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Original Article

A tool to measure complexity in public health interventions: Its statistical properties and meta-regression approach to adjust it in meta-analysis

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ABSTRACT

Background: Public health interventions are conventionally cited as a popular example of complex interventions. Complexity of public health interventions has always been an obstacle for the meta-analysis of these studies. Earlier an attempt was made by Public Health Evidence South Asia (PHESA) to numerically measure the complexity in public health interventions by a tool. This study is an extension of that initiative which aims to investigate various statistical distributional properties of the complexity score and adjust the measured complexity in meta-analysis.

Methods: Complexity score of 71 studies was used to identify the best probability distribution that fits the complexity score, study its sampling distribution and determine the optimum power transformation. Meta-regression was employed to adjust the measured complexity in meta-analysis.

Results: Lognormal distribution was observed to be an ideal probability distribution for the complexity score, the sampling distribution of the mean of complexity score was found to be normally distributed and the optimum power transformation for the complexity score was '−0.42'. The raw estimate from random effects meta-analysis was found to be −0.05, 95% CI −0.14 to 0.04, whereas the estimate adjusted for complexity from meta-regression was −0.048, 95% CI −0.13 to 0.03. There was a reduction in the proportion of heterogeneity (I – squared) after adjusting for complexity (73.01%–66.30%), indicating that complexity had an impact on the effect estimates of studies.

Conclusion: The concept of measuring the inherent complexity and adjusting it in meta-analysis adds novelty to the existing meta-analysis approach. This innovative approach is likely to create a new dimension for meta-analysis of complex community level

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interventions and provide more precise evidence. However, further methodological research and piloting is required to establish the validity and sensitivity of this approach.

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1. Introduction

Complexity is the characteristic of a phenomenon of being present in a complicated network of numerous components, where there is an opportunity for the components to interact with each other. As a consequence, it would be idealistic to define the most active component and figure out which component or combinations of components is pivotal in achieving the outcome/s. Public health interventions are conventionally cited as a popular example of complex interventions. They are intended to upkeep the health of the community and are delivered at the level of population. The innate characteristics of these interventions to cater to an outstretched population, encompass a bundle of activities and contextual confinement entrusts complexity.[1] Important sources responsible for complexity in public health interventions are (1) The number of interacting components within the experimental and control interventions (2) The number and difficulty of behaviours required by those delivering or receiving the intervention (3) Number of groups or organizational levels targeted by the intervention (4) Number and variability of outcomes (5) Degree of flexibility permitted in the tailoring of the intervention. Other than these factors, the presence of non-linear causal pathways between intervention and outcome (i.e., change in outcome not proportional to change in intervention) is an additional and a key source of complexity.[2–4]

Systematic reviews involve a prudently selected focused research question and yield comprehensive evidence by capturing all available relevant published studies on the concerned research question.[5] Systematic review methodology involves scientific processes to collect, combine, analyze and summarize all available evidence with minimum or no bias. Meta-analysis is a statistical technique by which the quantitative results from several studies are integrated to yield a summary result.[6] Systematic review combined with meta-analysis has been accepted as a potential robust method of health care research evidence synthesis.[5]

Complexity of public health interventions has always been an obstacle for the meta-analysis of these studies.[1] Further, it is more likely to mask the true effect in meta-analysis of public health interventions. Therefore measuring this complexity and adjusting the measured complexity in meta-analysis using a suitable statistical technique is a required strategy to counter this limitation. Earlier an attempt was made by the Public Health Evidence South Asia (PHESA) to numerically measure the complexity in public health interventions by means of a tool.[1] The tool was developed focussing four primary domains of complexity namely population, intervention, context and outcome. The items included in the tool were segregated after a meticulous examination of published public health interventions. The scoring pattern was set for each item based on its importance and number of options such that, higher score reflects a higher complexity. The scores of all items of a domain were added to obtain domain specific complexity score and addition of complexity scores of all four domains presented the total complexity score for the study.

As an extension of the complexity tool development endeavour, this study is meant to investigate the statistical distributional properties of the complexity score and adjust the measured complexity in meta-analysis using meta-regression.

2. Methodology

Eight diverse Cochrane public health systematic reviews were identified[7–14] as a pathway to obtain the studies pertaining to public health interventions. From these systematic reviews 71 such studies were retrieved. The selected studies were subjected to complexity assessment using the PHESA tool and the corresponding total complexity scores were obtained, which formed the basis of this work. The average complexity score of 71 studies was 35.23, with a minimum score of 20 and a maximum of 83.

The methodology has been substantiated under two broad sub-sections.

2.1. Statistical distributional properties

2.1.1. Distribution fitting – identifying the ideal or best probability distribution that fits the total complexity score

A histogram was constructed to identify the distributions that are likely to fit the total complexity score. Based on the shape of the histogram, a list of such distributions was generated. Later, the parameters of the anticipated distributions were estimated by maximum likelihood technique. Anderson-Darling (AD) goodness of fit test was used to evaluate the quality of fit i.e., to decide which among the anticipated distributions is the best fit. Higher P-value (>0.05) or a lower test statistic value was the criterion adopted to decide the best fit.[15,16]

2.1.2. Studying the sampling distribution of the mean of total complexity score

Bootstrapping method was employed to explore the sampling distribution of the mean of total complexity score. One thousand boot strap samples of the same size were generated from the complexity scores. These samples were selected by simple random sampling with replacement.[17]

2.1.3. Box–Cox transformation

Box–Cox transformation[18] was used to normalize the total complexity score. It is given by;

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