psychological Symptom |
| Birks et al. (2009) [22]                   | 289 | England                              | Behavior                        | Stress response                        |
| Bodenlos et al. (2015) [23]                | 310 | USA                                  | Attention                       | Social function, Stress response       |
| Bowlin & Baer (2012) [24]                  | 280 | USA                                  | Attention                       | Negative affect, Stress response, Well-being |
| Brittian et al. (2015) [25]                | 2315| USA                                  | Thought                         | Psychological symptom                  |
| Calogero & Pina (2011) [26]                | 225 | USA                                  | Thought                         | Negative affect, Psychological symptom |
| Chen et al. (2014) [27]                    | 113 | USA                                  | Thought                         | Psychological symptom                  |
| Coffey et al. (2010) [28]                  | 413 | USA                                  | Attention, Thought, Behavior    | Psychological symptom                  |
| Costa et al. (2013) [29]                   | 1078| Spain, Mexico, Portugal, Brazil      | Attention, Thought, Behavior    | General health, Happiness              |
| Deng et al. (2011) [30]                    | 263 | China                                | Attention                       | Negative affect, Positive affect, QOL  |
| Disch et al. (2000) [31]                   | 467 | USA                                  | Attention                       | Social function, Happiness             |
| Flett et al. (2016) [32]                   | 214 | Canada                               | Attention, Thought              | Negative affect                        |
| Gilbert & Christopher (2009) [33]          | 268 | USA                                  | Attention, Thought              | Psychological symptom                  |
| Griva & Anagnostopoulos (2010) [34]        | 268 | Greece                               | Behavior                        | Psychological symptom                  |
| Hintz et al. (2015) [35]                   | 223 | USA                                  | Thought                         | Negative affect, Stress response       |
| Hipwell (2005) [36]                       | 183 | Scotland                             | Behavior                        | Psychological symptom                  |
| Hovey & Seligman (2007) [37]               | 190 | USA                                  | Behavior                        | Psychological symptom                  |
| Iwasaki (2003) [38]                       | 85  | Canada                               | Behavior                        | Well-being, General health             |
| Jayalakshmi & Magdalin (2015) [39]         | 125 | India                                | Behavior                        | Well-being                             |
| Khan et al. (2016) [40]                    | 207 | Pakistan                             | Behavior                        | Psychological symptom                  |
| Kim et al. (2015) [41]                     | 107 | USA                                  | Behavior                        | Well-being                             |
| Kneeland & Dovidio (2019) [42]             | 97  | New Zealand                          | Thought                         | Stress response, Psychological Symptom |
| Koesten et al. (2009) [43]                 | 395 | USA                                  | Behavior                        | General health                         |
| Kraemer et al. (2016) [44]                 | 452 | USA                                  | Attention, Thought              | Negative affect                        |
| Krafft et al. (2019) [45]                  | 339 | USA                                  | Thought                         | Stress response                        |
| Lihua et al. (2017) [46]                   | 330 | China                                | Behavior                        | Psychological symptom                  |
| Luo & Wang (2009) [47]                     | 284 | China                                | Behavior                        | Psychological symptom                  |
| Mahmoud et al. (2012) [48]                 | 508 | USA                                  | Behavior                        | Negative affect, Stress response       |
| Marino et al. (2016) [49]                  | 795 | Italy                                | Attention                       | Happiness                              |
| Masuda & Tully (2012) [50]                 | 494 | USA                                  | Attention, Behavior             | Psychological symptom, General health   |
| Masuda & Wendell (2010) [51]               | 91  | USA                                  | Attention, Thought              | Stress response, General health         |
| Masuda et al. (2009) [52]                  | 301 | USA                                  | Attention, Behavior             | Stress response, General health         |
| Masuda et al. (2010) [53]                  | 375 | USA                                  | Thought, Behavior               | Stress response, General health         |
| Mayorga et al. (2018) [54]                 | 448 | USA                                  | Behavior                        | Negative affect, Stress response, Psychological symptom |
| Moeller & Seehuus (2019) [55]              | 2054| USA                                  | Behavior                        | Psychological symptom                  |
| Montes-Berjes & Augusto (2007) [56]        | 119 | Spain                                | Attention, Behavior             | Psychological symptom                  |
| de Oliveira et al. (2015) [57]             | 184 | Brazil                               | Thought                         | Psychological symptom                  |
| Ranjabar et al. (2013) [58]                | 369 | Iran                                 | Behavior                        | Social function, Psychological symptom, General health |
| Sanchez et al. (2018a) [59]                | 308 | USA                                  | Behavior                        | Psychological symptom                  |

(Continued)
Relationship between attention and mental health status

Studies on attention measured the awareness of personal experiences such as body sensation, thought, and emotion (e.g., mindfulness, metacognitive awareness). Table 4 and Fig 2 present a medium correlation between attention and mental health status ($r = .34$, 95% confidence interval [CI] = .30 to .38). Because we observed a large statistical heterogeneity ($I^2 = 91.8$%), we conducted a subgroup analysis based on the classification of mental health status.

Six studies reported a bivariate relationship between attention and negative affect. The results of this meta-analysis indicate a medium correlation between attention and negative affect ($r = -.39$, 95% CI = −.47 to −.31). Two studies reported a bivariate relationship between attention and positive affect. The results of this meta-analysis indicate a small or medium correlation between attention and positive affect ($r = .23$, 95% CI = .15 to .31). Four studies reported a bivariate relationship between attention and happiness. The results of this meta-analysis indicate a small or medium correlation between attention and happiness ($r = .28$, 95% CI = .15 to .41). Five studies reported a bivariate relationship between attention and stress response. The results of this meta-analysis indicate a medium correlation between attention and stress response ($r = -.35$, 95% CI = −.45 to −.25). Nine studies reported a bivariate relationship between attention and psychological symptom. The results of this meta-analysis indicate a medium correlation between attention and psychological symptom ($r = -.32$, 95% CI = −.46 to −.18). Two studies reported a bivariate relationship between attention and QOL. The results of this meta-analysis indicate a medium correlation between attention and QOL ($r = .32$, 95% CI = .23 to .40). Three studies reported a bivariate relationship between attention and well-being. The results of this meta-analysis indicate a medium correlation between attention and well-being ($r = .39$, 95% CI = .31 to .47). Four studies reported a bivariate relationship between attention and general health. The results of this meta-analysis indicate a medium correlation between attention and general health ($r = .32$, 95% CI = .17 to .48). We did not conduct subgroup analysis because only one study reported a bivariate relationship between attention and social function.
Abstracts identified through PsycINFO, PubMed, CENTRAL, SIGLE, and PsyEXTRA database search

\[ N = 876 \]

Articles screened on basis of title and abstract

Articles excluded for not meeting inclusion criteria

\[ N = 616 \]

Duplicate articles

\[ N = 18 \]

Relevant full-text articles assessed for eligibility

\[ N = 242 \]

Articles identified through reference

\[ N = 38 \]

Not used cognitive behavioral measure

\[ N = 118 \]

Not used mental health measure

\[ N = 18 \]

Not analyzed between cognitive behavioral and mental health measure

\[ N = 63 \]

Not university students sample

\[ N = 2 \]

Not collected data review articles

\[ N = 12 \]

Not reported sufficient data to calculate effect size

\[ N = 8 \]

Unable to obtain

\[ N = 4 \]

Studies included in meta-analysis

\[ N = 55 \]

Fig 1. Flowchart of study selection.

https://doi.org/10.1371/journal.pone.0223310.g001
Relationship between thought and mental health status

Studies on thought measured thinking variables (e.g., automatic thoughts, irrational belief). Table 4 and Fig 3 present a medium or large correlation between thought and mental health status ($r = .46$, 95% CI = .39 to .53). Because we observed a large statistical heterogeneity ($I^2 = 96.5\%$), we conducted a subgroup analysis based on the classification of mental health status.

Seven studies reported a bivariate relationship between thought and negative affect. As a result of integrating the effect size, we found a medium or large correlation between thought and negative affect ($r = .46$, 95% CI = .35 to .58). Six studies reported a bivariate relationship between thought and stress response. As a result of integrating the effect size, we found a large correlation between thought and stress response ($r = .54$, 95% CI = .31 to .77). Fifteen studies reported a bivariate relationship between thought and psychological symptom. As a result of integrating the effect size, we found a medium or large correlation between thought and psychological symptom ($r = .43$, 95% CI = .32 to .54). Four studies reported a bivariate relationship between thought and general health. As a result of integrating the effect size, we found a medium correlation between thought and general health ($r = -.36$, 95% CI = -.40 to -.32). We did not conduct subgroup analysis because no studies or only one study reported a bivariate relationship between positive affect, happiness, social function, QOL, and well-being.

Relationship between behavior and mental health status

Studies on behavior measured coping processes of external or internal experiences (e.g., problem-solving coping, commitment). Table 4 and Fig 4 presents a medium correlation between behavior and mental health status ($r = .33$, 95% CI = .27 to .38). Because a large statistical heterogeneity was observed ($I^2 = 95.2\%$), we conducted a subgroup analysis based on the classification of mental health status.

Four studies reported a bivariate relationship between behavior and negative affect. As a result of integrating the effect size, we found a small or medium correlation between thought and negative affect ($r = -.40$, 95% CI = -.63 to -.17). Three studies reported a bivariate relationship between behavior and positive affect. There is no significant correlation between behavior and positive affect as a result of integrating the effect size ($r = .21$, 95% CI = -.07 to .49). Three studies reported a bivariate relationship between behavior and happiness. As a

Table 2. Classification of the included studies.

| Category                  | Studies | N  |
|---------------------------|---------|----|
| Cognitive behavioral variables |         |    |
| Attention                 | 20      | 36 |
| Thought                   | 23      | 33 |
| Behavior                  | 29      | 48 |
| Mental health             |         |    |
| Negative affect           | 13      | 17 |
| Positive affect           | 4       | 5  |
| Happiness                 | 4       | 8  |
| Social function           | 5       | 5  |
| Stress response           | 14      | 17 |
| Psychological symptoms    | 32      | 41 |
| Quality of life           | 2       | 3  |
| Well-being                | 5       | 6  |
| General Health            | 9       | 15 |

https://doi.org/10.1371/journal.pone.0223310.t002
Table 3. Measures used in each classification.

| Measure | Psychometrics | Studies |
|---------|---------------|---------|
|         | α             | rxx     |

**Attention**

Mindful Attention Awareness Scale (Brown & Ryan, 2003) [81]

- α: .80
- rxx: .81

- Deng et al. (2011) [30]
- Flett et al. (2016) [32]
- Gilbert & Christopher (2009) [33]
- Masuda & Tully (2012) [50]
- Masuda & Wendell (2010) [51]
- Masuda et al. (2009) [52]
- Shapiro et al. (2011) [62]
- Wang et al. (2017) [68]
- Woodruff et al. (2013) [71]

Five Facet Mindfulness Questionnaire

- α: .75 - .91

- Bodenlos et al. (2015) [23]

(Baer et al., 2006) [82]

- Bowlin & Baer (2012) [24]

Coffey et al. (2010) [28]

 Trait Meta-Mood Scale (subscale; Attention, Clarity)

- α: .86 - .90

- Coffey et al. (2010) [28]

(Salovey et al., 1995) [83]

- Costa et al. (2013) [29]

Metacognition questionnaire

- α: .72 - .89
- rxx: .76 - .94

- Marino et al. (2016) [49]

(Cartwright-Hatton & Wells, 1997) [84]

Emotion-Regulation Skills Questionnaire (subscale; Awareness)

- α: .90
- rxx: .75

- Berking et al. (2012) [20]

(Berking & Znoj, 2008) [85]

Cognitive and Affective Mindfulness Scale-Revised

- α: .74 - .77

- Kraemer et al. (2016) [44]

(Feldman et al., 2007) [86]

Self-Compassion Scale (subscale; Mindfulness)

- α: .81
- rxx: .85

- Zhou et al. (2013) [73]

(Neff, 2003) [87]

Learning Styles Inventory (subscale; Deep cognitive processing)

- α: .82
- rxx: .88

- Disch et al. (2000) [31]

(Schmeck, 1983) [88]

**Thought**

Objectified Body Consciousness Scale (subscale; Surveillance)

- α: .76 - .89

- Calogero & Pina (2011) [26]

(McKinley & Hyde, 1996) [89]

Dysfunctional Belief and Attitudes about Sleep Scale

- α: .69

- Vand et al. (2014) [66]

(Morin, 1993) [90]

Perceived Control Over Stressful Events Scale (subscale; Present control)

- α: .79 - .86
- rxx: .48 - .59

- Hintz et al. (2015) [35]

(Frazier et al. 2011) [91]

Response Styles Questionnaire (subscale; Ruminative)

- α: .80

- Flett et al. (2016) [32]

(Nolen-Hoeksema & Morrow, 1991) [92]

- Su & Chen (2015) [63]

(Nolen-Hoeksema et al., 1994) [93]

- Thanoi & Klainin-Yobas (2015) [64]

Intolerance of Uncertainty Scale

- α: .94
- rxx: .74

- Kraemer et al. (2016) [44]

(Freeston et al., 1994 [94]; Buhr & Dugas, 2002 [95])

Mizes Anorectic Cognitions Questionnaire-Revised

- α: .90

- Masuda et al. (2010) [53]

(Mizes et al., 2000) [96]

- Masuda & Wendell (2010) [51]

(Continued)
| Measure                                                                 | Psychometrics | Studies                                      |
|------------------------------------------------------------------------|---------------|---------------------------------------------|
| Crandell Cognitions Inventory                                          | .95 -         | Gilbert & Christopher (2009) [33]           |
| (Crandell & Chambless, 1986) [97]                                      |               |                                             |
| Emotion-Regulation Skills Questionnaire (subscale; Tolerance, Readiness | .90 - .93     | Berking et al. (2012) [20]                  |
| to confront distressing situations)                                   | .75 - .78     |                                             |
| (Berking & Znoj, 2008) [85]                                            |               |                                             |
| Ruminative Reflection Questionnaire                                    | .90 - .91     | Coffey et al. (2010) [28]                   |
| (Trapnell & Campbell, 1999) [98]                                       |               |                                             |
| Cognitive Distortion Questionnaire                                    | .85 - .87     | de Oliveira et al. (2015) [57]              |
| (de Oliveira et al., 2015) [57]                                        |               |                                             |
| Automatic Thought Questionnaire-Negative                               | .98 -         | Wong (2010) [69]                            |
| (Holon & Kendall, 1980) [99]                                           |               |                                             |
| Automatic Thought Questionnaire-Positive                              | .97 -         | Wong (2010) [69]                            |
| (Ingram & Wisnicki, 1988) [100]                                       |               |                                             |
| Scale of Ethnic Experience (subscale; Perceived discrimination)        | .83 - .91     | Brittian et al. (2015) [25]                 |
| (Malcarne et al., 2006) [101]                                         |               |                                             |
| Acculturative Stress Scale for International Students (subscale;       | .92 -         | Wong et al. (2014) [70]                     |
| Perceived discrimination)                                             |               |                                             |
| (Sandhu & Asrabadi, 1994) [102]                                       |               |                                             |
| Everyday Discrimination Scale                                         | .88 -         | Chen et al. (2014) [27]                     |
| (Williams et al., 1997) [103]                                         |               |                                             |
| Ruminative Response Scale                                             | .90 - .67     | Kneeland & Dovidio (2019) [42]              |
| (Treynor et al., 2003) [104]                                          |               |                                             |
| White Bear Suppression Inventory                                      | .89 - .69     | Kneeland & Dovidio (2019) [42]              |
| (Wegner & Zanakos, 1994) [105]                                        |               |                                             |
| Thought Control Questionnaire                                         | .67 - .79     | Zawadzki et al. (2018) [72]                 |
| (Wells & Davies, 1994) [106]                                          | .67 - .83     |                                             |
| Cognitive Fusion Questionnaire                                        | .88 - .93     | Krafft et al. (2019) [45]                   |
| (Gillanders et al., 2014) [107]                                       | .80          |                                             |
| **Behavior**                                                          |               |                                             |
| Acceptance and Action Questionnaire                                   | .88 - .90     | Masuda & Tully (2012) [50]                  |
| (Bond & Bunce, 2003) [108]                                            | .72          | Masuda et al. (2009) [52]                   |
| (Bond & Bunce, 2003) [108]                                            |               | Masuda et al. (2010) [53]                   |
| Dialectical Coping Scale                                              | .81 -         | Woodruff et al. (2013) [71]                 |
| (Wang et al., 2016) [67]                                              |               | Wang et al. (2016) [67]                     |
| Brief COPE Inventory                                                  | .81 - .88     | Mahmoud et al. (2012) [48]                  |
| (Carver, 1997) [109]                                                  |               |                                             |
| Emotional Intelligence Scale                                          | .87 -         | Birks et al. (2009) [22]                    |
| (Schutte et al., 1998) [110]                                          |               | Jayalakshmi & Magdalín (2015) [39]         |
| General Coping Questionnaire (subscale; dispositional coping)         | .86 - .92     | Sasaki & Yamasaki (2005) [61]               |
| (Sasaki & Yamasaki, 2002) [111]                                       | .63 - .86     |                                             |
| Religious Coping Scale                                                | .97 -         | Hovey & Seligman (2007) [37]                |
| (Boudreaux et al., 1995) [112]                                        |               |                                             |

(Continued)
Table 3. (Continued)

| Measure                                                                 | Psychometrics\(\alpha\) | Studies                                                      |
|-------------------------------------------------------------------------|---------------------------|--------------------------------------------------------------|
| Trait Meta-Mood Scale (subscale; Repair)                                | .86 - .90                 | Coffey et al. (2010) [28]                                    |
| (Salovey et al., 1995) [83]                                             |                           |                                                              |
| Trait Coping Style Questionnaire                                        | -                         | Luo & Wang (2009) [47]                                       |
| (Wang, 1999) [113]                                                     |                           |                                                              |
| Difficulties in Emotion Regulation Scale                                | .76 - .90                 | Coffey et al. (2010) [28]                                    |
| (Gratz & Roemer, 2004) [114]                                            |                           | Mayorga et al. (2018) [54]                                  |
| Proactive Coping Inventory                                             | .80 - .85                 | Griva & Anagnostopoulos (2010) [34]                         |
| (Greenglass, 2002) [115]                                                |                           |                                                              |
| Brief Religious Coping Scale                                           | .60 - .94                 | Khan et al. (2016) [40]                                      |
| (Pargament et al., 2011) [116]                                          |                           | Kim et al. (2015) [41]                                      |
| Cognitive Flexibility Scale                                            | .72 - .82                 | Koesten et al. (2009) [43]                                  |
| (Martin & Rubin, 1995) [117]                                            |                           |                                                              |
| Social Problem-Solving Inventory-Revised                                | .68 - .91                 | Ranjarbar et al. (2013) [58]                                |
| (D’ Zurilla et al., 2011) [118]                                         |                           |                                                              |
| Coping Orientation for Problem Experiences                              | .45 - .92                 | Iwasaki (2003) [38]                                          |
| (Carver et al., 1989) [119]                                             |                           |                                                              |
| Social Skills Inventory                                                | .75 - .88                 | Moeller & Seehuus (2019) [55]                               |
| (Riggio, 1986) [120]                                                   |                           |                                                              |
| Coping Strategies Inventory                                            | .71 - .94                 | Sanchez et al. (2018a) [59]                                 |
| (Tobin et al., 1989) [121]                                             |                           | Sanchez et al. (2018b) [60]                                 |
| Confucian Coping Scale                                                 | .51 - .77                 | Lihua et al. (2017) [46]                                    |
| (Li & Hou, 2012) [122]                                                 |                           |                                                              |
| Responses to Stress Questionnaire (subscale; engagement disengagement coping) | .80 - .92             | Bettis et al. (2017) [21]                                  |
| (Connor-Smith et al., 2000) [123]                                      |                           |                                                              |
| Problem-Solving Questionnaire                                          | .51 - .86                 | Hipwell (2005) [36]                                          |
| (Cassidy & Long, 1996) [124]                                           |                           |                                                              |
| **Negative affect**                                                    |                           |                                                              |
| Positive and Negative Affect Schedule (subscale; Negative affect)      | .84 - .87                 | Anderson & Arnoult (1989) [19]                              |
| (PANAS; Watson et al., 1988) [125]                                      |                           |                                                              |
| Depression Anxiety Stress Scale (subscale; Depression, Anxiety)        | .90 - .95                 | Bowlin & Baer (2012) [24]                                   |
| (DASS; Crawford, & Henry, 2003) [126]                                   |                           |                                                              |
| **(Continued)**                                                        |                           |                                                              |
| Measure                                                                 | Psychometrics$^a$ | Studies                                                                 |
|------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------|
|                                                                       | $\alpha$         | $r_{xx}$                                                                |
| Thought, Feeling, and Experience Questionnaire (subscale; Depression, Anxiety, Hopelessness) | .90              | -                                                                       |
| (TEFQ: Thanoi et al., 2011) [127]                                       |                  | Thanoi & Klainin-Yobas (2015) [64]                                      |
| Objectified Body Consciousness Scale (subscale; Body shame)            | .72 - .89        | Calogero & Pina (2011) [26]                                             |
| (McKinley & Hyde, 1996) [89]                                            |                  |                                                                         |
| Body Image Guilt and Shame Scale (subscale; Body guilt)                | .88 - .90        | Calogero & Pina (2011) [26]                                             |
| (Thompson et al., 2003) [128]                                          |                  |                                                                         |
| Multiple Affect Adjective Check List                                   | .72 - .85        | Anderson & Arnoult (1989) [19]                                          |
| (Zuckerman, 1960) [129]                                                |                  |                                                                         |
| Positive affect                                                        |                  |                                                                         |
| Positive and Negative Affect Schedule (subscale; Positive affect)      | .86 - .90        | Deng et al. (2011) [30]                                                 |
| (PANAS; Watson et al., 1988) [125]                                     |                  |                                                                         |
| Mental Health Inventory (subscale; positive affect)                    | .81 - .96        | Sanchez et al. (2018b) [60]                                             |
| (Veit & Ware, 1983) [130]                                              |                  |                                                                         |
| Happiness                                                              |                  |                                                                         |
| Satisfaction with Life Scale                                           | .87 .82          | Costa et al. (2013) [29]                                                |
| (SWLS; Diener et al., 1985) [131]                                      |                  |                                                                         |
| Fordyce Emotion Questionnaire                                          | - .86           | Woodruff et al. (2013) [71]                                             |
| (Fordyce, 1988) [132]                                                  |                  |                                                                         |
| Social and Emotional Health Surveys                                    | .92 -            | Marino et al. (2016) [49]                                               |
| (SEHS; Furlong et al., 2014) [133]                                     |                  |                                                                         |
| Spiritual Well-Being Scale (subscale; Existential well-being)          | - -              | Disch et al. (2000) [31]                                                |
| (Ellison, 1983) [134]                                                  |                  |                                                                         |
| Oxford Happiness Questionnaire-Short                                   | .78 .86          | Wong (2010) [69]                                                        |
| (Hills & Aygyle, 2002) [135]                                           |                  |                                                                         |
| Social function                                                        |                  |                                                                         |
| Medical Outcomes Study Short Form Survey (subscale; Social functioning) | .80              | Bodenlos et al. (2015) [23]                                             |
| (Ware & Sherbourne, 1992) [136]                                        |                  |                                                                         |
| Interpersonal Relationship Harmony Inventory                            | - -              | Wang et al. (2016) [67]                                                 |
| (Kwan et al., 1997) [137]                                              |                  |                                                                         |
| General Health Questionnaire (subscale; Social dysfunction)            | .70 - .90        | Koesten et al. (2009) [43]                                              |
| (Goldberg, 1978) [138]                                                 |                  |                                                                         |
| Stress response                                                        |                  |                                                                         |
| Interpersonal Reactivity Index (subscale; Personal distress)           | .71 - .77        | Masuda & Wendell (2010) [51]                                            |
| (Davis, 1983) [139]                                                   |                  |                                                                         |

(Continued)
Table 3. (Continued)

| Measure                                                                 | Psychometrics$^a$   | Studies                                      |
|------------------------------------------------------------------------|--------------------|----------------------------------------------|
| Perceived Stress Scale                                                | $\alpha$ .84 - .86 | $r_{xx}$ .85                                 | Birks et al. (2009) [22] |
| (Cohen et al., 1983) [140]                                            |                    |                                              | Bodenlos et al. (2015) [23] |
|                                                                        |                    |                                              | Shapiro et al. (2011) [62] |
|                                                                        |                    |                                              | Kneeland & Dovidio (2019) [42] |
| Depression Anxiety Stress Scale (subscale; Stress)                    | .93               |                                              | Bettis et al. (2017) [21] |
| (DASS; Crawford, & Henry, 2003) [126]                                  |                    |                                              | Bowlin & Baer (2012) [24] |
|                                                                        |                    |                                              | Hintz et al. (2015) [35] |
|                                                                        |                    |                                              | Mahmoud et al. (2012) [48] |
| Thought, Feeling, and Experience Questionnaire (subscale; Stress)     | .90               |                                              | Thanoi & Klainin-Yobas (2015) [64] |
| (TEFQ; Thanoi et al., 2011) [127]                                     |                    |                                              |                             |
| Counseling Center Assessment of Psychological Symptoms-34 (subscale; distress) | .76-.89           | 74-.87                                      | Kraft et al. (2019) [45] |
| (Locke et al., 2012) [141]                                            |                    |                                              |                             |
| The Social, Attitudinal, Familial, and Environmental Scale            | .89               |                                              | Mayorga et al. (2018) [54] |
| (Mena et al., 1987)                                                   |                    |                                              |                             |
| Responses to Stress Questionnaire (subscale; social stress)          | .80-.92           | .69-.81                                     | Bettis et al. (2017) [21] |
| (Connor-Smith et al., 2000) [123]                                     |                    |                                              |                             |
| **Psychological symptoms**                                            |                    |                                              |                             |
| Beck Depression Inventory                                             | .86               |                                              | Anderson & Arnould (1989) [19] |
| (Beck et al., 1961) [142]                                             |                    |                                              | Hovey & Seligman (2007) [37] |
|                                                                        |                    |                                              | de Oliveira et al. (2015) [57] |
|                                                                        |                    |                                              | Wong (2010) [69] |
|                                                                        |                    |                                              | Woodruff et al. (2013) [71] |
|                                                                        |                    |                                              | Kneeland & Dovidio (2019) [42] |
|                                                                        |                    |                                              | Lihua et al. (2017) [46] |
| Beck Anxiety Inventory                                                | .92               | .75                                          | de Oliveira et al. (2015) [57] |
| (Beck et al., 1988) [143]                                             |                    |                                              | Wong (2010) [69] |
|                                                                        |                    |                                              | Woodruff et al. (2013) [71] |
|                                                                        |                    |                                              | Lihua et al. (2017) [46] |
| Center for Epidemiologic Studies Depression Scale                    | .85               | .53                                          | Brittian et al. (2015) [25] |
| (Radloff, 1977) [144]                                                 |                    |                                              | Gilbert & Christopher (2009) [33] |
|                                                                        |                    |                                              | Tucker et al. (2016) [65] |
| Medical Outcomes Study Short Form Survey (subscale; Mental health 5)  | .77               |                                              | Montes-Berges & Augusto (2007) [56] |
| (Ware & Sherbourne, 1992) [136]                                       |                    |                                              | Sanchez et al. (2018a) [59] |
| Brief Symptom Inventory                                               | .74 - .89         |                                              | Berking et al. (2012) [20] |
| (Derogatis & Spencer, 1982) [145]                                     |                    |                                              | Coffey et al. (2010) [28] |
|                                                                        |                    |                                              | Masuda & Tully (2012) [50] |
| Hopelessness Depression Symptom Questionnaire                         | .93               |                                              | Zhou et al. (2013) [73] |
| (Metalsky & Joiner, 1997) [146]                                       |                    |                                              |                             |
| Penn State Worry Questionnaire                                        | .88               | .79                                          | Vand et al. (2014) [66] |
| (Meyer et al., 1990) [147]                                            |                    |                                              |                             |
| Eating Disorder Examination Questionnaire                             | .84 - .85         | .81                                          | Calogero & Pina (2011) [26] |
| (Mond et al., 2006) [148]                                             |                    |                                              |                             |
| Three Dichotomous Items                                              | -                 | -                                            | Su & Chen (2015) [63] |

(Continued)
Table 3. (Continued)

| Measure                                                  | Psychometrics   | Studies                           |
|----------------------------------------------------------|-----------------|-----------------------------------|
|                                                          | α   | r_xx                         |
| (Rost et al., 1993) [149]                                |     |                              |
| Posttraumatic Diagnostic Scale                            | .92 | .83                          | Su & Chen (2015) [63] |
| (Foas et al., 1997) [150]                                |     |                              |
| Hopkins Symptom Checklist-21-item version                | .90 | -                            | Wong et al. (2014) [70] |
| (Green et al., 1988) [151]                               |     |                              |
| Patient Health Questionnaire-9 Scale                     | .89 | -                            | Chen et al. (2014) [27] |
| (Kroenke et al., 2001) [152]                             |     |                              | Bettis et al. (2017) [21] |
| Generalized Anxiety Disorder 7-item                      | .92 | .83                          | Chen et al. (2014) [27] |
| (Spitzer et al., 2006) [153]                             |     |                              | Bettis et al. (2017) [21] |
| General Health Questionnaire (subscale; Depression)      | .70 | -.90                        | Ranjbar et al. (2013) [58] |
| (Goldberg, 1978) [138]                                   |     |                              |
| SCL-90 Symptom checklist                                 | .62 | .96                          | Luo & Wang (2009) [47] |
| (Derogatis, 1994) [154]                                  |     |                              |
| State-Trait Anxiety Inventory (subscale; Trait scale)    | .92 | -                            | Griva & Anagnostopoulos (2010) [34] |
| (Spielberger et al., 1970) [155]                         |     |                              |
| Personality Assessment Inventory (subscale; Anxiety)     | .90 | -                            | Hovey & Seligman (2007) [37] |
| (Morey, 1991) [156]                                      |     |                              |
| Scale for Measuring Depression and Anxiety                | .74 | -                            | Khan et al. (2016) [40] |
| (Costello & Conrey, 1967) [157]                          |     |                              |
| PTSD Checklist                                            | .97 | .96                          | Zawadzki et al. (2018) [72] |
| (Weathers et al., 1993) [158]                            |     |                              |
| Inventory of Depression and Anxiety Symptoms              | .77-.89 | .72-.83                    | Mayorga et al. (2018) [54] |
| (Watson et al., 2007) [159]                              |     |                              |
| Quality of life                                          |     |                              |
| World Health Organization Quality of Life-BREF           | .68 | .82                          | Deng et al. (2011) [30] |
| (Skevington et al., 2004) [160]                          |     |                              | Woodruff et al. (2013) [71] |
| Well-being                                               |     |                              |
| Subjective Well-Being                                    | .90 | -                            | Shapiro et al. (2011) [62] |
| (Diener, 1984) [161]                                     |     |                              |
| Scale of Psychological Well-Being                        | .86 | .93                          | Bowlin & Baer (2012) [24] |
| (Ryff, 1989) [7]                                         |     |                              |
| Medical Outcomes Study Short Form Sruvey (subscale; Emotional well-being) | .80 | - | Bodenlos et al. (2015) [23] |
| (Ware & Sherbourne, 1992) [136]                           |     |                              |
| Warwick-Edinburgh Mental Well-being Scale                | .89 | .91                          | Jayalakshmi & Magdalin (2015) [39] |
| (Tennant et al., 2007) [162]                             |     |                              |
| Mental Health Inventory (subscale; psychological well-being) | .81 | .96                          | Kim et al. (2015) [41] |
| (Veit & Ware, 1983) [130]                                |     |                              |
| General Health                                           |     |                              |
| General Health Questionnaire                             | .70 | .90                          | Costa et al. (2013) [29] |
| (Goldberg, 1978) [138]                                   |     |                              | Koesten et al. (2009) [43] |
|                                                          |     |                              | Masuda & Tully (2012) [50] |

(Continued)
result of integrating the effect size, we found a medium correlation between behavior and happiness \((r = .39, 95\% \text{ CI} = .23 \to .56)\). Four studies reported a bivariate relationship between behavior and social function. As a result of integrating the effect size, we found a small correlation between behavior and social function \((r = .19, 95\% \text{ CI} = .07 \to .31)\). Six studies reported a

Table 3. Estimated associations between cognitive behavioral variables and mental health.

| Classification of mental health | Attention | \(r\) | \(N^a\) | Sample size | \(I^2\) | \(95\% \text{ CI}\) | Thought | \(r\) | \(N\) | Sample size | \(I^2\) | \(95\% \text{ CI}\) | Behavior | \(r\) | \(N\) | Sample size | \(I^2\) | \(95\% \text{ CI}\) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative affect | -.39 | 6 | 5,275 | 84.5 | .46 | 7 | 9,696 | 94.7 | -.40 | 4 | 1,873 | 95.1 |
| | \([- .47, -.31]\) | \([.35, .58]\) | | \([- .63, -.17]\) | |
| Positive affect | .23 | 2 | 557 | 0.0 | - | 0 | - | - | .21 | 3 | 1,093 | 94.8 |
| | \([.15, .41]\) | | | \([- .07, .49]\) | |
| Happiness | .28 | 4 | 19,111 | 96.9 | - | 1 | 1,592 | - | -.39 | 3 | 1,634 | 88.7 |
| | \([.15, .41]\) | | | \([- .23, .56]\) | |
| Social function | - | 1 | 1,860 | - | - | 0 | - | - | - | 1.19 | 4 | 5,628 | 94.5 |
| | | | | \([.16, .46]\) | |
| Stress response | -.35 | 5 | 3,684 | 80.9 | .54 | 6 | 3,463 | 96.7 | -.47 | 6 | 2,293 | 73.1 |
| | \([- .45, -.25]\) | \([.31, .77]\) | | \([- .55, -.39]\) | |
| Psychological symptom | -.32 | 9 | 7,883 | 96.6 | .43 | 15 | 8,615 | 95.8 | -.29 | 17 | 18,041 | 97.7 |
| | \([- .46, -.18]\) | \([.32, .54]\) | | \([- .40, -.19]\) | |
| Quality of life | .32 | 2 | 557 | 0.0 | - | 0 | - | - | - | 1 | 147 | - |
| | \([.23, .40]\) | | | | |
| Well-being | .39 | 3 | 3,292 | 69.5 | - | 0 | - | - | - | .23 | 3 | 1,189 | 0.1 |
| | \([.31, .47]\) | | | \([.17, .29]\) | |
| General health | .32 | 4 | 3,042 | 90.9 | -.36 | 4 | 2,035 | 0.0 | .38 | 7 | 6,128 | 91.3 |
| | \([.17, .48]\) | \([- .40, -.32]\) | | \([.29, .47]\) | |
| Overall | .34 | 36 | 45,261 | 91.8 | .46 | 33 | 26,802 | 96.5 | .33 | 48 | 37,901 | 96.0 |
| | \([.30, .38]\) | \([.39, .53]\) | | \([.27, .38]\) | |

\(^a\)N = number of studies
\(^b\)Based on Trim and Fill method

https://doi.org/10.1371/journal.pone.0223310.t004
Fig 2. Forest plot of the relationship between attention and mental health.

https://doi.org/10.1371/journal.pone.0223310.g002
bivariate relationship between behavior and stress response. As a result of integrating the effect size, we found a medium or large correlation between behavior and stress response \( (r = -0.47, 95\% \text{ CI } = -0.55 \text{ to } -0.39) \). Seventeen studies reported a bivariate relationship between behavior and psychological symptom. As a result of integrating the effect size, we found a medium correlation between behavior and psychological symptom \( (r = -0.29, 95\% \text{ CI } = -0.40 \text{ to } -0.19) \).

Three studies reported a bivariate relationship between behavior and well-being. As a result of integrating the effect size, we found a small or medium correlation between behavior and well-being \( (r = 0.23, 95\% \text{ CI } = 0.17 \text{ to } 0.29) \). Seven studies reported a bivariate relationship between behavior and general health. As a result of integrating the effect size, we found a medium correlation between behavior and general health \( (r = 0.38, 95\% \text{ CI } = 0.29 \text{ to } 0.47) \). We did not conduct a subgroup analysis because only one study reported a bivariate relationship between behavior and QOL.

### Reporting bias

We assessed the risk of reporting bias through visual inspection and linear regression tests of funnel plots \[77\]. Because it has been argued that the test for funnel plot asymmetry should be used only when there are at least 10 studies \[18\], we only conducted a linear regression test when there were over 10 studies. With the linear regression test, asymmetry of the funnel plot was detected in studies that reported bivariate relations between attention and mental health status \( (p < 0.001) \). Based on the trim and fill method, the uncorrected effect size (before adding the possible missing studies) is 0.34 \( (95\% \text{ CI } = 0.30 \text{ to } 0.38) \), and the corrected effect size (after adding six possible missing studies) is 0.32 \( (95\% \text{ CI } = 0.28 \text{ to } 0.36) \). Although there is evidence of publication bias, its effect is not significant \( \text{Fig } 5 \).

### Discussion

This study is the first meta-analysis of the relationship between cognitive behavior variables and mental health status in university students. We found that the overall correlation coefficients between cognitive behavioral variables and mental health status were medium (attention: \( r = 0.32 \); thought: \( r = 0.46 \); behavior: \( r = 0.33 \)). However, we detected a large heterogeneity (attention: \( I^2 = 91.8\% \); thought: \( I^2 = 96.5\% \); behavior: \( I^2 = 96.0\% \)), which means that the effect sizes likely depend on mental health status, while cognitive behavioral variables are related to mental health status. Therefore, we classified mental health as “negative affect,” “positive affect,” “happiness,” “social function,” “stress response,” “psychological symptom,” “QOL,” “well-being,” and “general health” and conducted a meta-analysis on them.

As Table 4 shows, attention has larger effect sizes than behavior in relation to well-being. For positive affect and QOL, attention shows significant effect sizes, but thought and behavior do not. Thought has larger effect sizes than attention and behavior on negative affect, stress response, and psychological symptom. In social function, behavior shows significant effect sizes, but attention and thought do not. These findings suggest that attention is related to the positive aspects of mental health such as well-being, and thought is related to the negative aspects of mental health such as negative affect. Behavior is related to social function, but attention and thought are not.

As mentioned above, this study identifies cognitive behavioral variables that are strongly related to the mental health status in university students. Next, we review how these cognitive behavioral variables have been used in existing psychotherapy. To develop effective psychological intervention methods, we will consider what kind of future research is necessary.

These results support previous studies that examined the effects of psychological treatment. First, the classification of attention in this study includes mindfulness and metacognitive
| Author(s) and Year | Weight | ZCOR [95%CI] |
|--------------------|--------|--------------|
| Anderson & Arnoult (1989) | 2.83% | 0.24 [0.09, 0.40] |
| Anderson & Arnoult (1989) | 2.83% | 0.19 [0.04, 0.35] |
| Gilbert & Christopher (2009) | 3.01% | 0.95 [0.83, 1.07] |
| Coffey et al. (2010) | 3.19% | 0.44 [0.38, 0.51] |
| Masuda & Wendell (2010) | 2.55% | 0.24 [0.04, 0.45] |
| Masuda & Wendell (2010) | 2.55% | 0.37 [0.16, 0.57] |
| Masuda et al. (2010) | 3.08% | 0.29 [0.19, 0.39] |
| Masuda et al. (2010) | 3.08% | 0.35 [0.25, 0.46] |
| Wong (2010) | 3.24% | 0.67 [0.58, 0.67] |
| Wong (2010) | 3.24% | 0.70 [0.65, 0.75] |
| Calogero & Pina (2011) | 3.11% | 0.44 [0.34, 0.53] |
| Calogero & Pina (2011) | 2.95% | 0.47 [0.34, 0.60] |
| Berking et al. (2012) | 3.03% | 0.28 [0.17, 0.40] |
| Costa et al. (2013) | 3.22% | 0.35 [0.29, 0.41] |
| Chen et al. (2014) | 2.95% | 0.27 [0.14, 0.40] |
| Vand et al. (2014) | 3.19% | 0.31 [0.24, 0.38] |
| Vand et al. (2014) | 3.09% | 0.32 [0.22, 0.42] |
| Wong et al. (2014) | 2.83% | 0.52 [0.37, 0.68] |
| Brittian et al. (2015) | 3.26% | 0.14 [0.10, 0.18] |
| de Oliveira et al. (2015) | 3.22% | 0.63 [0.57, 0.69] |
| Hintz et al. (2015) | 3.11% | 0.45 [0.36, 0.55] |
| Hintz et al. (2015) | 2.95% | 0.45 [0.32, 0.58] |
| Su & Chen (2015) | 2.95% | 0.27 [0.14, 0.40] |
| Thanoi & Klainin-Yobas (2015) | 3.28% | 0.51 [0.49, 0.54] |
| Thanoi & Klainin-Yobas (2015) | 3.26% | 0.53 [0.49, 0.57] |
| Flett et al. (2016) | 2.94% | 0.78 [0.64, 0.91] |
| Kraemer et al. (2016) | 3.20% | 0.50 [0.44, 0.57] |
| Tucker et al. (2016) | 2.71% | 0.27 [0.09, 0.45] |
| Zawadzki et al. (2018) | 3.13% | 0.45 [0.36, 0.54] |
| Zawadzki et al. (2018) | 3.13% | 0.38 [0.29, 0.47] |
| Kneeland & Dovidio (2019) | 2.90% | 0.67 [0.53, 0.81] |
| Kneeland & Dovidio (2019) | 2.90% | 0.61 [0.47, 0.75] |
| Krafft et al. (2019) | 3.06% | 1.02 [0.91, 1.13] |
| RE Model | 100.00% | 0.46 [0.39, 0.53] |

Fisher's z Transformed Correlation Coefficient
awareness (e.g., Mindful Attention Awareness Scale [81], Metacognition Questionnaire [84]). As techniques to promote mindfulness and metacognitive awareness, mindfulness-based psychotherapy [163], attention training [164], and computer-based training to train attention [165] are available [12]. Mindfulness-based psychotherapy is the most frequently reported and effective technique by clinical trials and meta-analyses [166–168]. Mindfulness is defined as “paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally” [169]. Several clinical trials and meta-analyses report that mindfulness-based psychotherapy is effective when it creates positive aspects in mental health [170,171]. Furthermore, integrating 23 meta-analyses that reported on the effectiveness of mindfulness-based psychotherapy revealed that mindfulness-based psychotherapy not only improved depressive symptoms (standard mean difference (SMD) = −.37) and anxiety symptoms (SMD = −.48) but also promoted QOL (SMD = −.39) [172]. In previous research, while the subjects were not purely university students, mindfulness-based psychotherapy not only improved the negative aspects of mental health but also promoted the positive aspects. In addition, in the present study, the attention process was correlated with positive aspects of mental health in university students [25,26,28], suggesting that psychological interventions targeting the attention process may be effective when promoting positive mental health in this population.

Second, the classification of thought in this study includes automatic thoughts and dysfunctional belief (e.g., Automatic Thought Questionnaire-Negative [99], Dysfunctional Belief and Attitudes about Sleep Scale [90]). Cognitive therapy is a technique to improve automatic thoughts and dysfunctional belief [12]. Cognitive therapy is a psychological treatment focused on thought that improves depressive symptoms and supports clients by observing and considering the thought processes [173]. The Society of Clinical Psychology reported that cognitive therapy is an effective treatment for depression [174]. A meta-analysis suggests that the cognitive therapy treatment of depression has a higher remission rate as opposed to no intervention (Odds Ratio = 0.42) [175]. Another meta-analysis shows that cognitive therapy improves generalized anxiety and social anxiety [176,177]. In previous research, while subjects were not purely university students, cognitive therapy improved the negative aspects of mental health. In the present study, the thought process was correlated with the negative aspects of mental health in university students [33,57]; so psychological interventions targeting the thought process may be effective treatments for the negative aspects of mental health in this population.

Third, the classification of behavior in this study included coping and commitment (e.g., Brief COPE Inventory [109], Acceptance and Action Questionnaire [108]). As techniques to promote coping and commitment, behavioral activation and acceptance and commitment therapy are available [12]. Behavioral activation is a psychological treatment that focuses on increased engagement in adaptive activities, decreased engagement in activities that maintain depression or increased risk of depression, and solving problems that limit access to rewards or that maintain or increase aversive control [178]. Acceptance and commitment therapy is a psychological treatment that focuses on decreasing experiential avoidance and increasing action along the valued direction [179]. Behavioral activation and acceptance and commitment therapy are effective in improving social dysfunctions because they aim to resolve problems by focusing on real-life behavior. In randomized controlled trials, behavioral activation and acceptance and commitment therapy are shown to be effective against social dysfunction (behavioral activation: $d = 1.21$ [180]; acceptance and commitment therapy; partial $\eta^2 = .22$ [181]). In previous research, while subjects were not purely university students, behavior activation and acceptance and commitment therapy improved social dysfunction. In the present
study, the behavior process was correlated with the social function in university students [43,58], therefore, psychological interventions that target the behavior process may be effective when it comes to social dysfunction in university students. As mentioned above, when providing psychological interventions to university students, it would be best to provide psychotherapy that focuses on the attention, thought, and behavior variables that target mental health problems.

Fig 4. Forest plot of the relationship between behavior and mental health. https://doi.org/10.1371/journal.pone.0223310.g004

Fig 5. Funnel plot of the relationship between attention and mental health. Black circles: included studies, White circles: added possible missing studies using Trim and Fill methods. https://doi.org/10.1371/journal.pone.0223310.g005
This meta-analysis is not without limitations. First, we detected a large heterogeneity in the studies included in the meta-analysis. The heterogeneity did not affect the results of the present study because this meta-analysis used the random effect model. However, future studies must consider heterogeneities among university students. Studies focusing on university students have at times taken into consideration several demographic variables, such as a student’s major [182]. In contrast, some studies were conducted without considering the differences in demographics [183]. These differences in demographics may affect the results of the analysis [22]. In addition, because the present study extracted only English articles, which is an international language, the influence of the cultural background could not be verified. In the future, it is necessary to analyze the data pertaining to each demographic, including the cultural background, and accumulate the findings. Furthermore, we could not conduct a meta-analysis on some of the classifications because we could not extract the required amount of data. Therefore, some relationships between cognitive behavioral variables and mental health status were unclear (e.g., thought and positive aspects of mental health [positive affect, happiness, QOL, and well-being]); it will be necessary to try and resolve this issue in the future.

Conclusion

The present study is the first to examine the relationship between cognitive behavioral variables and mental health status among university students using meta-analysis. The findings reveal that cognitive behavioral variables are overall correlated with mental health status. Therefore, psychological treatment based on CBT is effective for solving mental health problems among university students. Psychological treatment, including thought process, can be effective in treating the negative aspects of mental health, and the attention process can be effective in treating the positive aspects of mental health. However, this meta-analysis could not reveal some of the relationships between cognitive behavioral variables and mental health status.

In summary, psychological treatment based on CBT is effective in solving mental health problems among university students. However, outcomes vary, and several factors influence them. Therefore, when examining the effects of psychological treatment on university students, various outcomes should be included.

Supporting information

S1 Table. PRISMA checklist.

(DOC)

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Conceptualization: Tomonari Irie, Kengo Yokomitsu.
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