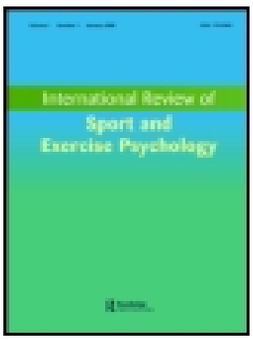

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Umbrella reviews (systematic review of reviews)

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ABSTRACT

With a 'downpour' of studies being published there is an increasing need to synthesize existing research to inform policy, practice and research. Umbrella reviews adopt explicit and systematic methods to search for, and identify, multiple systematic reviews and meta-analyses to compare and contrast findings of individual reviews, and provide an overall picture of findings for a particular research question. Using research on physical activity and mental health as a test case, we identified and assessed 11 umbrella reviews using recommended criteria from the Cochrane collaboration (Pollock et al., 2020). Our findings suggest that many methodological components of umbrella reviews were done well by the included reviews and are in line with best practice in conducting systematic reviews. Some issues, specific to umbrella review methodology, need further attention in future reviews. These include dealing explicitly with potential primary study overlap, using MeSH terms in search strategies, detailing the data extraction process and presenting all necessary information from primary studies and included systematic reviews. Opening an umbrella with these considerations in mind will help sport and exercise psychology researchers conduct such reviews in the future.

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Systematic review; methodology; sport; physical activity; mental health

Considering a rain of evidence

We are in the grip of a pandemic of evidence (Ioannidis, 2016). The impact of COVID-19 has only accelerated this phenomenon in disrupting science in a number ways but particularly through the startling increase in submissions as many of us 'worked from home' (Else, 2020). One analysis of submissions to Elsevier's health & medicine journals alone found an increase in submissions of 63% (from 147,401 submissions in February-May 2019 to 240,587 in the same period in 2020; Squazzoni et al., 2020). Irrespective of COVID-19, the growth in the number of active researchers globally, pressures of research evaluation processes that decide tenure and promotion, the rapid increase in available journal outlets, developments in online publishing, including the recent move toward preprint publishing, have all contributed to a huge and growing amount of evidence available to the public, practitioners and policy makers. Of course, one way to make sense of all of this evidence, that further adds to the evidence mix, is to create new output through knowledge syntheses such as scoping reviews, meta-analyses or realist syntheses.

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Inherent to biomedical science and evidence-based medicine, randomized controlled trials (RCTs) have become the gold standard approach for assessing treatment efficacy. Systematic reviews and meta-analyses (see this issue) then aim to synthesize the findings from these individual studies and explore inconsistencies and biases in the evidence. Reflecting the growth in publishing in general, there has been a similar explosion in the number of systematic reviews being published. Ioannidis (2016) reported that annual publications between 1991 and 2014 in PubMed increased 2,728% for systematic reviews and 2,635% for meta-analyses versus only 153% for all PubMed-indexed items. A key message from this analysis is that more systematic reviews of trials are being published annually than actual new randomized trials – a message to keep in mind when we later focus on the topic of research on physical activity and mental health. The logical next step is adopting explicit and systematic methods to search for and identify multiple systematic reviews and meta-analyses to compare and contrast findings of individual reviews, and provide an overall picture of findings for a particular phenomenon (Aromataris et al., 2015; Pollock et al. 2020).

Although a relatively new term, these are now commonly described as 'umbrella reviews', 'meta-reviews', 'overview of reviews' or 'review of reviews'. We think the term umbrella review is quite apt as such reviews provide an "umbrella that prevents you from getting 'soaking wet' under a 'rain of evidence'" (Biondi-Zoccai, 2016, p. VIII). Through an evidence-based medicine lens, if conducted in a rigorous and transparent methodological process, umbrella reviews are considered one of the highest levels of evidence synthesis available (Fusar-Poli & Radua, 2018). As a result, they might significantly impact research, policy, and practice by allowing a decision maker to 'zoom out' to larger scales of evidence in interpreting the strengths and limitations of existing knowledge (Ioannidis, 2009). This may be particularly useful when research questions are wide in scope (e.g. assessing different interventions for helping athletes with anxiety) or when evidence is rapidly required to inform a new policy or procedure and existing reviews are available (e.g. developing a new physical activity guideline for health).

Umbrella reviews currently appear rare in the field of sport and exercise psychology. Using related search terms ("review of reviews," "systematic review of reviews," "review of systematic reviews," "overviews of reviews," "summary of systematic reviews," "summary of reviews," and "synthesis of reviews") and handsearching of the table of contents of 5 sport and exercise psychology journals up to November 2020 (*International Review of Sport and Exercise Psychology; Psychology of Sport and Exercise; Journal of Sport and Exercise Psychology; International Journal of Sport and Exercise Psychology; Sport, Exercise and Performance Psychology*), we found only two review of reviews with one published in the *International Review of Sport and Exercise Psychology* (Biddle et al., 2011) and the other in the *Psychology of Sport and Exercise* (Biddle et al., 2019). Notably, both are focused on physical activity rather than sport. By definition, the need for an umbrella review at a minimum, arguably rests on whether there are at least two existing systematic reviews to consider. So the presence or absence of umbrella reviews in any given field reflects the relative maturity of investigation into a particular research question, and whether sufficient primary studies have been conducted that warrant systematic review. Our brief scan of a limited number of discipline specific journals suggests that may not yet be the case for sport psychology topics.

An example, in contrast, is the development of evidence-based statements, or guidelines, on recommended physical activity levels for good health. While guidelines by themselves are unlikely to lead to behavior change, they can serve several important functions including raising awareness about physical activity, informing national policy, and underpinning monitoring and surveillance, and guiding future research directions (Milton et al., 2020). Creating guidelines requires a rigorous synthesis of existing evidence but typically within a limited timeframe and resources. Accordingly, relying on existing systematic reviews or umbrella reviews becomes a necessity. In Canada, new 24-hour Movement Guidelines for Adults aged 18–64 years and Adults aged 65 years or older were released in 2020 (Ross et al., 2020). Reflecting the 24 hours in a day, these guidelines provide recommendations for physical activity, sedentary behavior and sleep. With a year to conduct the work to inform the guideline recommendation and to complement planned systematic reviews, four umbrella reviews were conducted to examine the health benefits of resistance training (El-Kotob et al., 2020) and balance and functional training (McLaughlin et al., 2020), the relationship between different modes of sedentary behavior and patterns of sedentary time and health (Saunders et al., 2020), and sleep duration and health (Chaput et al., 2020). Across the four umbrella reviews, 45 systematic reviews were identified, consisting of 950 primary studies and over 5 385 000 participants (Kho et al., 2020). This illustrates the role that umbrella reviews can play in efficiently appraising a large volume of research to inform a clear outcome and deliverable such as a guideline. Kho et al. (2020) describe this process in detail, and they provide a clear roadmap for others interested in conducting an overview of systematic reviews for guideline development. A short summary of the umbrella and systematic review methodology to support the US physical activity guidelines is also available (Torres et al., 2018).

Opening the umbrella

The defining feature of umbrella reviews is that a systematic review is the unit of searching, inclusion and data analysis (Pollock et al., 2020). While there may be flexibility in the unit that a systematic review itself is dealing with (an RCT or a cross-sectional study for example), it is necessary that a rigorous and replicable search strategy was conducted to identify those units. If you were to read no more about umbrella review methodology, a starting point for conducting one would be to follow best practice guidance in conducting a systematic review (Hartling et al., 2012), and those familiar with conducting systematic reviews will recognize the similarities in process and methods used for an umbrella review (Aromataris et al., 2015). However, there are some important distinctions to be aware of. Table 1 provides an overview of differences between systematic reviews and umbrella reviews (Pollock et al., 2020).

Fortunately, there is no shortage of advice on how to do an umbrella review. Gates et al. (2020) conducted a scoping review of existing guidance on the conduct of overviews between 2009 and 2020. They identified 59 documents produced by 24 research groups providing explicit methods guidance. Both the Cochrane Collaboration (Pollock et al., 2020) and the Joanna Briggs Institute (Aromataris et al., 2020) have recently released guidelines for conducting umbrella reviews and these are both recommended by Gates and colleagues (2020). The research team that developed the Cochrane guidance is now working on the Preferred Reporting Items for Overviews of Reviews (PRIOR) which

Table 1. Comparison of methods between Systematic Reviews and Umbrella Reviews [adapted from Pollock et al. (2020)].

	Systematic Reviews	Umbrella Reviews
Objective	To summarize evidence from *primary studies*	To summarize evidence from *systematic reviews*
Selection criteria	Describe clinical and methodological inclusion and exclusion criteria. The study design of interest is the *primary study*.	Describe methodological inclusion and exclusion criteria. The study design of interest is the *systematic review*.
Search	Comprehensive search for relevant *primary studies*.	Comprehensive search for relevant *systematic reviews*.
Inclusion	Include all *primary studies* that fulfil eligibility criteria.	Include all *systematic reviews* that fulfil eligibility criteria.
Assessment of methodological quality/risk of bias	Assess risk of bias of included *primary studies*.	Assess methodological quality/risk of bias of included *systematic reviews*, and primary studies contained within included systematic reviews.
Data collection	From included *primary studies*.	From included *systematic reviews*.
Analysis	Synthesize results across included *primary studies* for each important outcome using meta-analyses, network meta-analyses, and/or narrative summaries.	Summarize and/or re-analyse outcome data that are contained within included *systematic reviews*.

will be a consensus-made check-list for overviews (Pollock et al., 2019b). This should be available in 2021-2022, and much like similar check-lists such as the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA; Liberati et al., 2009), will provide a framework for peer reviewers, journal editors, and healthcare decision-makers to critically appraise umbrella reviews (Pollock et al., 2019b).

Given that evidence-informed, consensus-based guidelines are nearly available, there seems little point in rehashing in detail all the steps in conducting an umbrella review. Rather, using as an illustrative case the research field of physical activity and mental health, a sub-field of exercise psychology, we will first compare the review methodology of 11 umbrella reviews using a check-list based on the key aspects of the Cochrane Chapter on "how to conduct overviews of reviews" (Pollock et al., 2020). We will then finish by reflecting on this assessment drawing on Hennessy and colleagues' (2019) practical steps for addressing some of the unique challenges of conducting an umbrella review.

Methods

An 'explosion' in systematic reviews of physical activity interventions has led to recognizing the need for higher-level syntheses (Baker et al., 2014). In the last few decades, there has been growing attention to the relationship between mental health and physical activity – in considering mental health as both an antecedent and consequence of physical activity participation. This includes the use of exercise and or physical activity as a treatment for mental illness (e.g. depression, anxiety). Given the growth of research on this topic and reflecting our own research interests, we were familiar with a number of umbrella reviews published in the field. This formed the basis of our decision to review the umbrella methodology used by researchers interested in physical activity as an intervention for mental health. We do this to illustrate key considerations in conducting an umbrella review rather than as a critique of those identified reviews.

Identifying the umbrella reviews

A search in Medline and Google Scholar was completed to identify umbrella reviews in the field of physical activity/exercise and mental health. In terms of Medline, an extensive search was completed, which is listed below. For Google Scholar, a more simplistic approach was taken by combining only keywords, and the first five pages of the search results were collected. After two authors screened the initial search titles and abstracts, and where agreement could not be made between the initial two screeners, the third author was brought in to decide. After screening, full-text screening was completed to identify the texts that were included in the review (see figure 1).

Search strategy

Medline

Creating the search strategy was done by combining MeSH terms and keywords in three distinct areas. The three areas are study design (umbrella reviews), physical activity/exercise, and mental health. The full search is below separated into these three sections.

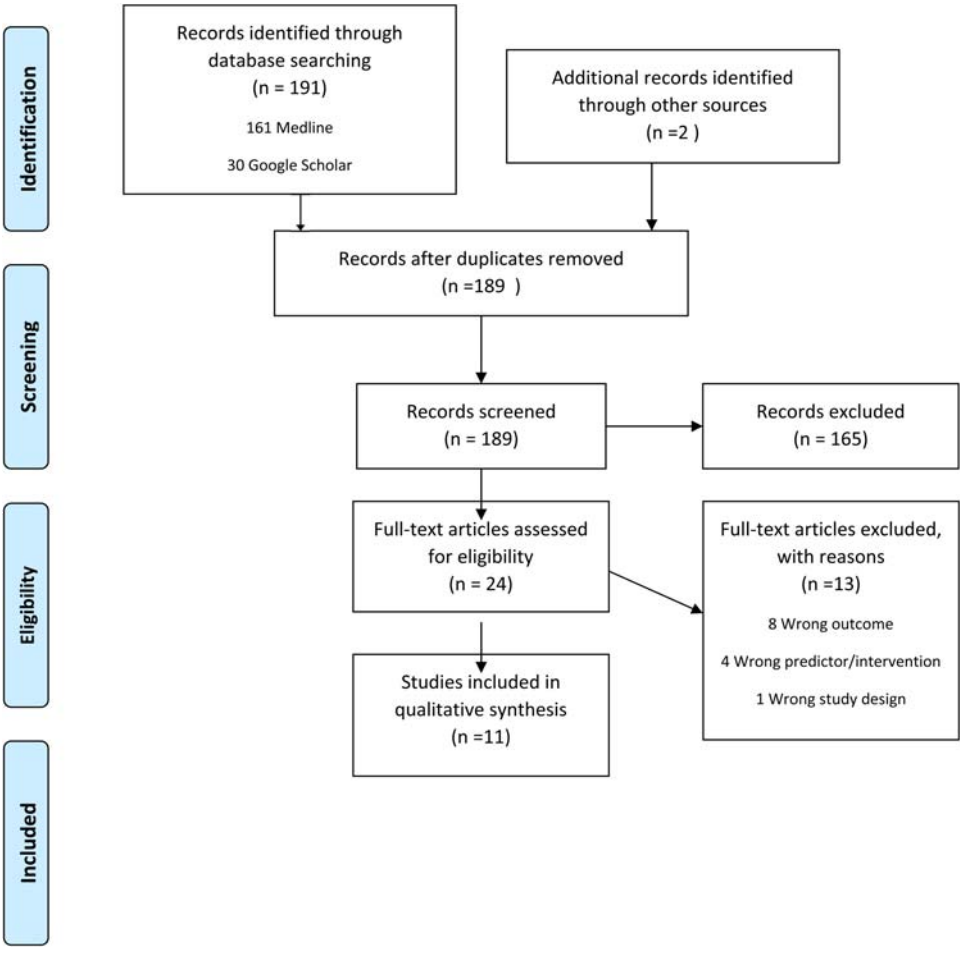

Figure 1. PRISMA Flow Chart.

Study design. exp Systematic Reviews as Topic/ or umbrella review.mp. or exp Meta-Analysis as Topic/ or systematic reviews of systematic reviews.mp. or systematic reviews of meta-analysis.mp. or meta-analysis of meta-analysis.mp. or systematic review of meta-analyses.mp. or meta-analysis of meta-analyses.mp. or umbrella systematic review.mp. or meta-review.mp. or review of reviews.mp. or meta-meta-analysis.mp.

Exercise/Physical activity. exercise/ or gymnastics/ or exp physical conditioning, human/ or running/ or jogging/ or swimming/ or walking/ or stair climbing/ physical fitness/ or cardiorespiratory fitness/ ((physical adj3 (fitness or activit* or conditioning)) or exercis* or athletic* or sport*).mp.

Mental Health. exp mental health/ or exp mental disorders/ or anxiety disorders/ or "bipolar and related disorders"/ or "disruptive, impulse control, and conduct disorders"/ or dissociative disorders/ or elimination disorders/ or "feeding and eating disorders"/ or mood disorders/ or motor disorders/ or neurocognitive disorders/ or neurodevelopmental disorders/ or neurotic disorders/ or paraphilic disorders/ or personality disorders/ or "schizophrenia spectrum and other psychotic disorders"/ or sexual dysfunctions, psychological/ or sleep wake disorders/ or somatoform disorders/ or substance-related disorders/ or "trauma and stressor related disorders"/ or anxiety.mp. or depression.mp. or major depressive disorder.mp. or anxiety disorder.mp. or mental.mp. or mental health.mp.

Google Scholar

The search was completed with the term "Exercise and mental health umbrella review". Only the first 30 articles were considered.

Inclusion criteria

To be included in the paper, the umbrella review must have 1) been an umbrella review (i.e. review of review), 2) included only mental health outcomes (e.g. depression scores, anxiety scores), 3) either a physical activity/exercise predictor (for longitudinal design or cross-sectional) or an intervention group involving physical activity/ exercise (for randomized control trial designs).

Data extraction

Using the Cochrane guidance (Pollock et al., 2020), a data extraction form was created regarding key elements of review methodology although this was not an exhaustive check-list (see Table 2). Data were extracted independently by the three authors. After evaluating the articles, the three authors met, discussed, and resolved any discrepancies which were largely related to more subjective criteria such as whether the research question was a good 'fit' for an overview. Research articles were scored for each criterion with Yes=1, No=0 or N/A.

Results

Overall, 11 umbrella reviews met the inclusion criteria for further analysis (Ashdown-Franks et al., 2020; Biddle et al., 2019; Biddle & Asare, 2011; Catalan-Matamoros et al., 2016; Dale et al., 2019; Daley, 2008; Hu et al., 2020; Kelley & Kelley, 2014; Rebar et al.,

Table 2. Criteria and Assessment of Included Umbrella Reviews [adopted from Pollock et al. (2020)]

Authors	Ashdown-Franks, 2020	Biddle, 2019	Biddle, 2011	Catalan-Matamoros, 2016	Dale, 2019	Daley, 2008	Hu, 2020	Kelley, 2014	Rebar, 2015	Stubbs, 2018	Wegner, 2020	Total
Overview criteria												
Defining the research question and assessing overview suitability												
An overview's research question should include a clear description of the populations, interventions, comparators, outcome measures, time periods, or settings.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
Is the research question a 'good fit' for an Overview? (i.e. enough evidence available from systematic reviews, broader scope, target audience, purpose is to inform healthcare decisions).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
Developing criteria for including systematic reviews												
The inclusion criteria should include a clear description of all relevant study characteristics (i.e. populations, interventions, comparators, outcome measures, time periods, settings)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	10
The inclusion criteria should specify how the authors define 'systematic reviews' or the type of methodology accepted (i.e. systematic reviews of randomized controlled trials only, or systematic reviews that include variable study designs such as observational studies).	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8
Managing overlapping systematic reviews												
Criteria set in place to deal with overlapping reviews	No	No	No	No	No	No	No	No	Yes	No	No	1
A citation matrix should be used to visually demonstrate the amount of overlap of primary studies included in the systematic reviews.	No	No*	No	No	No	No	No*	No	No	No	Yes	1
Searching and selecting systematic reviews for inclusion												
	No	No	No	No	Yes	No	Yes	Yes	Yes	No	Yes	5

(*Continued*)

Table 2. Continued.

Authors	Ashdown-Franks, 2020	Biddle, 2019	Biddle, 2011	Catalan-Matamoros, 2016	Dale, 2019	Daley, 2008	Hu, 2020	Kelley, 2014	Rebar, 2015	Stubbs, 2018	Wegner, 2020	Total
A comprehensive and reproducible literature search should be conducted using MeSH headings "reviews" and "systematic reviews" within commonly recognized databases (e.g. Medline, Embase, Cochrane)												
Systematic reviews collated by the literature search should be evaluated against the Overview inclusion criteria.	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	10
Extracting data from included systematic reviews												
Overview authors should establish in advance how they will deal with extracting missing or inadequately reported data	No	No	No	No	No	No	No	No	No	No	No	0
Data extraction should be conducted by two independent reviewers with clear guidelines for resolving discrepancies	No	No	No	No	No	No	No	Yes	No	Yes	No	2
Assessing methodological quality/risk of bias for included systematic reviews and their primary studies												
Methodological quality and risk of bias for systematic reviews should be assessed using either tools such as AMSTAR	Yes	Yes	No	Yes	No*	No	Yes	Yes	Yes	Yes	Yes	8
Overview authors should include: a table that provides a breakdown of how each systematic review was rated on each question of the tool, the rationale behind the assessments, and an overall rating for each systematic review (if appropriate).	No	No	No	Yes	No	No	Yes	Yes	No	No	No	3
Authors should extract and report the domain-specific and/or overall quality/risk of bias assessments for the relevant primary studies contained within each included systematic review	No	No	No	No	No	No	No	No	No	No	Yes	1
Collecting and presenting data on descriptive characteristics of included systematic reviews (and their primary studies)												
The following descriptive characteristics of each systematic review should be presented if	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	9

relevant: a. Basic information b. Search strategies c. Population d. Interventions e. Comparators f. Primary and secondary outcomes												
Information about the primary studies should also be described (e.g. authors; year of publication; study design; country of publication)	No	No	No	No	No	No	No*	No	No	No	No	0
Collecting, analyzing and presenting quantitative outcome data												
When summarizing outcome data, data should be extracted as they were reported in the underlying systematic reviews and then reformatted and presented in text, tables and/or figures, as appropriate.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
Overview authors who re-analyze outcome data should use the standard meta-analytic principles.	N/A	N/A	N/A	Yes	N/A	N/A	N/A	Yes	Yes	N/A	Yes	4
Total	7^	7^	6^	10	7^	4^	10^	12	11	9^	12	
Mean(SD)												m=8.64 (3.38)

Note. ^ = total score was out of 16. *=score was given a no, but certain aspects of the criteria were met. SD = standard deviation.

2015; Stubbs et al., 2018; Wegner et al., 2020). Please see Figure 1 for the PRISMA flow chart of included reviews. The umbrella reviews scored an average of 8.64 (SD=3.38)(see Table 2). The maximum score was 16 or 17, depending on if the umbrella review included a new meta-analysis of the systematic reviews which may not always be appropriate. All of the included reviews scored a point for "An overview's research question should include a clear description of the populations, interventions, comparators, outcome measures, time periods, or settings.", "Is the research question a 'good fit' for an overview? (i.e. enough evidence available from systematic reviews, broader scope, target audience, purpose is to inform healthcare decisions)." and "When summarizing outcome data, data should be extracted as they were reported in the underlying systematic reviews and then reformatted and presented in text, tables and/or figures, as appropriate."

None of the overviews scored a point for "Overview authors should establish in advance how they will deal with extracting missing or inadequately reported data" and "Information about the primary studies should also be described (e.g. authors; year of publication; study design; country of publication)".

Only one review (Wegner et al., 2020) scored a point for "Authors should extract and report the domain-specific and/or the overall quality/risk of bias assessments for the relevant primary studies contained within each included systematic review". One review (Kelley & Kelley, 2014) scored a point for "Criteria set in place to deal with overlapping reviews". One review (Wegner et al., 2020) scored a point for "A citation matrix should be used to visually demonstrate the amount of overlap of primary studies included in the systematic reviews." Two reviews (Kelley & Kelley, 2014; Stubbs et al., 2018) scored a point for "Data extraction should be conducted by two independent reviewers with clear guidelines for resolving discrepancies". Table 2 presents each review's score on the criteria. It is not a surprise that reviews meeting the fewest criteria (Daley, 2008; Biddle & Asare, 2011) were published before the first extensive guidance was available (Aromataris et al., 2014).

Top guidelines to ensure best practice in sport and exercise psychology

Umbrella reviews summarize multiple systematic reviews or meta-analyses to provide a 'catch all' paper in the field. We used the Cochrane Chapter on conducting umbrella reviews (i.e. overviews) to create the criteria for assessing the umbrella reviews (Pollock et al., 2020). We then identified 11 umbrella reviews in the field of physical activity and mental health. In reviewing these, we found that many of the umbrella reviews do a sound job describing the scope, assessing the quality of the included reviews and using appropriate methods to extract and present the results. However, certain aspects of the recommended methodology were not reported in many of the umbrella reviews. These should be addressed in the future (e.g. dealing with overlap, using MeSH terms in the search strategy, detailing the data extraction process and presenting all necessary information from primary studies and included systematic reviews). This discussion will outline the areas that the umbrella reviews did well and highlight some top guidelines (Hennessy et al., 2019) in ensuring best practice in sport and exercise psychology.

Detailing a clear scope

Formulating the research question and review scope is the important first step that then informs later methodological decisions. This requires some familiarity with the existing literature and a decision as to whether a systematic review might be more appropriate – particularly if existing systematic reviews are considered out of date. Hennessy et al. (2019) suggest that while there is not necessarily a 'wrong' focus for an umbrella review, authors should focus on "bridging literatures or illuminating discrepant findings" (p. 357) or on topics that are controversial or when potential biases have not been systematically examined (Papatheodorou, 2019). All of the included umbrella reviews adequately outlined their reviews' scope and purpose. Biddle et al. (2019) provide an updated umbrella review of physical activity and mental health in children and adolescents but extends the focus by assessing whether mental health outcomes could be considered causally associated with physical activity. Treading similar ground, one review was used to inform an Expert Statement on Physical Activity and Brain Health for Children and Youth within a tight timeframe (Dale et al., 2019). Both can be considered bridging literature as were several others in our sample where there was an interest in examining the impact of physical activity as a treatment across different populations (Ashdown-Franks et al., 2020; Stubbs et al., 2018). Others were more narrow in scope in considering exercise as a treatment for depression in specific populations including adults with arthritis and other rheumatic diseases (Kelley & Kelley, 2014), older adults (Catalan-Matamoros et al., 2016) or children and adolescents (Wegner et al., 2020). An umbrella review should go beyond just reiterating the findings from each systematic review and offer new insights through their collective synthesis.

Identifying synthesis literature through strategic searches

As with all systematic reviews, an umbrella review must have a systematic, transparent and reproducible search strategy. An important step will be deciding how to define a 'systematic review' in the context of no single agreed upon definition (Gates et al., 2020). There may be a restriction to certain types of reviews (e.g. meta-analyses) or relevant criteria set by the systematic reviews themselves (e.g. study design). In our sample of reviews, the inclusion criteria of reviews and search strategies were generally well described, although not all studies explicitly defined 'systematic review' in their methods. Many of the included umbrella reviews did not utilize MeSH terms in their search strategies (6/11). Without the inclusion of MeSH terms the search may be subject to missing studies that should be included in the umbrella reviews, and including MeSH terms of systematic review study designs is recommended (Pollock et al., 2020).

There are two areas, particularly with data extraction, that the included umbrella reviews did not do particularly well. These likely reflect more the level of detail in reporting rather than the quality of the umbrella reviews per se. First, authors should consider and state how they will proceed if data they are interested in extracting is not available, or inadequately reported (Pollock et al., 2020). This was not done in any of the reviews we sampled. This may reflect the broad nature of the research questions where potential for such missing data was not anticipated. An example might be a secondary interest in attrition in the exercise interventions being reviewed – are people more likely to

drop out of an exercise intervention compared to comparison groups? Inferences might then be made about the acceptability of exercise as an intervention. If authors need to extract important data from the primary studies then it might indicate a systematic review is actually needed. Second, the data extraction should be conducted independently by two reviewers with clear guidelines for resolving any discrepancies (2/11 of the included umbrella reviews explicitly articulated how this criterion was met). One review that met this described that "both authors coded all studies independent of each other. Upon completion of coding, all coding sheets were merged into one common codebook and reviewed by both authors for correctness. Disagreements were resolved by consensus" (Kelley & Kelley, 2014, p. 2). Addressing this criterion has important resource implications to undertake a review in the first place but is an important need to ensure as few errors as possible are made in the screening and data extraction process. Hennessy et al. (2019) provide a clear and transferable template for data extraction that could be implemented for sport and exercise psychology umbrella reviews.

Considering overlap of the literature

All of the umbrella reviews we assessed conclude that there is evidence for physical activity in improving a range of mental health outcomes. To what extent do the systematic reviews being included consist of the same primary studies? Potential overlap in included studies may introduce bias by including the same primary study's outcome data multiple times, and double-counting outcome data may give some studies too much influence (Pollock et al., 2020) and lead to misinterpretation of the umbrella reviews' results. The majority of the sampled umbrella reviews did not explicitly discuss how overlap was going to be dealt with, nor how it would be handled if overlap was found. Wegner et al. (2020) provide a contrasting example in their review of exercise interventions for depression among children and youth. In a table, they list the overlap of single studies in each of the four systematic reviews they found in their search. They then use this information to only include each primary study once in their meta-analysis. This is one area where umbrella reviews can improve in the field of sport and exercise psychology.

This lack of attention to overlap is consistent with previous work done on the subject in other fields (Pieper et al., 2014). Pieper et al. (2014) found that only 53.3% of the studies identified in their review mention overlap. They developed a statistical approach to report overlap among overviews. Their approach is called a corrected covered area or CCA. This starts with the creation of a citation matrix with primary publication citations (one per row) and individual reviews (one per column). Each primary publication that is included in each review is then checked. Then the following formula calculates CCA.

$$CCA = \frac{N - r}{r\,(c - r)}$$

Where N is the total number of included publications in the reviews, r is the number of rows (primary studies), and c is the number of columns (included reviews). Finally, the interpretation of the CCA score of 0-5% would be considered slight, 6–10 moderate, 11–15 high, and >15 very high overlap. We suggest that using this statistical approach with a matrix table (a visual representation of the

overlap) should be included in all umbrella reviews. This will help interpret the final results of the umbrella review.

There is new guidance on handling primary study overlap that recommends moving beyond just reporting the CCA score (Hennessy & Johnson, 2020) and embracing the overlap issue. Both high and low overlap may be informative. High overlap provides an opportunity to compare conclusions made by review authors and to explore why any divergence in interpretation exists (if at all). Low overlap may indicate the need to closely examine the search strategies of the systematic reviews particularly if the umbrella review's research question was narrow in focus. Suppose there are two meta-analyses or systematic reviews addressing the same question and/or with large overlap of primary studies. In that case, selecting the meta-analysis or review with the largest database and the one most recently published, might be more efficient than conducting an umbrella review (Fusar-Poli & Radua, 2018). A decision tool for selecting systematic reviews for inclusion in overviews of reviews can be considered (Pollock et al., 2019a).

Choosing and applying review quality tools

When assessing the quality of the included reviews, many tools have been suggested (e.g. AMSTAR, AMSTAR-2, ROBIS; Shea et al., 2007, 2017; Whiting et al., 2016). The majority (8/11) of the included umbrella reviews included an appropriate tool for assessing each study's quality. The most-reported assessment tool was the AMSTAR or AMSTAR-2. AMSTAR-2 is likely relevant to sport and exercise psychology as it can be applied for both randomized and non-randomized intervention studies. Stubbs et al. (2018) provide an example of how the quality of the systematic reviews or meta-analyses can then be linked to grading of specific recommendations. Some umbrella reviews could use the GRADE tool (Guyatt et al., 2008) to assess and report the certainty of evidence for any pre-defined, outcomes of interest.

However, umbrella reviews are limited by the amount, quality and comprehensiveness of the information in the primary studies (Ioannidis, 2009). Both the Cochrane Collaboration (Pollock et al., 2020) and Hennessy et al., 2019) outline the importance of presenting information on the quality of the primary studies included in each systematic review as it is possible to have a high-quality review with lower quality primary studies. As Weir et al. (2016) comment, all that glitters is not gold if poor quality studies are included in systematic reviews. Such assessment of the primary studies was not done consistently in the umbrella reviews included in our sample and could lead to misrepresentation of the findings. This is not uncommon more broadly in the reporting of umbrella reviews (Hartling et al., 2012). It is recommended that authors extract the assessments that are presented in each included systematic review in narrative or table summaries.

Appropriate options for handling synthesis and reporting

Ensuring the right approach when synthesizing the data that has been extracted from your included reviews is another important consideration. Both the Cochrane Collaboration (Pollock et al., 2020) and Hennessy et al. (2019) provide excellent recommendations

for doing such a task. For example, Pollock and colleagues breaks down this analysis into a continuum anchored by summarizing and re-analyzing outcome data. Where the umbrella review falls on this continuum is related to the objectives and available data. This is re-emphasized in the Hennessy et al. (2019) review of best practice, as they provide three synthesis options; narrative synthesis, semi-quantitative synthesis or quantitative synthesis. Within the included umbrella reviews in our paper, we found that majority of the reviews extracted data as they were reported in the underlying systematic reviews and then re-presented in the umbrella results section. In terms of quantitative analysis, the included umbrella reviews (with a meta-analysis portion) analyzed the data appropriately. For example, Rebar et al. (2015), after accounting for the overlap in studies between meta-analyses, and removing meta-analyses with low quality ratings, reported that physical activity reduced depression by a medium effect with no significant heterogeneity across meta-analyses. In the future, it may be beneficial to have a potential check-list that provides guidelines on when to perform a meta-analysis in an umbrella review and when to provide a narrative synthesis. Pollock et al. (2020) provides some guidance in the context of Cochrane overviews.

Reporting the large amount of data extracted or re-analyzed can be a difficult task to undertake. However, to gain the full picture of the results, many aspects of the systematic reviews need to be reported. For example, within the included umbrella reviews in our paper, we found that most of them present descriptive results of their included reviews well (9/11 were deemed adequate). However, two areas may need greater attention in the future. First, documenting and presenting the search strategies used by the included reviews. This is important as it provides insight into datedness and can provide a better sense as to whether appropriate databases were searched. Second, more information is needed about the primary studies as 0/11 described them in a meaningful way. The Cochrane Collaboration (Pollock et al., 2020) suggests that information regarding the primary studies' descriptive characteristics and risk of bias should be described. However, this appears to be one issue where there is ongoing debate about whether, when, and how supplemental primary studies should be included in overviews (Gates et al., 2020). The need to examine the primary studies might appear counterintuitive when considering the goal of the umbrella review is to synthesize findings at the level of the systematic review. However, data may be poorly extracted from the primary studies and/or important information not provided. Accordingly, overview authors are recommended to carefully check systematic reviews for errors in data extraction as these errors may be further compounded in the umbrella review (Gates et al., 2020).

Closing the umbrella

The purpose of this review was to provide an introduction to umbrella reviews, highlight key literature in the field to help researchers conduct such reviews, and identify common gaps in how these reviews have been conducted thus far in the illustrative research field of physical activity and mental health. These gaps include the need to deal explicitly with potential primary study overlap, using MeSH terms in the search strategy, detailing the data extraction process and presenting all necessary information from primary studies and included systematic reviews. All should be dealt with in the protocol (and pre-registered) phase of developing an umbrella review. While umbrella reviews are not regularly

reported in the field of sport and exercise psychology their appearance is likely to emerge as the volume of research being conducted continues to grow rapidly. Umbrella reviews can provide a comprehensive overview of a specific research topic and will be increasingly important for translating research findings into recommendations, and in identifying new research directions (Schlesinger et al., 2019).

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