Preregistration for ‘Data Processing Strategies to Determine Maximum Oxygen Uptake: A Systematic Scoping Review and Experimental Comparison’

Simon Nolte

This document includes the preregistration of the aforementioned project. It follows the ‘Inclusive Systematic Review Registration Form’ (Akker et al., 2020). For more information on the distinct parts of the planed work including analysis code, visit the accompanying file `detail_review.pdf` and `details_comparison.pdf`.

Meta-data

Target discipline

Sport Science; Sports Medicine

Title

‘Data Processing Strategies to Determine Maximum Oxygen Uptake: A Systematic Scoping Review and Experimental Comparison’

Author(s)/Contributor(s)

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Tasks and Roles

SN: Conceptualization; Data curation; Formal Analysis; Software; Investigation; Methodology; Visualization; Writing

OJQ: Conceptualization, Investigation; Methodology

Review methods

Type of Review

Scoping review, following the PRISMA-ScR guidelines (Tricco et al., 2018). Accompanied by an empirical analysis (see `details_comparison.pdf` for more information)

Review Stages

Search, Automated Screening, Random Sampling, Manual Screening, Extraction

Current review stage

Before Search; the project has not started yet.

Start date

05 March 2022

End date

30 April 2022 (for data extraction)

Background

As the most relevant physiological determinant of endurance performance, the maximum oxygen uptake ($\dot{V}O_{2max}$) is determined by measuring gas exchange measures during cardiopulmonary exercise testing (Bassett, 2000). Different processing routines of the collected raw data lead to different $\dot{V}O_{2max}$ values (Robergs & Burnett, 2003).

Robergs et al. (2010) aimed to map the current state of data processing strategies in scientific cardiopulmonary exercise testing. They stated that there exist "two potential methods for this content: (i) a summary of published research, and (ii) a survey circulated via the Internet to as many exercise physiologists as possible," while choosing the latter for their article (Robergs et al., 2010). A systematic review of published research on the data processing methods for $\dot{V}O_{2max}$ determination has yet not been conducted.

Once the most common strategies have been identified in the literature, they can be compared in terms of their influence on determining the $\dot{V}O_{2max}$. Martin-Rincon et al. (2019) compared an arbitrary chosen set of data processing strategies, but only on a group level in an assorted data set of mostly recreational or untrained individuals. Systematic comparisons on an individual level in well-trained athletes while controlling for external factors (protocol, measurement device, …) are lacking.

Primary research question

Which methods for processing of gas exchange data are currently used in the scientific literature when determining the maximum oxygen uptake?

Secondary research question

How do the commonly used strategies for data processing influence the determined value for the maximum oxygen uptake?

Expectations / hypotheses

— No hypothesis tested due to the mapping character of the review —

— The empirical part of the project is purely descriptive —

Dependent variable(s) / outcome(s) / main variable(s)

Data processing strategy used

Independent variable(s) / interventions(s) / treatment(s)

— No independent variables used —

Additional variable(s) / covariate(s)

- Metabolic cart used
- Data preprocessing algorithm used

Software

R Version 4.x (R Core Team, 2021)

Funding

— No funding was received for this project —

Conflicts of interest

— All researchers involved state that there is no conflict of interest —

Overlapping authorship

— No overlapping authorship is expected —

Search Strategy

Databases

PubMed & Web of Science

Interfaces

PubMed & Web of Science

Grey literature

— No grey literature will be searched —

Inclusion and exclusion criteria

Inclusion:

- only research related to ‘maximum oxygen uptake’ (or similar term in title, abstract or keywords)
- only research published in 2017 or later

Query strings

PubMed: `(((((("maximum oxygen uptake") OR ("maximal oxygen uptake")) OR ("VO2max")) OR ("maximum oxygen consumption")) OR ("maximal oxygen consumption")) AND (("2017/01/01"[Date - Publication] : "3000"[Date - Publication]))`

Web of Science: `(((((ALL=("maximum oxygen uptake")) OR ALL=("maximal oxygen uptake")) OR ALL=("VO2max")) OR ALL=("maximum oxygen consumption")) OR ALL=("maximal oxygen consumption")) AND PY=(2017-2022)`

Search validation

— no search validation procedure is conducted, as we aim to only map current methodical practices on a sample of research articles. We do not believe that our search strategy incorporates a systematic bias towards this goal. —

Other search strategies

— No further search strategies are used —

Procedures to contact authors

— We will not contact any authors during the review —

Results of contacting authors

— Not applicable as we do not contact authors —

Search expiration and repetition

We will conduct one single literature search in March 2022, which will not be repeated.

Search strategy justification

We aim to map current methodical practices in a specific yet often employed setting (determining maximum oxygen uptake). As measurement devices and methods change with time, we decided to include only studies from the past five years (2017 to today). We want to keep the initial search quite broad to have a better control of article exclusion in later stages (e.g. by automated title screening instead of additional initial exclusion criteria in search). As we later only take a random sample of our search results, we do not need to exhaustively review the literature, which is why we refrain from searching additional databases and grey literature.

Based on Robergs et al. (2010) we use the term $\dot{V}O_{2max}$ to denote the highest oxygen uptake during a short exercise test until subjective exhaustion. Criteria to distinguish between $\dot{V}O_{2max}$ and $\dot{V}O_{2peak}$ are not universally accepted and heavily rely on the method used to process the gas exchange data (e.g. $\dot{V}O_2$ plateau as primary criteria or RER_{max} as secondary criteria). We do not use $\dot{V}O_{2peak}$ as a search term, as we expect such search to return many studies using exercise protocols that are generally not considered eligible for determining the maximum oxygen uptake.

We believe that our search strategy provides a reasonable subset of the current scientific literature determining the $\dot{V}O_{2max}$.

Screening

Screening stages

1. Automated screening from Titles and meta data
2. Automated removal of duplicates (based on DOI)
3. Random sample of 500 articles
4. Manual title and abstract screening
5. Full-text retrieval and screening
6. Data extraction
7. *If less than 200 results remain after step 5, we will add an additional random sample of 100 article (step 3). This may be repeated until a minimum of 200 articles remains in step 5.*

Screened fields / blinding

During manual title and abstract screening, all additional information will be blinded to the person screening. During full text screening no blinding applies. More information are available in the `details_review.pdf` file.

Used exclusion criteria

During automated screening:

- No DOI attached
- Title contains at least one of the following phrases: ‘review’; ‘correction’; ‘meta-analysis’; ‘comment’; ‘retraction’; ‘editorial’; ‘erratum’; ‘reply’
- article duplicated (based on DOI assigned)

During manual abstract screening:

- text not in English language
- no original research article
- no research in humans
- $\dot{V}O_{2max}$ not measured (e.g. only estimated)

During manual text screening:

- no full text available
- all of the above criteria (from manual abstract screening)
- $\dot{V}O_2$ not continuously measured
- testing protocol not to subjective exhaustion
- testing protocol longer than 20 minutes (on average)

Screener instructions

— See document `details_review.pdf` for more details —

Screening reliability

All screening will be employed by two independent screeners (SN and OJQ).

Screening reconciliation procedure

Conflicts during screening will be resolved by discussion between the two screeners.

Sampling and sampling size

After the automated title and meta data screening and removing of duplicates, we will perform a random sample of 500 articles (see `detail_review.pdf` for technical details).

We believe a final sample size of 200 studies after all exclusion steps to be sufficient, assuming that about half of these lack appropriate reporting of methods, and half contain valuable information. We expect about 50% of the initially sampled articles to be excluded during abstract and full-text screening and therefore use the sampling size of 500.

If after all exclusion steps less than 200 articles remain, we will extend the random sampling by an additional 100 articles (using the same random seed), until the threshold of 200 articles after final exclusion is meet.

Screening procedure justification

Due to economical and methodological reasons we perform no exhaustive literature search and investigate a sample of articles (see above). All exclusion criteria aim to leave the studies, that measured $\dot{V}O_{2max}$ using an appropriate testing procedure in humans.

Data management and sharing

We will store the initial search results in a `csv` (for PubMed) and a `xls` (for Web of Science) file. The automated exclusion will be done in R (R Core Team, 2021) and documented in R Markdown. Results of manual screening and data extraction will be documented in a `csv` file. For more information see the file `details_review.pdf`.

All data and analysis code will be made publicly available on GitHub.

Miscellaneous screening details

— No further details —

Extraction

Entities to extract

- metabolic cart used
- type of metabolic cart/data basis (breath-by-breath, mixed chamber, …)
- preprocessing algorithm
- data processing software
- interpolation procedure
- data processing/determination of $\dot{V}O_{2max}$:
  - type (time average, breath average, digital filtering)
  - alignment (rolling, binned, …)
  - interval (in sec/breath, parameters for filtering)

Extraction stages

All extraction happens in a single manual step by one researcher (SN).

Extractor instructions

See the document `details_review.pdf` for more details.

Extractor blinding

No blinding is applied during extraction.

Extraction reliability

Only a single researcher will extract the information

Extraction reconciliation

— Not applicable, as extraction will be done by a single researcher —

Extraction procedure justification

We aim to extract data on the data processing methods for $\dot{V}O_{2max}$ testing. We also collect related information (e.g. metabolic cart used) as stated above. If information are missing or incomplete we will document this, but not exclude the article.

Data management and sharing

Extracted data will be saved in a `csv` file and publicly shared via GitHub.

Synthesis and quality assessment

— As this is a scoping review, we will not perform any quality assessment of the included research. Instead we will simply count the methodical characteristics from the included research. Note that this scoping review is accompanied by an empirical comparison of different data processing methods (see `details comparison.pdf` for more information). —

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