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Original Article

A tool to measure complexity in public health interventions

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ABSTRACT

Background and objective: Public health interventions are targeted to a diverse population, composed of multiple components, mostly context dependent and therefore they are often regarded as complex. The complex nature of the public health interventions discourages the use of conventional Meta-analytic techniques and acts as a hurdle to combine the findings of studies conducted across different locations. Measuring complexity of different studies and adjusting for these complexities during Meta-analysis would be an appropriate method to address this problem and obtains the pooled estimate. Hence this study was conducted with an objective of developing a tool for quantifying the complexities in public health intervention studies.

Methodology: With the help of a large number of published public health interventions, a checklist was prepared for compiling the instrument. The checklist was obtained for all the domains namely population, intervention, context and outcome. This was further debated and cross checked with experts to form the final list. Items in the final list were appropriately scored for each domain based on long discussions, debates and expert meetings and obtained the tool. The reliability of the tool was assessed by two raters independently scoring the same studies with the developed tool and computing the Intra-class Correlation Coefficient (ICC). Further the tool was applied to a number of studies to measure domain specific and overall complexities.

Results and conclusion: The overall ICC of the tool was found to be 0.840 and ICC for population, intervention and outcome was found to be good (0.855, 0.859 and 0.916 respectively), whereas ICC for context was found to be low (0.381). The tool was applied to measure the complexities of population, intervention, context and outcome of 26 Public health intervention publications. The tool has a good scope for application in Meta-analysis of public health systematic reviews.

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1. Introduction

Public health interventions are the interventions targeted to protect and promote health of the people and commonly delivered at population level. Most often public health intervention is a multi-armed strategy with several interdependent strategies targeted at a specific objective, delivered to a heterogeneous population and context dependent. Context refers to the social, economical, political, cultural and organizational setting in which an intervention is implemented. Due to the above stated facts the public health interventions are referred to as “complex”.^{1,2} The complexities involved in the public health interventions have an impact on the outcome which itself is most often complex.

Systematic reviews and Meta-analysis have been accepted as important tool in the evidence synthesis of health care intervention effectiveness. Many international organizations like the Cochrane Collaboration (www.cochrane.org), Department for International Development in UK (<https://www.gov.uk/dfid>), International Initiative for Impact Evaluation (www.3ieimpact.org) have incorporated this methodology in synthesizing evidence of effectiveness of very focused and non complex interventions. However the complex nature of the public health interventions discourages the use of conventional Meta-analytic techniques to integrate the findings of such interventions.

In recent times, there have been attempts to understand the complexity in public health interventions.^{1–4} However till now we do not have a mechanism to measure the complexity and hence there is a lack of methodology to integrate results of these interventions after accounting for complexities. In the present study, we made an attempt to identify the complexities in various domains of public health interventions namely population, intervention, context and outcome. Further we developed a tool to measure the complexities in these domains and also assessed the reliability of the developed tool.

2. Methodology

The overall objective was to develop a tool to measure complexities in public health interventions. First we generated a checklist of items to be included in the tool which could measure the complexities in the domains of population, intervention, context and outcome. In order to get the items list, we identified a heterogeneous group of published public health interventions and examined each of these publications. We used the systematic reviews of public health interventions published in the Cochrane Library as an initial pathway for identifying these studies. Once such studies have been identified, the full text articles were retrieved. Each of these articles was examined by two authors to obtain the checklist which was likely to represent complexity. From this checklist, the items reflecting complexities under the domains of population, intervention, context and outcome were identified and separated with the help of repeated discussions involving all authors. Whenever required, opinions were sought from methodological experts. Thus shortlisted items

were incorporated in the final checklist. A scoring pattern was developed for each item based on its importance and number of options in each item. The scoring was designed in such a way that, higher score represents more complexity. Finally all item scores were added to obtain a total complexity score for each domain.

For testing the reliability of the instrument, two independent raters assessed the same set of studies and scored for each item in the tool. Using the scores given by two raters, Intra-class Correlation Coefficient (ICC) was calculated for the total score as well as score for each domain.

3. Results

Six systematic reviews^{5–10} of public health interventions were identified from the Cochrane Library and all the individual studies included in these reviews were retrieved. The six systematic reviews together contributed to 26 individual studies,^{11–36} which were used for developing this tool. The following is the final checklist of variables considered under each domain to measure complexity.

Population: age, gender, region.

Intervention: number of intervention groups, total number of components in each intervention, number of components having subcomponents, type of intervention, number of groups of people who delivered the intervention, number of settings where the intervention is delivered, control group, duration of intervention.

Context: income of the country, stakeholders involvement, incentives, cultures involved, organizations involved, political influence, education status, access to mass media and health services.

Outcome: number of primary outcomes, type of outcome.

After considerable deliberations within the team members and external experts, the item list was finalized with corresponding scores. One of the basic understandings in the scoring was, as the scope of complexity increases, the score increases. The developed scores are depicted in [Table 1](#).

Using the developed tool, two raters independently assessed ten studies to measure the tool reliability. Each domain was scored as explained above to obtain domain score as well as total complexity score and Intra-class Correlation Coefficient (ICC) was computed. The ICC values have been presented in [Table 2](#).

The developed tool was used for measuring complexity score for all 26 studies included in the 6 systematic reviews. Results of the overall assessment scores and domain specific scores for individual studies are given in [Table 3](#). Further we attempted to segregate complexity score based on each systematic review. These results are presented in [Table 4](#).

4. Discussion

Public health interventions are complex interventions, which are mostly delivered to heterogeneous groups at population level and in complex context. The complexity in the domains

Table 1 – Complexity scoring of population.

Items	Complexity score
Age (Range of difference between maximum and minimum age of population in a study)	
■ 1–10	1
■ 11–20	2
■ 21–30	3
■ 31–40	4
■ >40	5
Gender	
■ Study is based on one gender either male or female	1
■ Both males and females	2
Region	
■ Only either urban or rural	1
■ Both urban and rural	2
Complexity scoring of intervention	
Number of intervention groups	
Score is equal to total number of intervention groups (if there is only 1 intervention group the score will be 1, for 2 groups score is 2 and so on)	
Control group	
■ No control group	0
■ Received no intervention	1
■ Received an alternative or usual intervention	2
Total Number of components in the intervention	
Components are defined as the related parts of an intervention. For example the inclusion of diet, exercise, and counselling are the components of the weight loss programme or intervention. Score is equal to total number of components, i.e., the direct intervention with no component will get the score 1, for the intervention with 2 components will get the score 2 and so on	
Number of components having subcomponents	
A subcomponent is the part of the component. For example in the weight loss programme exercise is one of the component and the subcomponents are sports and aerobics. Score is equal to total number of components having subcomponents. Score increases as the number of components having subcomponents increases	
Type of intervention in each component	
Vaccines/drugs	1
Drops, injections, tablets	
Device/instrument	1
Example; electric fans, safety kits, condoms, mosquito nets, helmets, water facilities (pumps), masks etc	
Activity	2
Physical [exercises, walking, gym, yoga, aerobic, Swimming, Sports etc]	
Competition [easy, drawing, racing], Clubs (coalitions)	2
Facilities	
Parks, jogging tracks, sports stadiums, swimming pools, cycling tracks, gymnasium	2
Policy	3
Reduce underage drinking, banning tobacco, smoking in public places, plastic covers, slaughtering cows etc	
Education	
Classroom sessions (oral/audio/visual), pamphlets, banners, posters, mass media, street plays, dramas, campaigns, group discussions/focus group discussions, games	
Number of groups of people who delivered the intervention	
NGO/local agency, international NGO, researchers, practitioners, research assistants, teachers, family, religious groups etc.	
Score is equal to total number of groups of people who delivered the intervention	
Number of settings where intervention is delivered	
Schools, home, health clinics, work places, public places, etc	
Score is equal to total number of settings where intervention is delivered	
Duration of intervention	
■ ≤3 months	1
■ 4–6 months	2
■ 7–12 months	3
■ >12 months	4
Complexity scoring of context	
Income of the country in which the study is conducted	
High, middle and low income status	
■ Combination of three	5
■ Combination of any two	4
■ Low income country	3
■ Middle income country	2
■ High income country	1

Table 1 – (continued)

Complexity scoring of context	
Involvement of stakeholders (<i>Teachers, family, peers, practitioners etc</i>)	
■ No	0
■ Yes (more than 2)	1
Incentives (<i>money, price, vouchers, food, any facilities</i>)	
■ Not provided	0
■ Provided	1
Various cultures involved	
■ No	0
■ Yes	1
Number of organizations involved	
■ One	0
■ More than one	1
Any political influence (<i>involvement of political and community leaders</i>)	
■ No	0
■ Yes	1
Education status	
Homogeneous (<i>The study targeted to people with similar educational status</i>)	0
Heterogeneous (<i>The study targeted to people with varied/diverse educational status</i>)	1
Access to media	
■ Yes	0
■ No	1
■ Not applicable	
Access to health services	
■ Yes	0
■ No	1
■ Not applicable	
Complexity scoring of outcome	
Total number of primary outcomes	
<i>The study will get the score as the number of primary outcomes</i>	
<i>For example if a study has 1 primary outcome, the score will be 1, for 2 primary outcomes, the score will be 2 and so on</i>	
Outcome measured	
■ Direct outcome	1
■ Indirect outcome	2
■ Composite Outcome	3

namely population, intervention, context and outcome was always a hurdle for pooling results of such interventions in systematic reviews. In this study we made an attempt to measure complexity in quantitative terms and thus enhance the methodology of meta-analysis. To our knowledge, this is the first attempt to develop a tool to measure complexity in public health.

The guidelines for assessing complexity of various domains in a study and allocated scores for each domain have been illustrated in Table 1. There is no upper limit for the total score and we made all attempts to capture all components of interest during scoring. The score can increase as number of

components or layers increases. The tool was found to have a good overall reliability ($ICC = 0.84$). The domains population, interventions and outcome had good reliability (0.855, 0.859, 0.916 respectively). However the context was found to have a low reliability ($ICC = 0.381$). In most of the publications, authors usually fail to provide proper detailed description of the context. This could have contributed more subjectivity in scoring context complexity and hence resulted in low reliability.

Using the developed tool we attempted to measure domain specific and overall complexity of 26 public health interventions and these scores are given in Table 3. The tool has the flexibility to measure new studies and incorporate diverse interventions. The overall score increases as complexity increases. The tool is fairly sensitive to all domains of the study. The minimum and maximum total score obtained from these studies were 19 and 55. The intervention complexity score is a major contributor for the overall score. The complexity scores of context domain were found to be low in all studies. This shows the fact that capturing context by reading a publication is a difficult task.

Table 4 shows the complexity scores reorganized according to systematic reviews. This is to demonstrate that even for

Table 2 – Intra-class correlation coefficient (ICC).

	ICC
Population	0.855
Intervention	0.859
Context	0.381
Outcome	0.916
Overall	0.840

Table 3 – Domain specific and overall complexity scores of 26 studies.^{11–36}

Study ID	Complexity score				
	Population	Intervention	Context	Outcome	Total
1	8	18	5	5	36
2	4	19	5	5	33
3	5	9	4	3	21
4	6	12	5	4	27
5	5	9	6	3	23
6	5	12	4	3	24
7	5	11	3	6	25
8	9	12	2	5	28
9	8	16	8	3	35
10	5	15	2	4	26
11	6	20	5	6	37
12	4	21	6	7	38
13	4	19	7	3	33
14	7	20	8	5	40
15	5	14	3	7	29
16	7	35	4	5	51
17	3	16	3	7	29
18	4	7	2	6	19
19	4	18	5	2	29
20	4	27	3	7	41
21	4	16	7	7	34
22	5	12	7	5	29
23	3	14	5	5	27
24	4	15	4	4	27
25	5	14	4	10	33
26	5	17	5	7	34

different studies addressing same question have varying complexity. Even though studies 1–6 assessed the effect of intervention to promote smoke alarm, their complexity varies from 21 to 36. Hence pooling these studies without considering complexity measure could be misleading. Similarly the complexity score among studies in intervention to prevent obesity in children ranges from 19 to 41 and so on. This substantiates the fact that if we can measure complexity and adjust it during Meta-analysis, it will provide a more precise pooled estimate of effect size.

5. Strengths of the study

This study is a first attempt to measure complexity in a public health intervention. While we prepare a systematic review of complex interventions we come across many studies addressing the same question. Many times, pooling effect measures is difficult due to the variations in components of interventions, population or outcome.³ Hence authors usually complete the review as a narrative one. The developed tool is very promising and the measure has the potential to be used as a covariate in meta-analysis in systematic reviews of complex intervention. The review can estimate the pooled effect measure after adjusting for complexity by methods like meta-regression. The tool has the potential to change the meta-analysis procedure of complex interventions and thus impact the evidence synthesis of such interventions.

Table 4 – Complexity score segregated based on systematic reviews.^{5–10}

Study ID	Complexity score				
	Population	Intervention	Context	Outcome	Total
Interventions for promoting smoke alarm ownership and function ⁵					
1	8	18	5	5	36
2	4	19	5	5	33
3	5	9	4	3	21
4	6	12	5	4	27
5	5	9	6	3	23
6	5	12	4	3	24
Workplace interventions for neck pain in workers ⁶					
7	5	11	3	6	25
8	9	12	2	5	28
9	8	16	8	3	35
10	5	15	2	4	26
Parenting interventions for the prevention of unintentional injuries in childhood ⁷					
11	6	20	5	6	37
12	4	21	6	7	38
13	4	19	7	3	33
14	7	20	8	5	40
Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults ⁸					
15	5	14	3	7	29
16	7	35	4	5	51
17	3	16	3	7	29
Interventions for preventing obesity in children ⁹					
18	4	7	2	6	19
19	4	18	5	2	29
20	4	27	3	7	41
21	4	16	7	7	34
22	5	12	7	5	29
Interventions for promoting reintegration and reducing harmful behaviour and life styles in street-Connected children and young people ¹⁰					
23	3	14	5	5	27
24	4	15	4	4	27
25	5	14	4	10	33
26	5	17	5	7	34

6. Limitations of the study

The derived tool had a good overall reliability and also good domain specific reliability of population, intervention and outcome but these are based on limited number of studies. The context domain had low reliability, probably due to subjectivity involved in the context measurement. We need to bring more objectivity into the tool. Further, reliability of the tool needs to be assessed with large number of studies and statistical distributional properties of the complexity scores need to be determined. We attempt to address these limitations in further versions of the tool.

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Conflicts of interest

All authors have none to declare.

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REFERENCES

- Craig P, Dieppe P, Macintyre S, Mitchie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new medical research council guidance. *BMJ*. 2008 Oct 25;337:979–983.
- Shepperd S, Lewin S, Straus S, et al. Can we systematically review studies that evaluate complex interventions? *PLOS Med*. 2009 Aug 11;6(8):1–8.
- Petticrew M, Rehfuess E, Noyes J, et al. Synthesizing evidence on complex interventions: how meta-analytical, qualitative, and mixed-method approaches can contribute. *J Clin Epi*. 2013 Aug 14;66:1230–1243.
- Anderson LM, Oliver SR, Michie S, Rehfuess E, Noyes J, Shemilt I. Investigating complexity in systematic reviews of interventions by using a spectrum of methods. *J Clin Epi*. 2013 Aug 14;66:1223–1229.
- DiGuseppi C, Goss CW, Higgins JPT. Interventions for promoting smoke alarm ownership and function [internet] *Cochrane Database Syst Rev*. 2010;(2) [cited 2014 Jan 18]. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD002246/pdf/standard>.
- Aas RW, Tuntland H, Holte KA, et al. Workplace interventions for neck pain in workers [in ternet] *Cochrane Database Syst Rev*. 2011;(4) [cited 2014 Jan 14]. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD008160.pub2/pdf/standard>.
- Kendrick D, Mulvaney CA, Ye L, Stevens T, Mytton JA, Stewart-Brown S. Parenting interventions for the prevention of unintentional injuries in childhood [internet] *Cochrane Database Syst Rev*. 2013;(3) [cited 2014 Jan 14]. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD006020.pub3/pdf/standard>.
- Hoe VCW, Urquhart DM, Kelsall HL, Sim MR. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults [internet] *Cochrane Database Syst Rev*. 2012;(8) [cited 2014 Jan 14]. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD008570.pub2/pdf/standard>.
- Waters E, de Silva-Sanigorski A, Hall BJ, et al. Interventions for preventing obesity in children [internet] *Cochrane Database Syst Rev*. 2013;(12) [cited 2014 Jan 25]. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD001871.pub3/pdf/standard>.
- Coren E, Hossain R, Pardo J, et al. Interventions for promoting reintegration and reducing harmful behaviour and lifestyles in street-connected children and young people [internet] *Cochrane Database Syst Rev*. 2013;(2) [cited 2014 Jan 19]. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD009823.pub2/pdf/standard>.
- MacKay AM, Rothman KJ. The incidence and severity of burn injuries following project burn prevention. *Am J Public Health*. 1982 Mar;72:248–252.
- Kendrick D, Marsh P, Fielding K, Miller P. Preventing injuries in children: cluster randomized controlled trial in primary care. *BMJ*. 1999 Apr 10;318:980–983.
- Kendrick D, Watson M, Dewey M, Woods AJ. Does sending a home safety questionnaire increase recruitment to an injury prevention trial? A randomized controlled trial. *J Epidemiol Community Health*. 2001 May 25;55:845–846.
- Miller RE, Reisinger KS, Blatter MM, Wucher F. Pediatric counseling and subsequent of smoke detectors. *Am J Public Health*. 1982 Apr;72:392–393.
- Bass JL, Mehta KA, Ostrovsky M. Childhood injury program in a suburban Massachusetts population. *Public Health Rep*. 1991 Jul-Aug;106(4):437–442.
- Mallonee S, Istre GR, Rosenberg M, Douglas MR. Surveillance and prevalence of residential-fire injuries. *New Eng J Med*. 1996 Jul 4;335:27–31.
- Bernaards CM, Ariens GAM, Knol DL, Hildebrandt VH. The effectiveness of a work style intervention and a lifestyle physical activity intervention on the recovery from neck and upper limb symptoms in computer workers. *PAIN*. 2007 Jun 5;132:142–153.
- Haukka E, Arjas PL, Juntura EV, Takala EP. A randomised controlled trial on whether a participatory ergonomics intervention could prevent musculoskeletal disorders. *Occup Environ Med*. 2008 Apr 16;65:849–856.
- Heuvel SG, Looze MP, Hildebrandt VH, Thé KH. Effects of software programs stimulating regular breaks and exercises on work-related neck and upper-limb disorders. *Scand J Work Environ Health*. 2003;29(2):106–116.
- Voerman GE, Sandsjo L, Vollenbroek-Hutten MMR, Larsman P, Kadefors R, Hermens HJ. Effects of ambulant myofeedback training and ergonomic counseling in female computer workers with work-related neck-shoulder complaints: a randomized controlled trial. *J Occup Rehabil*. 2007 Mar;17(1):137–152.
- Duggan AK, McFarlane EC, Windham AM, et al. Evaluation of Hawaii's healthy start program. *Future Child*. 1999 Spring-Summer;9(1):66–90.
- Fergusson DM, Grant H, Horwood LJ, Ridder EM. Randomized trial of the early start program of home visitation. *Pediatrics*. 2005 Dec;116:803–809.
- Johnson Z, Howell F, Molloy B. Community mothers' programme: randomized controlled trial of non-professional intervention in parents. *BMJ*. 1993 May;306:1449–1452.
- Minkovitz CS, Hughart N, Strobino D, et al. A practice-based intervention to enhance quality of care in the first 3 years of life. *JAMA*. 2003 Dec 17;290:3081–3091.
- Brisson C, Montreuil S, Punnett L. Effects of an ergonomic training program on workers with video display units. *Scand J Work Environ Health*. 1999 Jun;25(3):255–263.
- Gerr F, Marcus M, Monteilh C, Hannan L, Ortiz D, Kleinbaum. A randomized controlled trial of postural interventions for prevention of musculoskeletal symptoms among computer users. *Occup Environ Med*. 2005 Jul;62(7):478–487.
- Yassi A, Cooper JE, Tate RB, et al. A randomized controlled trial to prevent patient lift and transfer injuries of health care workers. *SPINE*. 2001, Aug 15;26(16):1739–1746.
- Amaro S, Viggiano A, Costanzo A, et al. Kalèdo, a new educational board-game, gives nutritional rudiments and encourages healthy eating in children: a pilot cluster randomized trial. *Eur J Pediatr*. 2006 Sep;165(9):630–635.

29. Reilly JJ, Kelly L, Montgomery C, et al. Physical activity to prevent obesity in young children: cluster randomized controlled trial. *BMJ*. 2006 Nov 16;333:1041–1043.
30. Dennison BA, Russo TJ, Burdick PA, Jenkins PL. An intervention to reduce television viewing by preschool children. *Arch Pediatr Adolesc Med*. 2004 Feb;158(2):170–176.
31. Harry-Berino J, Rourke J. Obesity prevention in preschool Native-American children: a pilot study using home visiting. *Obes Res*. 2003 May;11(5):606–611.
32. Mo-suwan L, Pongprapai S, Junjana C, Puetpaiboon A. Effects of a controlled trial of a school-based exercise program on the obesity indexes of preschool children. *Am J Clin Nutr*. 1998 Nov;68(5):1006–1011.
33. Hyun M, Seo M. Rehabilitation for homeless adolescent substance abusers at a halfway house in Korea. *J Korean Acad Nurs*. 2003;33(8):1161–1170.
34. Rotheram-Borus MJ, Song J, Gwadz M, Lee M, Rossem RV, Koopman C. Reductions in HIV risk among runaway youth. *Prev Sci*. 2003 Sep;4(3):173–187.
35. Tischler V, Vostanis P, Bellerby T, Cumella S. Evaluation of a mental health outreach service for homeless families. *Arch Dis Child*. 2002 Mar;86(3):158–163.
36. Slesnick N, Prestopnik JL. Ecologically-based family therapy outcome with substance abusing runaway adolescents. *J Adolesc*. 2005 Apr;28(2):277–298.