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The implementation of intersectoral community approaches targeting childhood obesity

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Does network development relate to implementation success of intersectoral community approaches targeting childhood obesity? An exploratory social network analysis.

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Submitted



Abstract

Background. The childhood obesity epidemic remains a major threat to public health. Intersectoral community approaches, in which the entire community of the child is mobilized to create a non-obesogenic environment, have shown promising results. It has however proven difficult to replicate these favourable results. This might be related to the fact that implementation of these interventions into practice is troublesome. It has been argued that intersectoral collaboration and community partnership are related to implementation success of these approaches, but whether they are and how is not well understood.

Methods. We evaluated the development of community partnership networks and implementation success within three EPODE-derived approaches in the Netherlands. A Social Network Analysis questionnaire was used to measure network parameters. Implementation success at the network level was determined via the 'JOGG progress tool'. Network data was analysed via UCINET, and the relation between network parameters and implementation success was evaluated descriptively.

Results. Implementation degree varied across communities, and was highest for the domain 'local organization' and lowest for the domain 'linkage between preventative and curative care'. Network size was largest and most constant in community A, whereas network size was lower in communities B&C but increased over time. Across communities, project management was identified as the most influential and prominent actor. We furthermore found indication for a positive association between a balanced distribution of actors per sector and the degree of IACO implementation, whereas a higher level of collaboration, a larger network size, a less centralized network and a decrease in centralization over time appeared associated with lower implementation degree. No indication was found for an association between the centrality of project management and implementation degree. We did find indication that the change in network parameters over time might be more strongly associated with implementation degree than the assessment of these parameters at one single point in time.

Conclusion. This study offers a novel insight on how IACO community partnership networks develop over time, and that network parameters are partly related to implementation success. Its results provide leads for the formulation of network development strategies that could potentially optimize IACO implementation. Future studies should further explore these leads and possible strategies in vivo, as to refine EPODE program methodology and ultimately improve IACO implementation.

Introduction

Childhood obesity

Childhood obesity is considered one of the major public health crisis of the twenty-first century (1, 2); Being obese as a child can lead to (severe) adverse effects on health during both childhood and adulthood (3-7). Despite numerous attempts to reduce and prevent childhood obesity, its prevalence remains high (1, 8, 9). Research has indicated that to lower the staggering prevalence rates of childhood obesity, a 'system approach' addressing the multifactorial aetiology of childhood obesity is needed (10, 11).

Intersectoral community approaches to address childhood obesity

To adequately address childhood obesity, not only the child needs to be targeted but also the complex systems embedding the child and its development. An example of such an approach is an Intersectoral community Approach to Childhood Obesity (IACO). One of the most successful IACOs to date has been the French 'Ensemble Prévenons l'Obésité De Enfants' (EPODE) approach. The EPODE methodology is described in more detail elsewhere (12-14). In short, EPODE engages stakeholders from multiple sectors to create a non-obesogenic environment by building on its four pillars: (a) political and organizational commitment, (b) collaboration between public and private organizations, (c) use of social marketing and (d) the support of scientific evaluation. In its two pilot communities, a fifty percent decline in the proportion of childhood obesity was achieved after ten years (15). This success led to the development of a dozen EPODE-derived interventions in several countries (12, 16), such as the Dutch JOGG approach (acronym for Youth At a Healthy Weight, in Dutch) (12). However, translating these IACOs into practice proves to be difficult; practioners often voice significant barriers to its implementation process (17). Failed translation of an IACO into practice can potentially cause a decline in the degree to which the target population is exposed to essential program elements, which in turn may lead to a decline or even loss of IACO intervention effect. It is therefore important to evaluate not only intervention effect, but also the IACO implementation process (18). Such an evaluation can help to detect translation failure in time, and it provides an opportunity to identify which IACO program elements are most effective, and what determines implementation success and failure (19).

IACO implementation and the importance of intersectoral network development

EPODE (and thus the Dutch equivalent, JOGG) argues that if an IACO is implemented by a variety of local stakeholders who are working together to reach intervention goals, the impact on childhood obesity will be greater than if individual stakeholders will try to reach these goals on their own (13). EPODE also expects that the level of collaboration and

network developments is related to implementation success (20). Several of the Dutch JOGG approach objectives therefore address the establishment and continuation of community partnership networks (box 1, column A).

The relationship between partnership networks and IACO implementation

The number of studies addressing the development of a stakeholder partnership network within intersectoral community approaches is still small (21-30). Most of the (social) network research in health promotion has focussed on transmission of diseases (31) and the influence of social support and capital on health outcomes (32-34). The few studies that did investigate the relation between partnership networks and IACO implementation showed that implementation of an IACO can increase the size of the local stakeholder network. Moreover, research has indicated that IACO implementation can increase the level of collaboration between individual stakeholders (28, 29, 35). A study by Kwait, Valente & Celentano also revealed that solid interorganizational collaboration can help to improve the targeted health outcomes (22). In contrast, research has also shown that if partnership networks are strongly structured, increased collaboration (increase in network ties, higher density) does not aid implementation progress (36). Also, community approaches often give rise to centralized networks with one prominent actor or agency involved (37), which is argued to impede continued implementation (21). Finally, Ramanadhan (35) mentioned that within an intersectoral community approach addressing cancer disparities, the level of implementation was related to a) the number of collaborations (network ties) that are initiated from one sector to another (intersectoral out degree) and b) whether collaboration (network tie) was perceived as reciprocal (reciprocity).

Fundamentals of Social Network Analysis

Traditional health promotion research often explains one or more outcome variables via one or more individual characteristics. In contrast, SNA relates network characteristics or network shape to determinants and processes within the social context (37, 38). SNA is based on fundamental principles of mathematical graph theory and sociology. A network is viewed as a model of nodes, lines and arrows. Every node portrays an actor and can represent an individual, an organization or even a country. Lines (ties between actors) and arrows (direction of the tie) denote the relations between actors. Hence, the position, location or connections of the actor in the network can be evaluated, and constructs as degree (level of connectedness of an actor) and centrality (importance of an actor in the network, different types) can be calculated. Moreover, characteristics of different groups or cliques of actors can be elucidated. The network as a whole can also serve as the unit of analysis; evaluating network density or centralization (37). Finally, the change of networks

over time can be analyzed. This is still a young field of research, but its development is said to be the “next logical growth in network research” (39). The operationalization of all SNA parameters used in this study is displayed in table 1.

Study objectives

The assumptions of JOGG and EPODE regarding network characteristics and performances or their relation to IACO implementation success have not yet been substantiated with evidence. We therefore evaluated both the development of community partnership networks as well as implementation success within three JOGG approaches instated in the Netherlands longitudinally. Our research objectives were threefold:

1. To examine the degree of IACO implementation of three communities implementing the JOGG approach using the JOGG ‘progress tool’;
2. To examine the development of community partnership networks over time in these three communities...
 - a) ..on the level of the network (size, (degree) centrality, centralization, (intersectoral) density).
 - b) ..on the level of the actor (quality of ties, in/out degree);
3. To examine the relation between network parameters and implementation success at the network level, taking into account the assumptions on this relation as defined in table 2.

Table 1. Network parameters

Construct	Definition
Network size	Number of actors in the network
Network density	Total number of ties in the network
Intersectoral density	Number of ties between different sectors
Degree centrality	Total number of ties one actor has in the network
In- and outdegree	Number of ties an actor has to other actors (outdegree) and from other actors (indegree)
Highest indegree	Actor with most incoming ties, considered the ‘prominent’ actor in the network
Highest outdegree	Actor with most outgoing ties, considered the ‘influential’ actor in the network
Network (in/out) degree centralization (<i>fig. 1</i>)	Percentage (%) of the largest possible variance in the number of in- and/or outgoing ties the central actor has in comparison to other actors in the network.

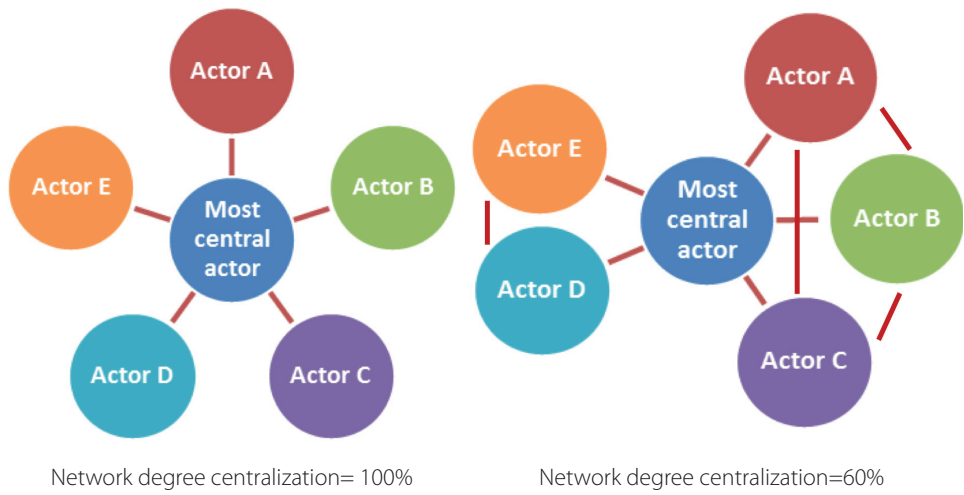


Figure 1. Network degree centralization
Network degree centralization= $100 * \Sigma(C^*-C_i) / \text{Max } \Sigma(C^*-C_i)$
(cmax= maximum value possible & c(ni) = degree centrality of node ni)

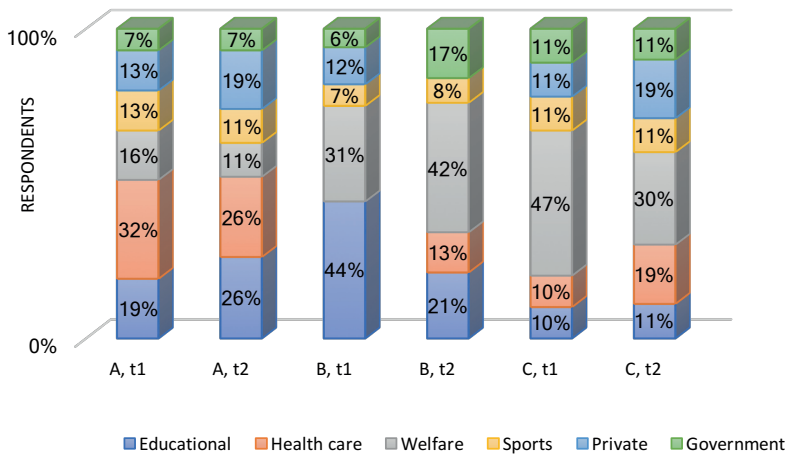


Figure 2. Sector representation per community per measurement

Table 2. Relevant JOGG program objectives and corresponding assumptions

Category	JOGG program objectives	Corresponding assumption on the relation between network parameters and implementation success	Measurement of the corresponding assumption
Actors & collaboration	There is an increase in the number of stakeholders in the childhood obesity prevention network	An increase in network size over time is related to higher IACO implementation degree at the network level	The number of actors in the network per community, per measurement will be counted and its relation to implementation degree explored descriptively.
	The network around JOGG contains a balanced composition of partners from diverse sectors.	A balanced distribution of actors per sector in the network is related to a higher IACO implementation degree at the network level	The total number of partners and the number of partners per sector (as defined in supporting information 1) will be counted. Then, the distribution of partners across sectors will be explored descriptively.
	There is an increase in the level of collaboration among stakeholders in the network.	A higher level of collaboration among actors is related to a higher IACO implementation degree at the network level.	The relation between implementation degree at the network level (measured via the JOGG progress tool) and the average level of collaboration in the network measured on a 1-5 Likert-scale will be explored descriptively.
Role of project manager	The project leader is responsible for the information flow to stakeholders about JOGG activities and themes.	A higher centrality of the project manager and subsequently the enablement of information spreading in a network is related to a higher implementation degree at the network level	The relation between the degree centrality of the project manager and implementation degree at the network level (measured via the JOGG progress tool) will be explored descriptively.
	The project manager involves local stakeholders in the JOGG approach, connects stakeholders and stimulates collaboration amongst stakeholders.	The level of network in/out degree centralization is related to IACO implementation degree at the network level	The relation between the degree centralization of the network and implementation degree at the network level (measured via the JOGG progress tool) will be explored descriptively.
	The project manager involves community stakeholders in the steering committee and workgroups.		

Methods

Sampling

Three communities implementing the JOGG approach were included via purposeful sampling (40). To obtain a sample of relevant organizations per community, we used a sequenced design with snowball sampling (36), as successfully employed in similar studies (30, 41). Hence, the project manager was asked to name all community organizations considered (potential) partners in the prevention of childhood obesity. The stakeholder most prominently involved in the prevention of childhood obesity per organization was then asked to participate. If possible, the project manager indicated which stakeholder was most prominently involved. Otherwise, the organization was contacted and asked to name the stakeholder in question. These stakeholders were asked to participate in the first network measurement. The cycle of sampling was repeated before the start of the second measurement one year later.

Research instruments

Network development was measured via network questionnaire based on Valente *et al.* (36), which measured level, form and satisfaction of collaboration. All organizations indicated by the project manager as (potential) partners for the prevention of childhood obesity were listed in the questionnaire. Firstly, participants were asked to indicate if they, in general, had collaborated to prevent childhood obesity with any other organizations in the community during the past year. If the participant answered this question in the negative, the questionnaire ended. If participants answered in the positive, the questionnaire continued and they were asked to state per organization if collaboration had been present in the past year. Participants were then asked to indicate the level of collaboration per organization. This level was represented on a five-point Likert scale ranging from 'little' to 'intensive' collaboration. Participants were also asked to indicate the form of collaboration (face-to-face and/or telephone and/or email) and their level of satisfaction with the collaboration. Satisfaction was also indicated on a five-point Likert scale ranging from 'unsatisfied' to 'very satisfied'.

Implementation of the approach at the network level was measured via a so called 'progress tool' created by the JOGG national bureau (appendix 1). This tool contains 34 questions on seven domains, namely 1) local organisation, 2) political and organizational commitment, 3) public private partnership, 4) social marketing, 5) scientific guidance and evaluation, 6) linkage between preventative and curative health care and 7) communication. Questions ranged from 'did you establish an action plan containing goals for the local community?' to 'did you monitor the local activities for all EPODE pillars?'. All statements were appointed a

score ranging from one to four; one indicated that no action was yet undertaken to achieve the goal stated, two indicated that 'first steps were undertaken to achieve the goal', three indicated that 'actions to reach the goals were well under way' and four indicating that the goals was achieved. A maximum total implementation score of (34×4) 136 points could be obtained.

Procedure

Two separated measures of network development were performed in each community with a one-year interval; the first measurement took place in early 2013, the second measurement in early 2014. If possible, the network questionnaire was filled out with an participant face-to-face after qualitative data collection (42). All other participants received an email invitation to fill out the questionnaire online via Qualtrics. Non-responders received a follow up email after six weeks. If participants did not respond to the follow-up email, a phone call was made to enquire about non-participation. Participants were then again provided with the opportunity to fill out the questionnaire or opt-out of the study.

The JOGG 'progress tool' was filled out by the project manager of the approach only at t2, with assistance of a coach from the national JOGG bureau. The tool was not filled out during t1 as it was instated by JOGG in 2014; hence data on implementation at the network level is only available for t2. Next to using scores derived from this tool for research purposes, scores were also used to guide the development of future implementation plans and strategies.

Analysis

All data from the network analysis was digitalized and cleaned using Excel. Data was then transported to UCINET and visually explored to check for errors. To ensure anonymity and facilitate analysis, replies from participants were generalized and appointed to the organization as a whole. If a participant stated to collaborate with an organization, regardless of level and form, this was considered a network tie. As successfully utilized in similar studies (30), we automatically considered a tie reciprocal if one of the participants indicated that collaboration face-to-face and/or via telephone was present. If only collaboration via email was indicated, the tie was not considered reciprocal unless both participants indicated collaboration was present. Next, network parameters were calculated. We evaluated size, in- and outdegree and (average) degree centralization on the network level. On the participant level we calculated average levels of in- and out degree, and determined which participants were most prominent (highest in-degree) and most influential (highest out-degree).

The quality of relations was explored by calculating the average level of collaboration, form and satisfaction with collaboration. All network parameters were compared through time ($t_1 \Rightarrow t_2$) and across networks. All data from the JOGG progress tool were accumulated in Excel. Scores per domain and a total implementation score (adding up all scores per domain) were then calculated.

Results / Discussion

Characteristics of the sample

Communities differed with regard to size, number of residents, levels of income and ethnic background of its residents (table 1). As for the number of inhabitants, a ratio of 4:2:1 for resp. community A, B and C was observed. The prevalence of childhood overweight was 24% for community A, 15% for community B and 12% for community C. The highest percentage of non-western immigrants and households with a low income was observed for community A.

Response rates varied from 53-83 % (mean of 72%, table 1). These response rates have been shown to produce robust, internally valid, network outcomes(43, 44). In community A, most respondents belonged to the health care sector (t_1 , t_2) and the educational sector (t_2) (sector categorization, additional information 1). The educational sector was also most prominently represented in community B at t_1 , whereas the welfare sector was the largest contributor at t_2 . Moreover for community B, the private partners included during t_1 were no longer part of the network during t_2 , while the health care partners took not yet part during t_1 , but were during t_2 . For community C, respondents mostly represented the welfare sector at both t_1 and t_2 (figure 2).

Implementation score

Across measurements, community C obtained the highest implementation score (102, max=140) and community A the lowest (84, max=140). Scores were on average highest for the domain 'local organization' and on average lowest for the domain 'linkage between preventative and curative care' (table 2). Community B furthermore scored notably lower on the domain 'public private partnership' and 'scientific evaluation' in comparison to communities A & C. Community A scored significantly lower on the domain 'communication'. These lower implementation scores for linking preventative and curative care might be related to the fact that this domain was added to the EPODE methodology especially for the Dutch setting, and in comparison little experience or best practices were available from the JOGG national bureau on how to realize this linkage(13). It is moreover known that

connecting preventative and curative care targeting childhood obesity is arduous(45), and research performed by JOGG has shown that communities need extra support to reach the objectives included in this domain(46).

Network parameters

Size of the network differed across communities and over time. Community A showed the largest and most stable network size, whereas communities B & C showed smaller network sizes that increased 20-30% in size over time. The average number of ties in the network per actor (average degree) at t1 was lowest for community B (2.98) and highest for community C (5.92). The average degree increased over time for community A and even more notably for community B, whereas a decrease was observed for community C. Previous studies have reported that a higher number of ties per actor in the network is associated with a more successful spread of information through the network (47). However, we agree with Valente *et al.* (48) that a successful spread of information might not equal implementation success. The ideal level of average degree might be context specific, and the 'more the merrier' might therefore not always be true for average degree (48). If the average degree at the start of IACO implementation or a change in average degree might be related to implementation success requires further investigation. Indegree centralization across communities and time was lower than outdegree centralization, except for community B at t1 (indegree equivalent to outdegree centralization). Project management was the most influential (highest indegree) and most prominent (highest outdegree) actor in all communities across time. An exception is community C at t1, at which school I & II were the most influential actors.

Quality of ties

Details on the quality of ties can also be found in table 1. Average levels of satisfaction were, to a great extent, similar throughout communities and ranged from 3.4 to 3.6 (scale 1-5). In all communities and across time periods, the most highly reported form of collaboration was 'face-to-face, email as well as telephone collaboration' (range 66-85%). The level (intensity) of collaboration increased from t1 to t2 in communities A&B and declined marginally over time in community C.

Table 1. Characteristics communities & network parameters

	Community A (DH)		Community B (L)		Community C (BR)	
	t1	t2	t1	t2	t1	t2
# inhabitants (<i>municipality/ community</i>)	510.320 / 27.400		121.249/ 13.325		180.053/ 7.345	
households with low income 2012	61%		56%		59%	
% non-western immigrants	55%		25%		17%	
Implementation site	Neighborhood		Neighborhood		Neighborhood	
Prevalence obesity children	24,3%(49)	(2011, 2-16 years)	15,2%(50)	(2013, 2-12 years)	12%(51)	(2013, 0-11 years)
Start of approach	2010		2011		2011	
# actors approached	44	36	22	43	23	35
Response rate	70% (31)	75% (27)	73% (16)	56% (24)	83% (19)	77% (27)
Network size	78	75	49	57	46	62
Average degree centrality	3.56	3.84	2.98	5.30	5.92	3.68
Density	0.071	0.077	0.060	0.053	0.077	0.074
Most prominent (highest indegree)	Project management	Project management	Project management	Project management	School I & II	Project management
Most influential (highest outdegree)	Project management	Project management	Project management	Project management	Project management	Project management
Centralization indegree	23%	19%	36%	45%	28%	24%
Centralization outdegree	31%	21%	36%	54%	33%	34%
Average satisfaction	3.62	3.62	3.37	3.49	3.62	3.47
Most cited form of collaboration	Face-to-face, email & telephone (66%)	Face-to-face, email & telephone (67%)	Face-to-face, email & telephone (69%)	Face-to-face, email & telephone (85%)	Face-to-face, email & telephone (74%)	Face-to-face, email & telephone (81%)
Average level of collaboration (intensity)	2.82	3.12	2.76	3.14	2.85	2.72

Table 2. Implementation score per community

Community	Local organization	Political & organizational commitment	Public Private Partnership	Social Marketing	Scientific evaluation	Linkage preventative & curative care	Communication	Total (max= 140)
A	15	12	13	12	12	13	7	84
B	18.5	15	9	12	9	12	17	92.5
C	20	15	16	12	15	10	14	102
<i>Average</i>	17.8	14	12.6	12	12	11.7	12.7	92.8

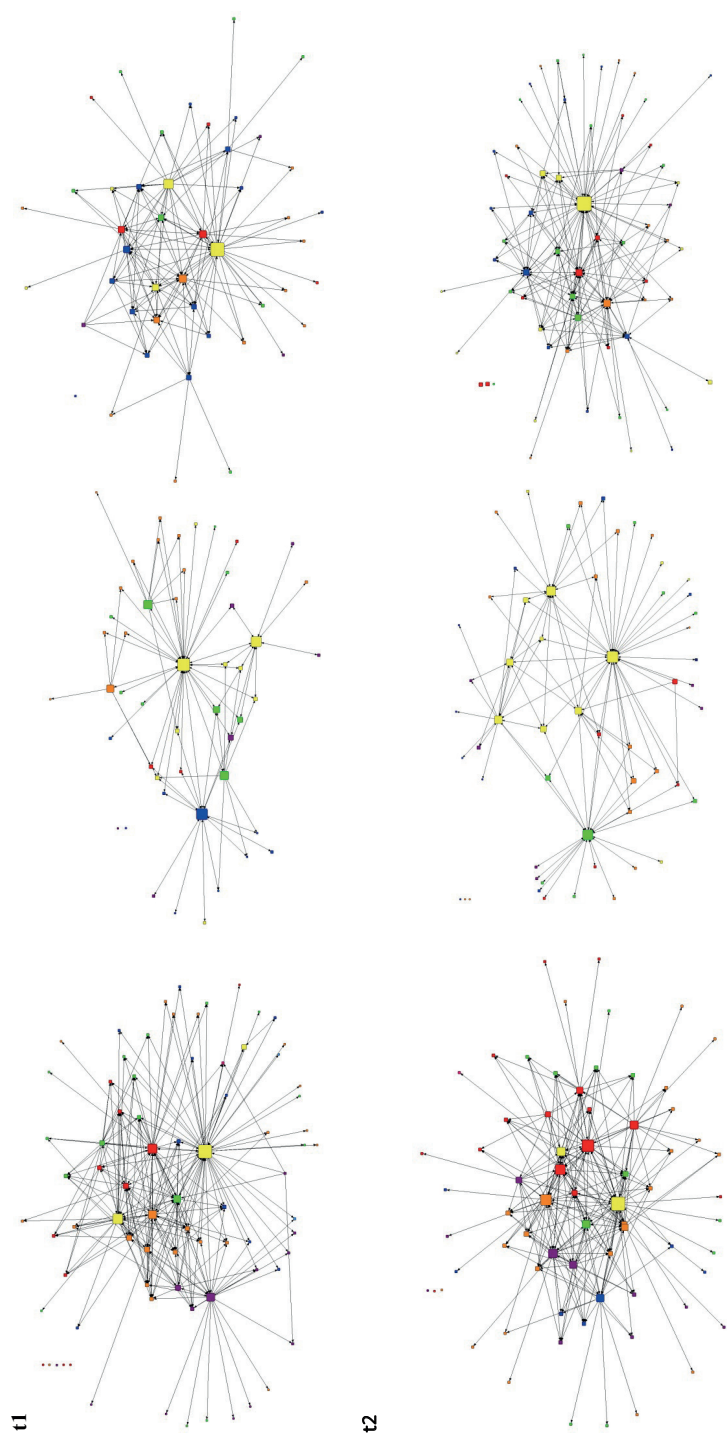


Figure 3. Centrality networks over time per community
Size of node reflects centrality; Sectors displayed as project management/ government (yellow), private (blue), sports (purple), welfare (green), health care (red), educational (orange)

Relation between network parameters and implementation degree at the network level

Network size & implementation degree

The community showing the lowest implementation degree (community A) had the largest network size over time. In contrast, the network sizes of community B & C were almost the same, whereas their implementation degree differed ten points (92.5 vs. 102 points). This might indicate that a larger network size is associated with lower implementation degree, but that a smaller network size is not necessarily associated with lower implementation degree. We moreover found an increase in network size for communities B & C and not for community A. This might suggest that an increase instead of a larger network size throughout time is associated with higher implementation degree. That being said, it should be noted that we could not account for community size in this descriptive comparison. Community C for instance had the smallest population. Its network size however was larger at t2 than that of community B, whose population was almost double the size. Community C moreover received the highest implementation score. It might thus be so that the network size of community C is, in relative terms, the largest and thus associated with implementation degree. Other studies did find an association between network size and network performance for public health interventions (21, 52, 53). A study with a larger sample of communities taking into account community size is needed to verify this assumption.

Distribution of actors per sector in the network & implementation degree

All communities, at both measurements, show an unbalanced distribution of partners within the network (figure 1). The most unbalanced distribution of partners at t2 is observed for community B, whereas the most balanced distribution was observed for community C at t2. Hence, this would indicate that a balanced distribution might be associated with successful implementation, but that an unbalanced distribution might not necessarily be associated with unsuccessful implementation. A remark should however be made in how we interpreted '(un)balanced'. For analytical purposes, we chose to operationalize a balanced distribution of partners as an equal (in number) distribution of partners across the six sectors defined. It is however so that not all six sectors are to be equally involved in the implementation of the IACO; every community can decide for themselves which sectors should be involved and which (and how many) IACO activities they will be prescribed. Hence, one could argue that it is only possible to determine whether the distribution of partners is 'balanced' if the number and content of the activities prescribed to the different sectors is taken into account.

The level of collaboration & implementation degree

The average level of collaboration in communities A & B increased from resp. 2.82 and 2.72 to reps. 3.12 and 3.14. In community C, the average level of collaboration decreased from 2.85 to 2.72. As community C was appointed the highest implementation score, this might indicate that a decrease in the level of collaboration is associated with a higher implementation degree, whereas an increasing level of collaboration might be associated with a lower level of implementation. At first glance, the association between high implementation degree and decreasing collaboration efforts might seem counter-intuitive. In previous IACO implementation studies, solid collaboration efforts has also been related to higher and not to lower levels of implementation degree (17). However, the association found might be based on 'a decrease in the level of collaboration over time' instead of 'a low level of collaboration throughout time'. As collaboration is considered a pre-requisite for IACO implementation success, one could imagine that a low level of collaboration might lead to IACO implementation failure. If actors however only decrease their level of collaboration, this might indicate that implementation is running smoothly and that they require less support from other actors to continue their successful implementation efforts. The opposite association found then might also make sense; actors might increase their collaborative effort if there is a risk for implementation failure.

The centrality of the project manager & implementation degree

Project management was the most central actor in all communities at t2. As implementation scores differed, this indicates the centrality of project management in itself might not be associated with implementation degree at the network level. Other studies have reported an association between high centrality of one or two actors and network performance (54-56). The lack of association we found might be due to the limited number of communities we could include. Project management was the most influential and most prominent actor in all three communities across time, except for community C at t1. Using these data, it is therefore not possible to verify whether a community network that has another most central actor would have performed better or worse with regard to IACO implementation.

Degree centralization of the network & implementation degree

Centralization in-degree (the level of variance in the number of incoming ties between the most central actor and other actors in the network) declined for communities A & C and increased for community B over time. Centralization out-degree (the level of variance in the number of outgoing ties) declined over time in communities A & C, whereas an increase in centralization out-degree was observed for community B. Overall, both in- and outdegree centrality were highest for community B, followed by community C and A. Hence, community B showed the largest increase in degree centralization over time and

the most centralized network in general. Community A had the least centralized network throughout time and showed the largest decrease in degree centralization over time. As community A obtained the lowest implementation degree, our data might indicate that a less centralized network or a decrease in centralization over time is associated with lower implementation degree. The association between a decrease in degree centralization and lower implementation degree might be explained by the central role that project management fulfilled in community A. For centralization to decrease, especially the most centralized actors (such as project management in community A) need to scale down their collaborative efforts. A decrease in project management collaborative efforts has often been reported to result in poor implementation sustainability, because other actors still expect project management to lead the way. These actors then do not show sufficient collaborative efforts themselves to compensate for the loss of effort by the project management (57). Hence, it might be so that the decline in centrality of project management instead of low centralization on its own is related to the drop in implementation degree. Supporting this hypothesis, a network that is decentralized from the beginning has been named to facilitate the adoption of innovations and long term implementation, whereas networks starting centralized have been related to determinants impeding IACO sustainability (17) such as fewer attempts at shared decision making amongst partners and lower commitment of partners to implement health promotion interventions (21).

Strengths & limitations

The use of an SNA questionnaire of Valente *et al.* (36, 58) can be counted among the strengths of this study. This questionnaire has been used in similar previous studies to successfully measure network development over time (21, 27). Furthermore, network development was evaluated longitudinally, which provided new insights into the relation between network development and implementation success. Some limitations of our study should however also be noted. Our study was merely exploratory. We used descriptive analyses to study the hypotheses stated by EPODE, no statistical analyses were performed. We therefore suggest future studies consider the use of multi-level statistics to (dis)confirm the results of this study. For example methods developed especially for social network analysis such exponential random graph models (P-models) (59-62), which allow for the statistical analysis of patterns or variances of network (performance) within networks involving multiple actors or groups. We furthermore could only include three communities in our study, and had only one measurement of implementation degree (namely at t2). It was therefore not possible to see whether implementation degree changed over time, and to draw definitive conclusions from our results. Moreover, implementation degree was self-reported by project management. Previous studies have shown that self-report of implementation behavior can be prone to bias (63-65), and results should therefore be interpreted with

caution. Finally, we encountered some drop-out of participants from t1 to t2. Although the response rates obtained have been shown to produce robust, internally valid, network outcomes (43, 44), we argue that our findings (especially in- and outdegree and the quality of ties) might be influenced by the participant drop-out. One could for example imagine that those actors with a lower in- and out degree, lower levels of collaboration and/or lower levels of satisfaction (and therefore less collaborative effort) might be more prone to drop out of the study, leading to inflated outcomes on these parameters.

Conclusion

This study examined network development and IACO implementation degree within three communities implementing the EPODE-derived IACO 'Youth on a Healthy Weight'. We furthermore evaluated the relation between specific network parameters and implementation degree at the network level, taken into account the assumptions on this relation as defined by EPODE and JOGG. To our knowledge, this is the first study to evaluate if and how network development over time is related to implementation degree within IACOs. It provides new insights into how IACO community partnership networks develop longitudinally and whether its network parameters associate with implementation degree. EPODE considers the establishment of a community partnership network as a prerequisite for successful IACO implementation (13). It states that childhood obesity can only be countered if all relevant partners within the community, both private and public, are mobilized to create a non-obesogenic environment. It is furthermore mentioned in previous studies that several aspects necessary for successful IACO implementation, such as community capacity and a broad spectrum of (human) resources and expertise, can only be mobilized if community partners work together to reach intervention goals (66-68). Our findings are partly in line with these statements about network development and implementation success; three out of five of the JOGG assumptions on network development and implementation success were (partly) supported by our results. However, we also found that other network characteristics and parameters were of possible influence on IACO implementation success. Previous studies have moreover revealed that network characteristics or parameters do not only influence implementation success but that implementation success also influences these variables. For instance, studies have found that if more IACO activities are implemented successfully and this success is visible to community partners, they are more likely to initiate, improve or intensify collaboration efforts (48). From our data, we are not able to deduce whether this circular relationship is also relevant or applicable to the communities included in our study. We do however argue that it is important to keep in mind that this relation is potentially reciprocal. Hence, improving implementation efforts by influencing other determinants of IACO implementation (17) might lead to a higher degree and quality of

collaboration and thereby further optimisation of implementation integrity. We also found that this relationship between network characteristics and IACO implementation success might not (as) static as proposed in the assumptions made by EPODE and JOGG. The change in network parameters over time instead of network parameter outcomes at one point in time might be associated with implementation degree. Future studies, including a larger number of communities, might be able to shed light on this presumption and elucidate whether certain changes as opposed to constancy in network parameters are associated with IACO implementation success. Finally, the results of this study offer indication on how network development strategies can be formulated to optimise IACO implementation. This could also be used to direct future studies and the development of EPODE program methodology, for example by testing in vivo whether these strategies can influence IACO implementation.

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