Supplementary materials

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Further methodology detail

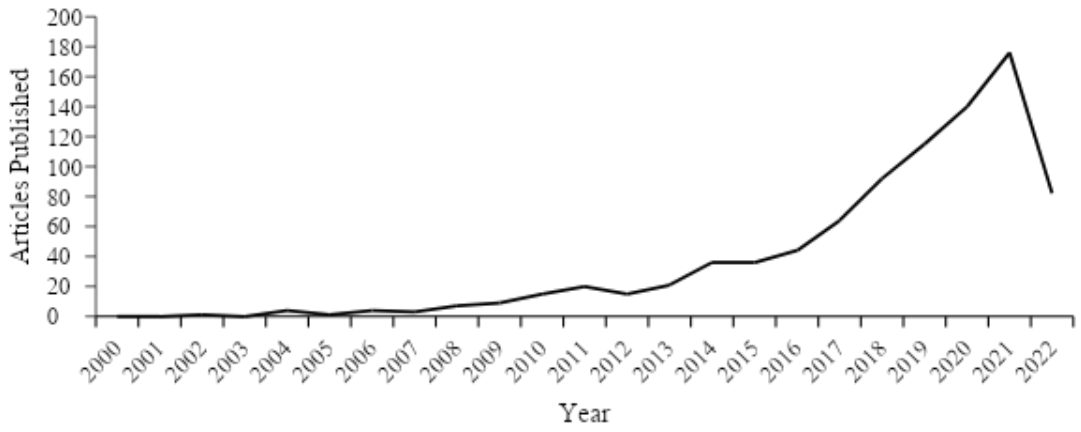
Article selection:

- A simple search was performed on Scopus for articles published in the subject areas Business, Management and Accounting, Psychology or Social Science since 2016 featuring the key words "psychological capital" in the article title, using the following terms:

  TITLE (psychological AND capital) AND PUBYEAR > 2016 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "SOCI"))
- Articles titles and abstracts were screened in the order in which they appeared in the Scopus search results. Accept/reject decisions were made for each until 52 articles had been accepted. The first two articles accepted served as training articles, where the data extraction protocol was trialled as specified in Phase 3: Data Extraction.
- Scopus results were filtered to articles published after 2016, as this was when the number of articles relating to PsyCap published in these areas per year on Scopus increased sharply (see Figure 1).

Figure S1

PsyCap Articles Published by Year



Note. Number of articles published on Scopus in the subject areas of Business, Management and Accounting, Psychology or Social Science since 2000 featuring the key words “PsyCap” in the article title. Sourced from Scopus search results analysis on May 5th 2022.
Included longitudinal design, excluded PsyCap as moderators.

- Quasi-experimental studies were excluded due to their non-observational nature.

Data extraction:

- The order that the articles were reviewed in was determined using a random sequence generator (https://www.random.org/).
- Two articles were determined to not fit the inclusion criteria after data extraction had begun. These were replaced by the next two articles from Scopus following the same process through which the original 52 were gathered.
- Linking sentences: Where multiple sentences met these requirements, the one that made the strongest causal claim was selected. Haber et al. (2022) selected the sentence which occurred first, however for the present study it was decided that selecting the sentence which maximally implied causation would provide greater insight. For the review of the discussion sections, the order of preference for locating relevant sentences was the first paragraph in the discussion, followed by the second paragraph, and so on.
- Causal implication of linking words: Where the selected linking sentence referred to mediation, if the linking language other than the reference to mediation had no causal

implication, this was rated as ‘weak’ to account for the inherent causality of a mediation relationship (Ghosh & Jacobson, 2016), whilst still relying upon what the authors conveyed aside from their use of mediation.

- Modifiers of linking words: Modifiers of the identified linking word or phrase were also identified for potential further exploratory analysis of how language affects causal interpretations, however this was not explored and is noted here for transparency. Modifying words are those that alter the nature of the linking relationship, including any phrases that demonstrate strength, weakness, or doubt about the robustness of the linking phrase, for example “We find that X is strongly associated with Y”.
- Action recommendations: If there were multiple action recommendations, the implication with the strongest causal implication was chosen. Where this did not distinguish the recommendation, that which occurred first was selected.
- The review tool identified whether Structural Equation Models or graphical causal models were used, whether variables were controlled or adjusted for, and whether confounding factors were discussed. It also examined whether a causal disclaimer statement was made (for example, “the observational nature of this study means that causal inferences cannot be drawn”), and whether there was any explicit acknowledgement of an intent to draw causal inference.

Analysis procedure

The statistical analyses for this study were largely descriptive. The first stage of analysis involved determining what linking words are used to describe relationships between predictors and outcomes in the PsyCap literature. This was done using a count and calculating proportions with a 95% confidence interval (CI) of the number of times each linking word was identified.

Next, estimates of the degree to which linking words state or imply causality in the PsyCap literature were generated using the proportion of linking words rated at each level of causal implication.

Similarly, in order to examine the prevalence of action recommendations that would require causal inference to have been made, the proportion of action recommendations rated at each level of causal implication was calculated.

The alignment between the language used to describe relationships and implications subsequently drawn was then examined. First, the distribution of linking word causal strength and causal action implications was plotted. Then, the proportion of articles where the rated causal strength of the action recommendation was commensurate to and stronger than the rated causal strength of the linking sentence was generated. Finally, a two-tailed Spearman's rho rank test at a 5% alpha level was conducted to examine the relationship between the strength of causal linking sentences and action recommendations.

Finally, proportions were used to examine the prevalence of transparent acknowledgment of causal intent, causal disclaimer statements, and models which could be used to support causal inference.

Note that during the discussion of results, we use the term 'linking sentence' rather than the 'linking word', which is used in the pre-registered analysis plan, for clarity. We conducted analyses using linking words to allow us to aggregate the root word of each linking word for analysis, however the linking words' causal implications were determined entirely by the rating of their respective linking sentences.

Changes to data extracted post-completion of data gathering

- The article numbers mentioned in this appendix are the identifiers assigned to each article. Article identifiers, titles, and DOIs can be found online at https://osf.io/w3hd8/?view_only=54150c2ed96b417896b3d7a3e8b1fbe5.
- Following discussion of the use of mediation is observational studies, linking sentences for meditation relationships rated 'None' were changed to 'Weak' due to the inherent causality of such a relationship. This affected 4 linking words. The changes were applied to the following articles.
    a. Article 26 (discussion)
    b. Article 32 (abstract)
    c. Article 36 (abstract)
    d. Article 45 (discussion)
- A second opinion from the primary supervisor of this study was sought for a number of linking language causality ratings. The following articles subsequently had their ratings altered:

a. Article 10 (abstract): ‘weak’ became ‘none’
b. Article 10 (discussion): ‘moderate’ became ‘strong’
c. Article 18 (discussion): ‘strong’ became ‘moderate’
d. Article 19 (discussion): ‘strong’ became ‘moderate’
e. Article 19 (action recommendation): ‘none’ became ‘weak’
f. Article 23 (abstract): ‘moderate’ became ‘weak’
g. Article 34 (abstract): ‘moderate’ became ‘strong’
h. Article 35 (discussion): ‘strong’ became ‘weak’
i. Article 47 (action recommendation): ‘strong’ became ‘weak’

- One change was made to an identified action recommendation. For Article 33, the sentence prior was added to the response as necessary context for the action recommendation causal implication rating.

Causal implication ratings of most commonly identified root words

Table S1

Causal implication ratings of most commonly identified abstract root words.

Root word	Causal implication			
	None	Weak	Moderate	Strong
Relate	62% (95% CI [38, 85])	38% (95% CI [15, 62])	-	-
Influence	-	20% (95% CI [0, 51])	-	80% (95% CI [60, 100])
Predict	100%	-	-	-
Impact	-	-	-	100%
Affect	-	-	-	100%

Table S2

Causal implication ratings of most commonly identified discussion root words.

Root word	Causal implication			
	None	Weak	Moderate	Strong
Relate	82% (95% CI [71, 100])	18% (95% CI [6, 37])	-	-
Effect	-	-	38% (95% CI [13, 71])	63% (95% CI [38, 96])
Influence	-	14% (95% CI [0, 54])	14% (95% CI [0, 54])	71% (95% CI [57, 100])

Sub-objective 3: Strategies to support credibility of causal inference

This study also looked for other indications of authors' potential interest in causation, including the use of strategies which can increase the credibility of causal inferences. Models which could be used to support causal inference were used in 88% (95% CI [82, 98]) of the articles examined: flowcharts with directed arrows, which imply a temporal order among variables and therefore some level of causality, were used in 74% of the articles, and half of the articles used Structural Equation Modelling (SEM). Additionally, variables were controlled in 62% (95% CI [50, 76]) of the articles, and confounding was discussed in 10% (95% CI [4, 18]) of the articles. Mediation analysis was used in 84% (95% CI [76, 94]) of articles. It should be noted that the models and strategies examined in the present study were selected as specific examples, and do not represent all possible approaches nor their effectiveness. Additionally, whether or not these were used in a way which would support causal inference was not examined, rather, the existence of strategies which could be used in this way was identified.

Differences to Haber et al.'s protocol

Objectives

The primary objectives of the present study were the same as Haber et al.'s (2022). Their secondary objectives were not explored in the present study. Some of their tertiary objectives were explored in the present study as secondary objectives, specifically:

- Haber et al.'s 9th objective is explored here as our 6th objective.
- Haber et al.'s 12th objective is part of our 7th objective.

The following table (**Table S3**) details Haber et al.'s pre-registered objectives in full, as well as the present study's objectives. Similar objectives are denoted using matched superscript letters.

Table S3

Comparison of Objectives

Haber et al.'s objectives	The present study's objectives
Primary:	Primary:
1. Identify the associational linking words and phrases used to describe relationships between exposures and outcomes examined in the high impact published health literature.[a]	1. Identify the linking words and phrases used to describe relationships between predictors and outcomes in psychological capital literature.[a]
2. Generate estimates of the degree to which linking words and phrases state or imply causality.[b]	2. Generate estimates of the strength of causality stated or implied by the linking phrases and sentences in the psychological capital literature.[b]
3. Examine the prevalence of recommendations and action claims, as well as other implications, that would require causal inference to have been made.[c]	3. Examine the prevalence of action claims, recommendations, and other implications that would require causal inference to have been made.[c]
4. Examine the prevalence of disconnections between the language used to describe relationships and implications subsequently drawn.[d]	4. Examine the prevalence of misalignments between causal implications of linking language and subsequent action implications.[d]
Secondary:	Secondary:
5. Develop a list of what linking words could be considered to imply causality, based on a guided framework.	5. Examine whether studies contain a transparent acknowledgement of an intent to draw causal inferences.

6. Document how the type and strength of language changes between the title, abstract, discussion, and action claim of journal articles.
7. Identify differences in the types and strength of language used across different types of studies, clinical areas, and journals.

Tertiary:

8. Examine trends in language over time.
9. Examine whether studies contain causal disclaimer statements.[e]
10. Examine language differences across journals.
11. Examine language differences across substantive medical topic areas.
12. Examine whether and how observational studies control/adjust for variables, and how that relates to language used.[f]
13. Examine and characterise modifying phrases used to describe relationships.

6. Examine whether studies contain explicit causal disclaimer statements, and whether causal links are implied anyway.[e]
7. Examine whether the authors explicitly used any strategies to increase credibility of causal inferences, such as explaining the intent of controlling/adjusting for a variable.[f]

Article selection

- Haber et al. determined the 15 highest-ranking health journals and used PubMed to identify all articles published within these journals within their specified time frame (2010-2019). The present study's initial article selection used a simplified approach.

Screening and selection

- Haber et al. had two levels of inclusion criteria: journal and article. The present study did not use journal as an inclusion criterion.

- Haber et al. required that the article's primary research question be concerned with one primary exposure and one primary outcome. Here, this criterion was extended to one *or more* variables in *any* of the research questions and included mediators, due to the high volume of studies in the psychological capital literature which investigate multiple research questions, exposures (or, as is more commonly worded in the psychology literature, predictor variables), and/or outcomes, and the prevalence of mediators in the literature. This change did not impact the objectives of this study, as we ensured that the selected linking sentence or action recommendation included psychological capital as either an independent variable or outcome variable, and this was factored into adjustments made to the review tool for data extraction.
- Haber et al. included a small selection of RCTs to address one of their secondary objectives. This secondary objective was not included in this study due to time and resource constraints and thus RCTs were not included.

Data extraction

Haber et al.'s (2022) review tool was adapted for greater applicability to the domain of psychological capital, including changes to questions and definitions for improved clarity and greater relevance to our present objectives.

- As mentioned above, their inclusion criteria was adapted to allow for studies with mediation models. Mediation inherently implies causality (Ghosh & Jacobson, 2016), although there is some argument that it is purely a statistical method (Hayes, 2013, as cited in Ghosh & Jacobson, 2016). Because mediation was used so commonly in the articles in our sample, when one sentence referenced mediators and another did not, the one which did not refer to a mediator was selected. This was in order to limit the extent to which conclusions might be driven by an assumption that reporting a mediation model implies causal inference.
- Questions relating to pop-outs were removed, as these are uncommon in this literature, as well as questions on causal theory explanations, as this was not relevant to the present study's objectives. Fewer options for the kind of formal causal model were included, based on what is commonly seen in research in this domain, and the response options for controlling variables were changed to 'yes/no' to suit our objectives. We also added a question on whether there was any acknowledgement of intent to draw causal inference to address our additional secondary objective (objective 5).

- Haber et al. reviewed all the articles' abstracts, but only one-third had the full text reviewed. In the present study, all articles were reviewed in full (i.e., abstract and discussion). This was decided after pre-registration once data extraction had begun, as many abstracts lacked action recommendations which would have severely limited the volume of data.
- When identifying linking sentences, Haber et al. selected the sentence which occurred first, however for the present study it was decided that selecting the sentence which maximally implied causation would provide greater insight.

Analysis

- The action recommendation analyses in the present study were performed on the data gathered from the discussion section, rather than the abstract. This was because few articles in the psychological capital literature included action recommendations within their abstracts.
- We did not separately rate the causality of the root words and the linking sentences; instead, the rating given to the respective linking sentence was used for root word analyses. This was due to the small-scale nature of this study, with one reviewer and only 50 articles.
- A Spearman's rho rank test was used here instead of ordinal logistic regression due to the simplicity of the analysis. With only one predictor variable and one outcome variable, it was decided that a simple Spearman's rho rank test would be sufficient.

Changes made to Review Tool after pre-registration

1. Question wording changes:
    a. In some instances, the word 'Exposure' had been used instead of 'Independent Variable'/'Predictor'; in all instances this was changed to 'Independent Variable' or 'Predictor'.
    b. It was made clear that when selecting identifying a linking sentence or action recommendation, the sentence selected must involve psychological capital in its capacity as either the independent/predictor variable or dependent/outcome variable.
    c. The description of Abstract: Primary Linking Sentence and Abstract: Primary Linking Word/Phrase was changed to specify that if there are multiple sentences

that equally meet these guidelines, the sentence with the strongest causal language was to be chosen.

d. The description of Discussion/Conclusion: Primary Linking Sentence was changed to specify that:
    i. The preference for this sentence is the first paragraph of the discussion or conclusions section,
    ii. If there are multiple sentences that equally meet these guidelines, the sentence with the strongest causal language should be chosen,
    iii. If there are none, the second paragraph should be reviewed, and so on until linking sentence is identified.
e. In the question “Discussion/conclusion: Action recommendation causal implication”, the response option “N/A: No action recommendation(s) provided in this *abstract*” was corrected to “N/A: No action recommendation(s) provided in this *discussion/conclusion*”
f. The question “Anywhere in text: Is "confounding" or "confounders" discussed or mentioned in relation to the methods, results, and/or interpretation of this study?” was edited to include “or "third variable"”.

2. The ‘Required’ settings on questions were removed where the description of the question said to leave blank if none.
3. The question “Introduction: Causal theory explanation sentence in introduction” & associated rating of causality was removed due to the broadness of question and its lack of relevance to the research objectives.
4. For the question “Introduction/methods: Formal causal model”, response options were streamlined by the removal of “equation-based toy model” and “simulation model”.
5. After data gathering, “causal directed acyclic graph (DAG)” was removed from the question “Introduction/methods: Formal causal model”, as no authors explicitly described their flowcharts as such, however some of these flowcharts with directed arrows might arguably constitute a DAG.