



The conjoint community resiliency assessment measure as a baseline for profiling and predicting community resilience for emergencies

Odeya Cohen^{a,b,*}, Dima Leykin^{c,d,1}, Mooli Lahad^{c,d,2},
Avishay Goldberg^{a,b,e,3}, Limor Aharonson-Daniel^{a,b,4}

^a Department of Emergency Medicine, Recanati School for Community Health Professions, Faculty of Health Sciences, Ben-Gurion University of the Negev, P.O. Box 653 Beer-Sheva 84105, Israel

^b PREPARED Center for Emergency Response Research, Ben-Gurion University of the Negev, P.O. Box 653 Beer-Sheva 84105, Israel

^c Department of Psychology, Tel-Hai College, Galil-Elyon 12208, Israel

^d The Community Stress Prevention Centre (CSPC), P.O. Box 797 Kiryat-Shmona 11016, Israel

^e Department of Health Systems Management, Faculty of Health Sciences & Faculty of Management, Ben-Gurion University of the Negev, P.O. Box 653 Beer-Sheva 84105, Israel

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ABSTRACT

Community resilience is a term that describes the community's ability to function amidst crises or disruptions. Community resilience is perceived as a fundamental element in emergency preparedness and as a mean of ensuring social stability in the face of crises, including disasters. However, there is a paucity of empiric evidence for this conjecture. This paper demonstrates the use of the Conjoint Community Resilience Assessment Measurement (CCRAM) for estimating the ability of a community to be resilient in the face of disaster. Six factors of community resilience were identified based on a study conducted in nine small to medium size towns ($N=886$): Leadership, collective efficacy, preparedness, place attachment, social trust and social relationship. Multiple logistic regressions yielded the CCRAM protective factors for perceived community resilience. Receiver Operating Characteristic (ROC) analysis confirmed the quality of the CCRAM as a diagnostic tool for perceived community resilience. The CCRAM tool is presented as a potential provider of information for authorities and decision makers as an aid for foreseeing and planning towards the challenges present during emergency times.

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1. Introduction

During a natural or man-made disaster, the population may experience physical injury, often there is damage to infrastructure, the availability of various services is impaired, resulting in

residents experiencing feelings of uncertainty, anxiety and stress. While preparing for disasters has long been attempted, the approach to community resilience in the face of a disaster is relatively new. Furthermore, it is a difficult area to resolve and handle. The functionality of the individual and of the community during these situations, and their ability to swiftly return to normal life, are significant factors associated with coping with emergency situations [1,2]. The term Community Resilience (CR) is used to describe the community's ability to deal with crises or disruptions. Originally used to consider resilience to social and/or economic disruptions, the term has been used to consider population response to a broad range of changes. Magis described it as "the existence, development and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise" [3]. CR is a multi-dimensional

Abbreviations: CCRAM, Conjoint Community Resilience Assessment Measurement; CR, Community resilience.

* Corresponding author at: Department of Emergency Medicine, Ben-Gurion University of the Negev, P.O. Box 653 Beer Sheva 84105. Tel.: +972 8 6428430; fax: +972 8 6472136.

E-mail addresses: odeyac@post.bgu.ac.il (O. Cohen), dimleyk@gmail.com (D. Leykin), lahadm@netvision.net.il (M. Lahad), avishy@exchange.bgu.ac.il (A. Goldberg), limorad@bgu.ac.il (L. Aharonson-Daniel).

¹ Tel.: +972 4 6900620; fax: +972 4 6950740.

² Tel.: +972 4 6900620; fax: +972 4 6950740.

³ Tel.: +972 8 6477780; fax: +972 8 6477634.

⁴ Tel.: +972 8 6472137; fax: +972 8 6472136.

concept, used by many fields for many situations, to describe and consider the intersection between economic, social and environmental capital [4]. In this article, we focus on CR at the local level in the context of a wide spectrum of emergencies that may affect the functioning of the community.

Embodied in the term CR are physical components such as infrastructure, economic resources, emergency preparedness and the availability of various services. Other components of CR relate to the individual's perceptions about his or her community. These include the existence of social networks, social capital, and the past experiences of community members with various stressful situations. Research on CR is associated with stressful events, but it is also related to the individual's ability to function fully in normal times. Indeed, some of the work on community resilience is rooted in research related to individual resilience, which has been used often with vulnerable populations, examining their ability to overcome economic and social deprivation. The roots of CR are firmly lodged in the pre-crisis period [5]. Physical and social infrastructures as well as interpersonal trust and ties do not emerge overnight. They are the product of ongoing activity by members of the community, sometimes in positions of authority, who recognize the importance of their development as part of the routine activities of the community and the authorities. As such, it is important to study the CR in routine times, before the outbreak of a crisis.

The attributes of resilient communities are intertwined with factors that reflect the existence of socioeconomic conditions that contribute to a sustainable lifestyle, effective risk management [6,7] and community development [8]. The use of forecasting in governance and community development enables decision makers to inform planning in order to facilitate their taking responsibility for policies and programs that can contribute to a better future. Governments and organizations are increasingly realizing and accepting CR as a key element in their emergency response plans [9–11]. However, there is scarce empirical evidence regarding measurement of CR, or subsequently, of the translation of published research into a standard accepted measurement framework [12].

This paper presents the use of a new tool, developed by a group of experts including the authors. The development, took the form of an iterative process that included the combination of literature reviews, past studies and a DELPHI process with a multidisciplinary group of senior content experts. Data was collected and the incorporation of advanced statistical methods rooting from the fields of exact sciences besides those common in the social sciences produced a unique view into community resilience. The tool holds the potential for anticipating the ability of a community to be resilient in the face of disaster. The study presents measurements of the community's resilience level during the pre-emergency period (resiliency baseline score), and suggests approaches to analyzing the gap between this assessment, and subsequent measurements that will be carried out. This is important for two reasons: (1) In order to assess the effectiveness of interventions for increasing emergency preparedness, and (2) to measure the effect of the crisis on the community. The gaps identified will provide decision makers with the information needed to intervene in an evidence-based focused manner in order to strengthen the community. Periodic repetitive assessments can form a gauge of the community's resilience level.

2. Materials and methods

Estimation of a community's capacity to cope with emergencies is accomplished through measurements by the Conjoint Community Resiliency Assessment Measure (CCRAM) tool (Aharonson-Daniel L. et al., under review), and using these results to produce periodical reports or to respond to specific queries.

2.1. The Conjoint Community Resiliency Assessment Measure (CCRAM) tool

The CCRAM is an innovative tool for multidimensional assessment of CR. It comprises two instruments: (1) a self-report survey instrument covering various components of resiliency (e.g. respondent's experiences and perceptions of their environment – their social ties and sense of community, attachment to place, faith, trust in local elected leaders and their ability to lead change) as well as demographic details and information on relevant personal experience of the respondent, and (2) a checklist is used to collect objective information on the existence of infrastructure and the availability and accessibility of services in routine and emergency situations from official representatives of the local or municipal authority. The objective part of the questionnaire will not be presented in this manuscript which focuses on the responders' perception of his or her community and indicators of their resilience in the face of disaster.

The data from surveys using CCRAM are entered into a database that can be used by municipal authorities, decision makers and academic researchers to monitor changes and adjust public policies as necessary to ensure effective responses to emergencies. The database is built by collaborative research, feeding information from many townships into one databank. The CCRAM data base is designed to enable researchers to provide decision makers with standard brief, clear and concise periodical reports, based on data accumulated in the electronic data base.

2.2. Research methods

The CCRAM population survey was conducted in nine small to medium size towns in Israel, including three types of communities: (1) midsize urban towns, (2) villages and planned communities and (3) collective communities (kibbutz). The study was conducted between August and November 2011, using face to face in door to door surveys at randomly selected addresses. Electronic questionnaires were distributed in small settlements with a complete electronic mailing list by Qualtrics (www.qualtrics.com), a web-based survey software.

The self-reported questionnaire asks participants to report on a 5-point Likert scale, the extent to which they agree with each statement (1–strongly disagree to 5–strongly agree) related to six domains: leadership, collective efficacy, preparedness, place attachment, social trust and social relationship. Items also enquire about general and socio-demographic information, including: gender, type of settlement, duration of residence in the community, age, family status, number of children, physical disability, dependence of others on the participant's care, level of education, religion, level of income, and employment status. Other items deal with history of

exposure to emergency situations, involvement in volunteering activity, belonging to an emergency response team in their place of residence and availability of emergency preparedness equipment such as shelters at home. Two final questions asked about perceived individual and CR after defining resilience as “the ability to quickly return to routine after an emergency event”. Variables were mostly categorical, nominal or ordinal variables in multi-choice questions. Where appropriate (age and duration of residence) numerical or ordinal (income) variables were used. The study was approved by the institutional review board of the faculty of health science at the Ben-Gurion University of the Negev. Participants gave their informed consent to take part in the study.

2.2.1. Statistical analysis

The CCRAM survey data analysis included 31 items from the self-report assessment which yielded six factors: leadership ($\alpha = 0.95$), collective efficacy ($\alpha = 0.84$), preparedness ($\alpha = 0.83$), place attachment ($\alpha = 0.78$), social trust ($\alpha = 0.85$) and social relationship ($\alpha = 0.72$) [13]. According to the type of variables, Pearson and Spearman correlation coefficients were calculated and used to examine the association between CCRAM factors and their relationship with background variables (general and socio-demographic information mentioned above). Partial correlation was used to adjust for background intervening variables. An Analysis of Variance (ANOVA) followed by repeated measures was used to examine effects of CR factors and type of community: midsize urban towns, villages and planned communities and collective communities, taking into account their interactions.

Perceived community resilience was recorded on a 5 point Likert scale as detailed above. Hierarchical logistic regression (HLR) was performed on a subset of the participants comprising the two extreme levels recorded: Low (1–2, $n = 88$) vs. High (4–5, $n = 522$), while the intermediate level (3, $n = 276$) was omitted from analysis. The regression model was run with two blocks: (1) socio-demographic variables such as community type, military/national service, income level and proportion of life in current community (low/high); and (2) CCRAM factors which included leadership, collective efficacy, preparedness, place attachment, social trust and social relationship.

In this analysis, CCRAM factors were submitted to the model after the socio-demographic variables, thus the model facilitated the examination of the net contribution of CCRAM factors on perceived community resilience beyond and above the socio-demographic characteristics.

Odds ratios are used in HLR to estimate the strength of association or non-independence between a binary and a categorical variable [14]. In this study we used odds ratio to describe the effect of certain variables on the perceived level of community resilience. The greater the odds ratio, the higher the score.

Furthermore, the classification probabilities for low/high perceived community resilience from the two steps of the HLR were saved and submitted to a receiver operating characteristic (ROC) analysis. This analysis describes the accuracy and diagnostic value of the CCRAM tool, in terms of its trade-off between sensitivity and specificity [15]. The ROC curves along with the area under the curve (AUC) of each step in the HLR further exhibited the contribution of the CCRAM factors to the perceived community resilience and

the quality of the model fit. Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 19.0.

2.2.2. Participants

Participants ($N = 886$) of the current study were Israeli adults (mean age = 45.28 years, $SD = 15.40$ years, range 18–86 years), drawn from nine small to medium size communities throughout Israel: midsize towns ($n = 485$), villages and planned communities ($n = 207$) and collective community ($n = 180$).

This sample was randomly selected from each settlement as described above. Response rates varied between settlement types and ranged from 80 to 95% resulting in a sampling ratio of 13% of households in midsize towns, 22% of households in villages and 40% of households in collective communities.

Participants had an average of 27.42 years living in their community ($SD = 16.9$ years, range 1–67 years). The majority, (55.7%) were women, and 71.4% were married or in a permanent relationship. In terms of religiosity, 57.5% were secular. Approximately 42% had an education level above high school. There was a significant relationship between proportion of life in current community and the type of community. Participants from villages and planned communities had a higher level of education and higher income. No difference was found in the gender distribution between the communities.

3. Theory

Community resiliency at the local level includes components from both physical and social realms [16]. Physical resources include existing infrastructure and services, which often reflect the socio-economic status of the community. The community's ability to lead itself with a set of skills, contributes to the opportunity to overcome a crisis or disturbance. This section will discuss the theories behind the components presumed to have an impact on the community resiliency.

3.1. Community characteristics

The role of the community in coping with crisis has been established in the literature. Dimensions that have significant influence on the participant's behavior and ability to overcome emergency situations include: social capital, social support, collective efficacy, connectedness, the sense of trust and belonging of the individual to the community and his or her place-attachment. These concepts are related to each other, and together create the specific social character of the community. In the past, studies of these paradigms, linked to resiliency, focused mainly on the individual, whereas now additional benefits at the community level are being examined [2,17,18].

3.1.1. Collective efficacy

Collective efficacy is defined as social cohesion among neighbors, combined with their willingness to intervene on behalf of the common good [19]. The concept, which was derived primarily from the field of criminology, was later associated with CR [18,20–22].

3.1.2. Social capital

Social capital is a feature of social life, including the networks, norms and trust that enable participants to act together more effectively towards a purpose or shared objectives [23]. Social networks allow the promotion of community cohesion [12]. Chandra [24] noted that social networks increase the ability to use information, resources and communication to respond and recover during and after a disaster. Thus by improving the individual's decision making ability, social networks help reduce damage from a potentially catastrophic event [25]. Elements of social networks boost capacity for communication between community members. This capacity – connectedness – is of immense importance to the individual when coping with a crisis [26,27]. According to Hobfoll [28], connectedness can provide solutions to practical and emotional problems that eventually lead to normalization after crisis. Kirschenbaum argues [29] that social networks are the building blocks of the community. As such, the networks provide a theoretical and an empirical framework for assessing the influence of the disaster.

3.1.3. Social trust

Social trust refers to the belief that others can be relied upon and to the willingness to act on the assumption of the other's benevolence. According to Cacioppo et al. [30], when people trust in one another, they may open themselves to potential exploitation, but more importantly, they signal their constructive intent to others, thereby inviting cooperation and mutually beneficial actions. Positive correlation between CR and social trust was found in a number of different studies [17,22,30,31].

3.1.4. Social support

Social support is a critical dimension of community resiliency [20]. According to Norris' studies [2,20], social support is divided into “received support,” receipt of actual help and “perceived support” which refers to the belief that help would be available if needed. The support can be received from various levels in the community ranging from family and friends to agencies and authorities. The effect of social support was found to be a significant protective resource in response to stressors [32]. The lack of perceived social support had in fact, negatively affected the reaction of victims exposed to a disaster [33]. These elements and knowledge have been incorporated into CCRAM factors Collective efficacy, Social trust and Social relationship.

3.2. Leadership

In addition to the above mentioned social features, leadership—governance or authority—is perceived as another core element of the CR [4,34–36]. According to Castleden et al. [12] “good governance” has a key role across the different disciplines dealing with resiliency. Leadership has a significant role in every phase of the crisis cycle: during the pre-event phase when constructing the emergency response plans, during the disaster itself and throughout the recovery period [35]. The importance of leadership was particularly evident in cases in which the leadership failed, and led to disastrous consequences [35]. The capability of authority and leadership is shown by their ability to direct and activate the first responders as well as to adjust the policies and procedures to the changing reality [22]. Stewart, Kolluru and Smith [37] state that resilience calls

upon active management and relies upon assessment and a willingness to take action in the face of adversity. Therefore, governments have to develop more comprehensive continuity plans in order to establish continuity after the crisis. Another aspect linked to this factor is the issue of trust [34]. Stewart, Kolluru and Smith [37] claim that trust can lead participants to develop more informal relationships. This evidence stems from interactions between parties that had previous interactions and were not operating under time sensitive constraints like disaster response [37]. Concurrently, public–private interactions which involved low levels of trust would appear to migrate towards more formal or contractual interaction. Gazley [38] suggests measuring trust and behavioral norms in public–private partnerships, to promote understanding of the way that informal partnerships are managed. Aspects of trust and belief in leadership are included in the leadership factor.

3.3. Emergency preparedness

Emergency preparedness is yet another CR dimension [39]. The World Health Organization-supported Hyogo framework for building resilient communities considers preparedness as an important component [9]. Cutter sees preparedness as a manifestation of social learning in the feedback process of resiliency building [1]. Previous studies explore the correlation between preparedness and a set of independent variables [1,12,16,40]. At the local level, preparedness is associated with leadership and authority. According to McDaniels et al. [41], resilient infrastructure systems, particularly “lifeline” services, are crucial for minimizing the societal impact of extreme events. This has extreme importance given that one infrastructure system failure leads to failures in other systems. Stewart et al. [37] argue that at the microeconomic level, resilience is boosted through activities like reinforcing buildings to improve resistance, conserving resources to better adapt to a situation, and leveraging flexible technologies to better identify alternative sources of supply when local outlets are impacted. These aspects of resilience are covered by the preparedness factor of the CCRAM.

3.4. Attachment to place

Another dimension of community resiliency is place attachment, a phenomenon that incorporates various aspects of bonding between people and places and involves the interplay of affect and emotions, knowledge and beliefs, behaviors and actions in reference to a place [42]. According to Norris [2] place attachment may be of special note for disaster and recovery since disruptions in this feature threaten both individual and communal aspects of self-definitions, and stronger attachments make such disruptions more devastating [43,44]. These aspects were included in a CCRAM factor named place attachment.

4. Results

The six factors of CR were positively correlated with each other, correlation coefficients ranging from 0.22 to 0.62, as shown in Table 1.

A Pearson product-moment correlation analysis found significant positive but weak correlations between CCRAM

and age, $r(878) = 0.18$, $p < 0.001$, and negative correlation with education level, $r(873) = -0.07$, $p < 0.05$.

Two-way ANOVA indicated that gender had a significant relationship with the CCRAM average score, $F(1, 876) = 4.62$, $p < 0.05$, with women reporting higher CR (female mean CCRAM score 3.50, s.d. 0.73 male mean CCRAM score 3.45, s.d. 0.68). Significant relationship was found between belonging to a local emergency service and CR, $F(1, 866) = 6.53$, $p < 0.05$. Controlling for socio-demographic variables, CR was strongly and positively correlated with satisfaction with quality of life in the community, $pr(798) = 0.63$, $p < 0.001$, negatively correlated with intention to leave the community during an emergency, $pr(798) = 0.27$, $p < 0.001$, and negatively correlated with sense of security threat in the community, $pr(798) = 0.12$, $p < 0.001$. When examined by type of community, a negative association between CR and intention to leave the community remained significant for midsize towns and collective communities only, but not for villages and planned communities. The type of community did not moderate the association between CR and satisfaction with quality of life in the community.

In addition, the CCRAM average score was significantly and strongly correlated with the single item measure of perceived community resilience, $pr(785) = 0.62$, $p < 0.001$. An analysis of covariance (ANCOVA) indicated a significant effect of type of community on CR, $F(2, 829) = 39.46$, $p < 0.001$, controlling for socio-demographic variables. Post-hoc pairwise comparisons using Bonferroni adjustment suggested that midsize towns had significantly lower reported CR ($p < 0.001$), while villages and planned communities, and collective communities did not differ from each other on the level of CR. Fig. 1 demonstrates these differences.

Fig. 2 demonstrates the use of the CCRAM tool for establishing an average score for each of the six factors and using it to portray a resilience profile for different communities. The communities depicted in the graph are compared with the overall mean score obtained for all communities. Similar graphs can be drawn by individual township.

For four out of the six factors, the individual profile of the sample town, which appears in the example provided in Fig. 2, is significantly lower than the average for the study population as a whole. The most significant finding for these towns is the difference between the score of the leadership (=2.7) and preparedness (=2.3) in comparison with the average of (=3.2) and (=2.9) respectively. However, on social relationship and trust, this town's score is not significantly different from the average score. The profile of the collective community described above shows that leadership (=4) and preparedness (=3.7) in

this type of dwelling are significantly higher than the average for this study's population.

4.1. Hierarchical logistic regression (HLR)

Hierarchical logistic regression was conducted to explore the contribution of each of the CCRAM factors to the perceived community resilience. Table 2 presents the results of the last step of the HLR. Significant socio-demographic variables were identified by this model. Community type differed where villages and planned communities had an odds ratio (OR) of 3.76 (95% CI 1.02–13.82), and Collective community 7.11 (95% CI 1.22–41.43) compared with the reference group midsize towns (1). Military/national service had a borderline effect where no-service compared with military service had an OR of 0.37 (95% CI 0.13–1.07). In this model, all CCRAM factors except for social relationship made a significant contribution to perceived community resilience. The OR ranged from 1.80 to 4.30. Collective efficacy had the strongest effect with OR = 4.30 (95% CI 2.28–8.10). The contribution of CCRAM factors beyond the socio-demographic variables was statistically significant, change in the $-2\log$ likelihood was 210.7 with $p < 0.001$. The regression coefficients are displayed in Table 2

4.2. A receiver operating characteristic (ROC) analysis

Classification probabilities of low/high perceived community resilience levels resulting from the HLR model were further analyzed using the ROC analysis to assess the diagnostic value of the CCRAM. Two curves were plotted: (1) socio-demographic variables and (2) socio-demographics and CCRAM factors (Fig. 3). The two models showed significance beyond the chance-alone reference curve. Socio-demographic variables area under the curve (AUC) AUC = 0.79 (SE = 0.026, $p < 0.001$; 95% CI(0.74–0.84), and socio-demographic variables and CCRAM factors AUC = 0.96 (SE = 0.7, $p < 0.001$; 95% CI(0.95–0.98)). The contribution of the CCRAM beyond the socio-demographic variables increased the AUC by 0.17 and there was no overlap of the 95% CI, indicating important and significant CCRAM contribution in the assessment of perceived community resilience.

5. Discussion

This paper demonstrates the ability to measure and assess community resilience using a tool designed for that purpose. It establishes a baseline community portrait which can later serve as a reference point for the community's capacity to cope with emergencies.

The CCRAM tool provides information regarding leadership, community characteristics, preparedness and attachment to place by assessing six factors which represent the community's structure and resources, as perceived by its members. The tool offers supporting information, including indicators, which reflect the capability of the community to face a crisis and recover from it. Using the CCRAM tool, the study authors assessed different levels of CR components, creating a unique profile for each community with descriptions of their respective baseline characteristics.

Measuring CR is a challenge; diverse approaches and attempts to measure it have not produced a generally

Table 1
CCRAM factors: Pearson product-moment correlations (N = 886).

Variables	α	1	2	3	4	5	6
1. Leadership	0.95	–					
2. Collective efficacy	0.84	0.62	–				
3. Preparedness	0.83	0.45	0.56	–			
4. Place attachment	0.78	0.60	0.42	0.37	–		
5. Social trust	0.85	0.36	0.51	0.42	0.34	–	
6. Social relationship	0.72	0.36	0.49	0.51	0.22	0.41	–

All correlation coefficients indicated in the table are statistically significant, $p < 0.001$.

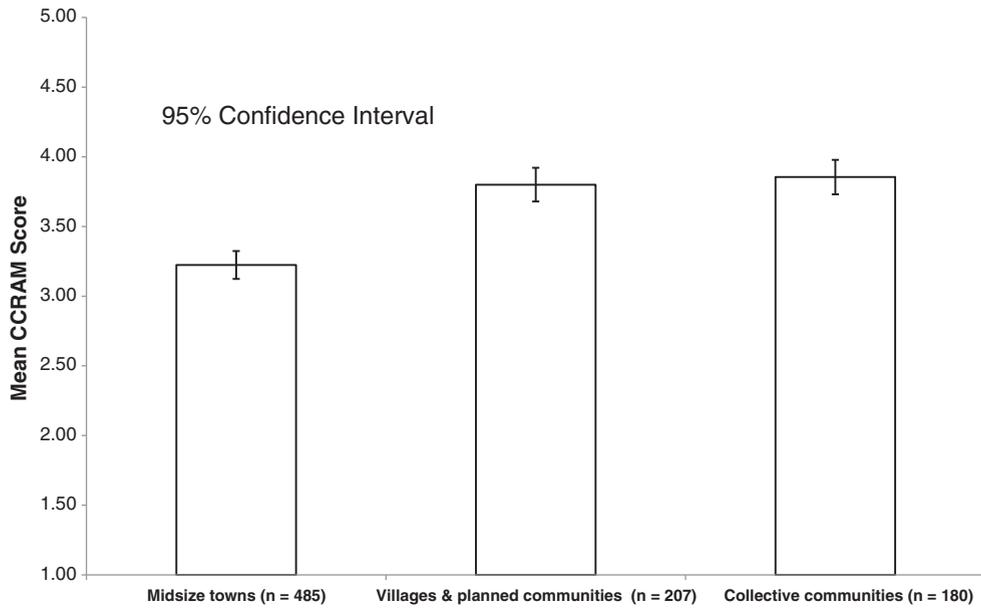


Fig. 1. Differences in community resilience as a function of type of community.

accepted framework for its measurement in the past [12]. In addition to the approaches that place emphasis on individual perception, other methods devised to measure CR using objective public information, do not take into account, the local residents point of view [21,45]. Nor do they ascribe a significant weight to objective data as indicators of CR [43]. The CCRAM instrument offers a combination of information from the municipal authority and from the individuals in the population about their perceptions. According to Eames and Egmosse [46], it is necessary to be attentive to the

participants' attitudes towards their community, developing a 'bottom-up' view that reflects their various relevant needs. Similarly, we attribute great importance to the "voice" of community members when dealing with emergency preparedness and response. The residents' perceptions yield an understanding of behavioral norms and expectations that express the existence or non-existence of communal values. For example, the statement: "I can rely on people in my town to come to my assistance in a crisis" reflects the social trust and faith that the participant has in his community.

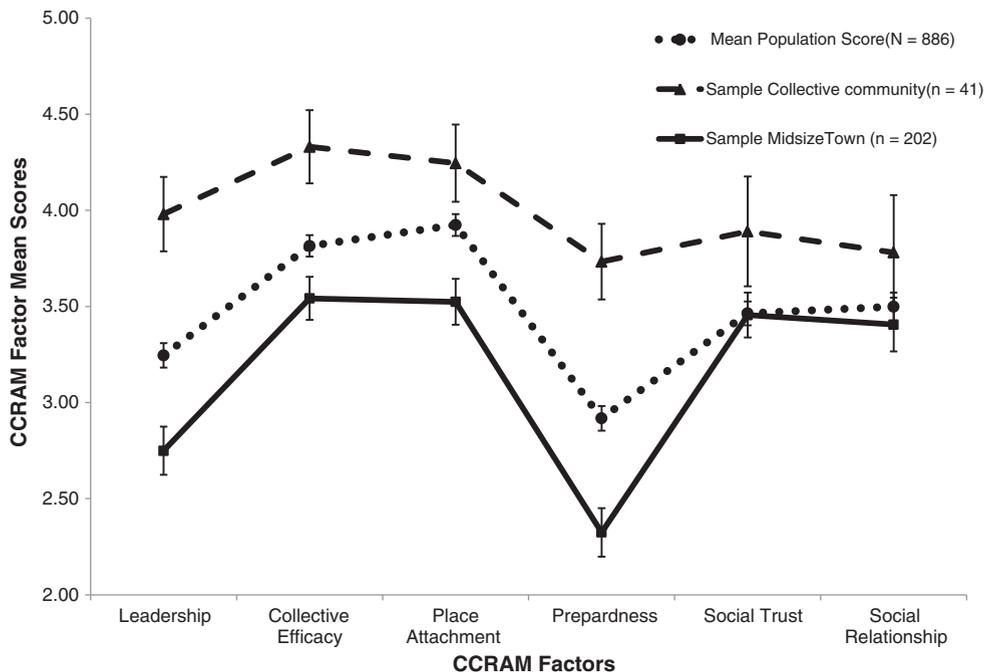


Fig. 2. Sample community profile compared with overall average scores. Note: Error bars denote 95% confidence interval.

Table 2

Factors associated with perceived community resilience: odds ratio and significance level from the hierarchical logistic regression (HLR) model.

Variables	Odds ratio		95% C.I. for OR	
	(OR)	<i>p</i>	Lower	Upper
1. Socio-demographic variables				
Community type				
Midsize towns	1			
Villages and planned communities	3.76	0.046	1.02	13.82
Collective communities	7.11	0.029	1.22	41.43
Income				
About average	1			
Less than average	0.57	0.269	0.21	1.54
More than average	1.01	0.987	0.35	2.88
Military/national service				
Military service	1			
No service	0.37	0.067	0.13	1.07
National service	6.24	0.052	0.99	39.56
Proportion of life in current community				
Low	1			
High	1.20	0.665	0.52	2.80
2. CCRAM factors				
Leadership	2.29	0.013	1.19	4.42
Collective efficacy	4.30	0.000	2.28	8.10
Preparedness	2.75	0.002	1.44	5.24
Place attachment	2.27	0.001	1.37	3.76
Social trust	1.80	0.015	1.12	2.88
Social relationship	1.06	0.770	0.70	1.62

-2 log likelihood at step 1 = 383.15 (df=6) and at step 2 = 172.48 (df= 12).

-2 log likelihood change of 2nd block with df=6, is 210.67, chi square $p < 0.001$.

The literature includes various references to the lack of research tools facilitating empirical assessment of community resilience and the resulting limitations for studying resilience [1,12,24]. Even researchers that perceive the social dimension

as fundamental, leave the development of a suitable tool for future research [47].

The CCRAM tool was built with the perception that CR encompasses a wide spectrum of components, each related one to the other. From that point of view, it is in a way similar to the Disaster Resilience of Place (DROP) model [1]. This model sees the environment, the natural and social systems together with the effect of the event affecting the capacities of the community to cope with natural emergencies. Other models use the Community Resilience Index Toolkit [48], and Coastal Resilience Index [49,50] that provide a self-assessment of diverse CR dimensions. The Emergency Events Scale [47] created a mathematical model which can be used at all levels of organizations and geographical scope to manage and predict emergency situations. All of these tools associated great importance to the social component, but do not offer sensitive means to measure it. The self-reported survey of the CCRAM delivers a valid measurement instrument for the social factor of the CR. This tool is flexible, designed to match the type of the emergency, and the effect of the type is expressed in two ways: firstly in the general information of the self-report survey and second through the objective information from the authority.

Measuring CR during routine life and creating a “baseline score” is presumed to be useful as a reference point for comparison during a crisis period. The magnitude of change and the direction of the change trend can serve as a predictor of a community's ability to sustain an assault and recover, in other words, its resilience. Cutter, in her CR model, mentioned the necessity of measuring CR in the pre-emergency period, for monitoring the effect of various circumstances influencing the CR score [1]. Our ongoing monitoring and periodic measurements will allow us to investigate the variations between different assessment point measurements. The analysis of data obtained by these measurements will not only facilitate

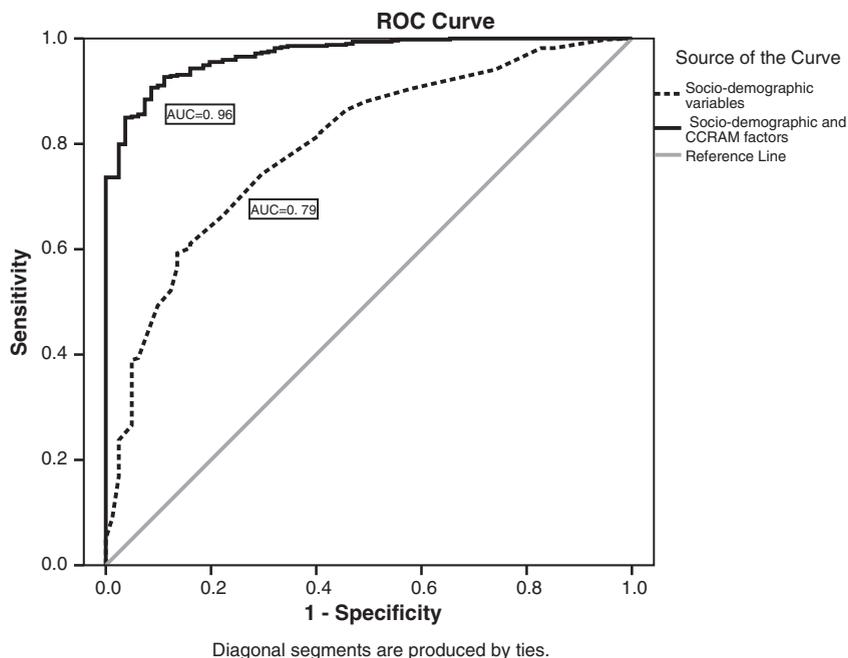


Fig. 3. Receiver operating characteristic (ROC) curves of the socio-demographic variables compared with final model including the CCRAM.

exploration of the influence that the emergency situation had on the CR profile and the CCRAM score, but will also enable the evaluation of the effectiveness of intervention plans. Understanding changes in the CR profile, together with advanced data analysis techniques, will help promote the ability to plan and foresee a community's capacity to recover in the face of emergencies.

The findings described in this study provide a portrayal of communities' resilience profiles, from a one-time measurement of CR during a non-emergency period. Following the results of the hierarchical logistic regression showing that the CCRAM indicator is associated with a high level of perceived CR, it is expected that the CCRAM will be a good predictor for CR during an emergency. This is important as often the disaster preparedness exercises concentrate more on the readiness of security system and infrastructure and less on the ability of the community to recover quickly from an emergency situation. The actual predictive value of the CCRAM score in disasters thus remains to be proven. Meanwhile, the CCRAM profile can be affected during times of calm by directing interventions towards factors which received low scores in certain communities. Theoretical validation of the CCRAM tool quality as a diagnostic tool for perceived CR using a ROC analysis [51] found that it was very good. These findings were replicated in several other databases of CCRAM measurements in different independent communities with similar results. As far as we know; this is a novel use of ROC analysis in studies of CR. While these analyses and logistic regressions are commonly used in the field of epidemiology, it is not common to use these tools to measure phenomena in the field of social science. However, this fits in well with a trend of increasing use of statistical approaches adopted from the exact sciences in the social sciences [52,53].

Aubrecht et al. recently argued that disaster management did not yet succeed in the social perspective [54]. In our opinion, measuring CR is one of the ways to meet this challenge.

6. Limitations and recommendation to further studies

The findings and the analyses presented in this paper are the outcome of a pilot study of the CCRAM instrument. The study population is smaller than desired, including 886 responders from nine settlements. In order to facilitate deeper and more specific conclusions regarding individual communities, sampling should be broader and include sub-populations from each community. Nevertheless even with this limited population, the potential of the tool can be demonstrated in a significant manner.

The aim of the tool was to use it repeatedly and compare the outcomes at different times or following interventions, experiments or quasi-experiments created by reality (such as war or disaster situations). This baseline study focuses on the potential values of the tool but does not examine the long term application of it.

The tool was developed in small to medium size communities and is currently being adapted and tested in cities, where the unit of measurement will be a neighborhood.

Future studies could also explore interface with other tools and the use of social networks for the measurement and enhancement of community resilience based on findings obtained by this tool.

Moreover, the application of additional statistical methods that are common in life and exact sciences can be used for measuring various aspects affecting community resilience, thus expanding the application of these tools into social science research.

7. Conclusion

Forecasting community capacity for resilience and coping with emergencies has great importance for authorities and decision makers. The innovative approach presented in this paper uses the CCRAM tool to provide information that will support planning and reinforce community capacity to sustain and withstand disasters.

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Appendix A. Supplementary data

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Odeya Cohen, BN MEM. Ph.D. student in the emergency medicine department. Researcher in the PREPARED Center for Emergency Response Research at Ben-Gurion University of the Negev, Beer-Sheva, Israel. Her PhD study deals with the research methodology and statistical modeling of community resilience.

Dmitry Leykin, B.A. in Education and multi-disciplinary studies from Tel Hai College. M.A. in Psychology, Tel Aviv University. Research fellow at the Community Stress Prevention Center; faculty member in Psychology and Social Work Department in Tel Hai Academic College; co-author of several articles on psycho-trauma measurement and treatments.

Prof. Mooli Lahad, Ph.D., Ph.D. is the founder and president of the Community Stress Prevention Center Kiryat-Shmona, and Professor of Psychology at Tel-Hai College, Israel. He is a senior medical psychologist; author and co-author of over 30 books and many articles on the topics of communities under stress, and coping with life threatening situations. Recipient of three professional prizes. Consultant to ministries nationally and internationally. Developer of the Integrative Model of Resiliency BASIC Ph, the community recovery model called "Islands of resiliency", and the See Far CBT psychotrauma treatment protocol.

Prof. Avishay Goldberg, MA, MPH, Ph.D. Deputy rector of Ben-Gurion University of the Negev, Israel and also a staff member of the Health Systems Management Department and of Emergency Medicine Department. Has a Ph.D. in Health Systems Management at Ben-Gurion University and a Masters in Public Health at the Uniformed Services University of the Health Sciences, Maryland, U.S.A. Served in the IDF Medical Corps; has published dozens of

articles in Health Care Policy & Management and in Disaster Management in leading scientific journals.

Limor Aharonson-Daniel, Ph.D. Head of the Department of Emergency Medicine and founding director of the PREPARED Center for Emergency Response Research at Ben-Gurion University of the Negev in Israel. Limor holds a B.Sc. in Statistics from the Tel-Aviv University and a Ph.D. in Community Medicine from the University of Hong-Kong. Current interests are in the academization of disaster preparedness and response and the development of methods and instruments to facilitate studies of injuries and disasters. Has published extensively in peer reviewed journals and authored several book chapters both on Injury Research Methods and on Disaster Preparedness Assessment.