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Statistical methods to model and evaluate physical activity programs, using step counts: A systematic review

S.S.M. Silva¹, Madawa W. Jayawardana¹, Denny Meyer¹

¹Department of Statistics, Data Science and Epidemiology, Swinburne University of Technology, Hawthorn, Victoria, Australia

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Sampathawaduge Sandun Silva ⚡

ABSTRACT

Background

Physical activity reduces the risk of noncommunicable diseases and is therefore an essential component of a healthy lifestyle. Regular engagement in physical activity can produce immediate and long term health benefits. However, physical activity levels are not as high as might be expected. For example, according to the global World Health Organization (WHO) 2017 statistics, more than 80% of the world's adolescents are insufficiently physically active. In response to this problem, physical activity programs have become popular, with step counts commonly used to measure program performance. Analysing step count data and the statistical modeling of this data is therefore important for evaluating individual and program performance. This study reviews the statistical methods that used to model and evaluate physical activity programs, using step counts.

Methods

Adhering to PRISMA guidelines, this review systematically searched for relevant journal articles which were published between January 2000 and August 2017 in any of three databases (PubMed, PsycINFO and Web of Science). Only the journal articles which used a statistical model in analysing step counts for a healthy sample of participants, enrolled in an intervention involving physical exercise or a physical activity program, were included in this study. In these programs the activities considered were natural elements of everyday life rather than special activity interventions.

Results

This systematic review was able to identify 78 unique articles describing statistical models for analysing step counts obtained through physical activity programs. General linear models and generalized linear models were the most popular methods used followed by multilevel models, while structural equation modeling was only used for measuring the personal and psychological factors related to step counts. Surprisingly no use was made of time series analysis for analysing step count data. The review also suggested several strategies for the personalisation of physical activity programs.

Conclusions

Overall, it appears that the physical activity levels of people involved in such programs vary across individuals depending on psychosocial, demographic, weather and climatic factors. Statistical models can provide a better understanding of the impact of these factors, allowing for the provision of more personalised physical activity programs, which are expected to produce better immediate and long-term outcomes for participants. It is hoped that this review will identify the statistical methods which are most suitable for this purpose.

PROTOCOL STATUS

Working

We use this protocol in our group and it is working

Define the review question

- 1 To identify the statistical methods used to evaluate the physical activity programs
To identify the statistical methods and models used to model the physical activity

Guideline

- 2 This systematic review was reported in accordance with the preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. This review has been registered with PROSPERO under the record number CRD42017076786 on 31st of October 2017.

Search

- 3 The search will be carried on online data bases (namely Pubmed/Medline, Web of Science and CINAHL) And will be considered articles published from 1st of January 2000 to 1st of August 2017. All the articles need to be published in English language.

Key words for the search

- 4 It was decided to use individualized key words in the search strategy for the above mentioned databases, in order to extract more relevant articles.

PubMed

accelerometer OR pedometer OR step count* OR "Fitness Trackers"[Mesh] AND statistic* OR statistical model* OR quantitative OR "Models, Statistical"[Mesh] OR "Data Mining"[Mesh] OR "Data Interpretation, Statistical"[Mesh] AND "Exercise"[Mesh] OR "physical activity" OR fitness OR Program* OR intervention

PsycINFO

accelerometer OR pedometer OR step count* OR "Fitness Trackers" AND statistic* OR statistical model* OR quantitative OR "Statistical Analysis"[Index Term] OR "Data Mining"[Index Term] OR "Data Interpretation" AND "Exercise"[Index Term] OR "physical activity" OR fitness OR Program* OR intervention

Web of Science

accelerometer OR pedometer OR step count* OR "Fitness Trackers" AND statistic* OR statistical model* OR quantitative OR "Data Mining" OR "Data Interpretation" AND "Exercise" OR "physical activity" OR fitness OR Program* OR intervention

Inclusion and exclusion criteria

- 5 Articles were selected if
 - (i) the study included data taken from a physical activity program or an intervention;
 - (ii) the data collection did not impact the usual natural lifestyle of the participants (e.g. studies where data was collected through walking on a treadmill or from a walking test were excluded);
 - (iii) the study needed to be carried out with at least one group of healthy participants;
 - (iv) the study needed to include a study variable related to "step counts" and this data needed to be collected using a device such as a pedometer or accelerometer;
 - (v) the study needed to carry out a quantitative analysis using "statistical modeling" .

Selection Process and Data Extraction

- 6 The articles which were found from the database search were uploaded to EndNote software and duplicates were removed by the first author.

The other two authors were then given online access to view the results.

The first two authors then independently screened the titles and abstracts against the inclusion criteria and shortlisted the most relevant articles.

The articles which had been accepted by both reviewers were shortlisted and the articles which had questionable eligibility were directed to the third reviewer for resolution.

This process shortlist the most relevant articles for a full text review.

The first two authors will then carry out the full text review independently and identify whether the article is within the inclusion criteria or not.

The articles which are then shortlisted from the full text review will then be eventually included in the review where the questionable articles were directed to the third author, for her decision.

Then in order to extract data from the selected papers we have maintained a well structured table which includes all the information about the paper from the author to statistical methods that they have used.

In order to include the results of each and every short listed study, another table was maintained including previous columns as well as significant predictions of the study and p values.

PRISMA flow diagram

- 7 Then the whole search process would be plotted in a well structured PRISMA flow diagram with the main reasons for rejections.

Quality assessment - Risk of Bias Assessment

- 8 The Downs and Black assessment tool [23] for health care interventions was used to measure the study quality of the included articles. This tool is appropriate for assessing both randomized and non-randomized studies of health care interventions. This checklist consists of 27 items distributed among five sub scales, namely; reporting (10 items), external validity (3 items:), bias (7 items:), confounding (6 items:) and power (1 item:). According to the tool, the maximum score that a study can obtain is 32, with higher scores indicating better quality. In this review the Downs and Black scores have been categorized as follows; high quality (22-25), moderate quality (18-21) and low quality (14-17).

Results

- 9 In order to present the results of the review that were generated by the previously prepared table in the data extraction stage, a taxonomy of statistical techniques were used.



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