Preventive Medicine Reports 13 (2019) 160–165

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

A social-network behavioral health program on sustained long-term body weight and glycemic outcomes: 2-year follow-up of a 4-month Microclinic Health Program in Jordan

Daniel E. Zoughbie[a], Joshua A. Rushakoff[a,b], Kathleen T. Watson[a], Nancy Bui[a], Amal Ireifij[c], Rami S. Farraj[c], Eric L. Ding[a,d,*]

[a] Microclinic International, 548 Market St., Ste 63776, San Francisco, CA 94104-5401, USA
[b] University of California San Francisco, School of Medicine, 1600 Divisadero Street, Suite C430, San Francisco, CA 94115, USA
[c] Royal Health Awareness Society, Medical City Circle, Yousef Imaish St, 699 Amman, 11821 Amman, Jordan
[d] Harvard Chan School of Public Health, Department of Nutrition, 655 Huntington Ave, Boston, MA 02115, USA

ARTICLE INFO

Keywords:
Diabetes mellitus
Type II
Self-management
Weight loss
Social networks
HbA1c
Behavioral intervention
Obesity

ABSTRACT

The burden of chronic diseases like diabetes and obesity is rapidly increasing in low and lower-middle income countries. This work assesses the long-term efficacy of a social-network based community health program for the management and prevention of type 2 diabetes.

Methods: The 4-month Microclinic Social Network Behavioral Health Program in Jordan (J-MCP) was an intervention for obesity and diabetes prevention and management conducted in the Kingdom of Jordan. Weight and HbA1c were collected at baseline, end of the 4-month program, and then 12 and 24 months after baseline. Multi-level longitudinal repeated measures analysis estimated the long-term change in metabolic outcomes, and estimated the intra-class correlations (ICCs) for assessing the degree of clustering that different social network levels, of microclinic group vs. classroom group vs. clinic geographic location vs. cohort temporal wave, contributed to body weight and glycemic changes.

Results: Of 315 participants, 83.2% completed the J-MCP program, with 90% followup at 12-months, and 70% at 24-months. At the end of the 4-month program, participants experienced a −2.8 kg (95% CI: −3.6 to −2.1) mean body weight decrease, a corresponding −1.1 kg/m^2 (−1.3 to −0.8) BMI decrease, and a −0.5% reduction in HbA1c (−0.6 to −0.3). At year 1, we observed significant mean weight reduction of −1.8 kg (−2.7 to −0.9), a corresponding −0.7 kg/m^2 (−1.0 to −0.4) reduction in BMI, as well as a −0.4% (−0.6 to −0.3) sustained reduction in HbA1c. At 2 years, participants sustained mean weight loss of −1.6 kg (−2.6 to −0.5), a −0.42 kg/m^2 (−0.8 to −0.04) reduction in BMI, and an absolute −1.0% (−1.1 to −0.8) sustained reduction in HbA1c. Analyzing different social network levels, classroom group explained ~50% of total clustering of total weight loss and 22% of HbA1c trajectories during the short 4 month intervention. However, during 12 and 24 month followup, microclinic social group clustering explained ~75% to 92% of long-term weight loss trajectories, and 55% of long-term HbA1c trajectories. The pattern of 1–2 year sustainability of the weight and HbA1c decreases was largely attributed to the microclinic social network clusters.

Conclusion: Results demonstrate that the 4-month J-MCP behavioral intervention yielded important 2-year sustained weight and HbA1c reductions, which were mostly attributed to microclinic social groups.

1. Background

The number of adults with type 2 diabetes mellitus (T2DM) continues to rise in low and lower-middle income countries (Klein, 1995; Whiting et al., 2011). Specifically, T2DM rates have surged in the Middle East. Six of the top ten countries for T2DM prevalence are now found in this region and 13.2% of Middle Eastern deaths in 2013 were attributed to T2DM (Mokdad, 2017; IDF, Diabetes Atlas Group, 2015; Al-Maatouq et al., 2010). Moreover, it is estimated that 5% of all disability-adjusted life years (DALYs) lost are attributable to high glucose

* Corresponding senior author at: Harvard Chan School of Public Health, Department of Nutrition, 655 Huntington Ave, Boston, MA 02115, USA.
E-mail addresses: danielzoughbie@microclinics.org (D.E. Zoughbie), Joshua.rushakoff@ucsf.edu (J.A. Rushakoff), aireifij@rhas.org.jo (A. Ireifij), doctor@rhc.jo (R.S. Farraj), eding@post.harvard.edu (E.L. Ding).

https://doi.org/10.1016/j.pmedr.2018.12.002
Received 7 May 2018; Received in revised form 28 November 2018; Accepted 11 December 2018
Available online 13 December 2018

levels, and 7.5% of all DALYs lost are due to high body mass index, both rising significantly since 2005 (Mokdad et al., 2016).

Providing healthcare for the increasing number of individuals with T2DM has posed a financial challenge throughout the region, making cost-effective, sustainable treatment alternatives of paramount importance (Whiting et al., 2011). Further complicating the current Middle East context are large refugee populations and migrations in the setting of ongoing regional conflicts. The shifting community structures, particularly ethnic communities being separated, have further strained resources for public health projects.

Behavioral and dietary risk factors are among the primary contributors to rising T2DM rates, and numerous studies have demonstrated that intensive lifestyle interventions can curb the effects of T2DM in at-risk adult populations (Knowler et al., 2002; Tuomilehto et al., 2001; Greaves et al., 2011; Iburg, 2017). Accordingly, there has been a push to assess both the translation of lifestyle interventions to resource-limited settings and the sustainability of resulting behavioral changes (Katula et al., 2011; Ackermann et al., 2008; Wadden et al., 2009). Social-network based behavioral health interventions leverage social support, social engagement, and resetting of social norms to foster sustainable, long-lasting health behavior change (Berkman and Glass, 2000; Vissenberg et al., 2012; Bahr et al., 2009). By affecting not only those enrolled in the intervention, but also the participant's family-and-friends network and the wider community through social-network mechanisms, these interventions can potentially spur a cascade of secondary health improvements. The challenge to date has been maintaining a behavioral change for two or more years (Vissenberg et al., 2012; Bahr et al., 2009; Thomas et al., 2011; Dennis, 2012; Norris et al., 2004; Paisey et al., 2002; Snel et al., 2012; Marinilli Pinto et al., 2008).

In the setting of increasing incidence of chronic diseases, it is imperative to assess the longevity of public health programs and focus on self-sustaining social modalities that can propagate change throughout a community and region to yield long-term sustained impact. Thus, Microclinic International (MCI) partnered with the Jordanian government to implement the Jordan-Microclinic Social Network Behavioral Health Program (J-MCP) and study the relative impact of social network support among diabetic populations in Jordan. A government supported program, J-MCP was designed to produce lasting improvements in glycemic control in a Middle-Eastern population that is partially comprised of low-income individuals and refugees who have been integrated into Jordanian society over several decades. We investigate two-year J-MCP program to evaluate the relative long-term effectiveness of this social network program for weight loss and HbA1c improvement, and elucidate whether and how different social structural groupings may explain long-term outcomes.

2. Methods

2.1. Recruitment

Participants were recruited by three local Jordan Ministry of Health (MoH) Care Centers through broad community outreach campaigns in Amman, Jordan. Some of the participants were Palestinian refugees who have been living in Jordan for decades, may live in or near refugee camp areas, and have established their own networks of family and friends in Jordanian society. The recruitment process was facilitated by project marketing activities (press releases, posters, media) and referrals from local physicians to MoH staff. Mentally competent adults (18 years or older) who were diabetic or pre-diabetic or who brought a diabetic or pre-diabetic family member were eligible to join the program. Also included were individuals who had two risk-factors (e.g. hypertension, family history, over 40, sedentary lifestyle). Eligible individuals were then contacted by MoH staff and invited to an introductory session. Those interested in registering for the program were encouraged to invite friends and family members who also had T2DM (fasting serum glucose higher than 125 mg/dl) or pre-diabetes (fasting blood glucose 100–124 mg/dl). These small groups of 2–6 individuals were organically formed, self-selected groups of people who knew each other previously through familial or social ties. The first member of the group or "node" was responsible for recruiting other members. No online social network was established for this project. The Ministry of Health maintained medical records and determined eligibility. All those interested in the program were eligible to register with their personal social networks (referred to as microclinics). Participants were asked to come fasting and take a finger prick glucose test before being given a meal.

Participants answered health questions prior to formal enrollment and consented to allow periodic data collection of behavioral and metabolic risk factors. Those who were under the age of 18, pregnant, or were not capable of informed consent were excluded from the program. To encourage completion of the program, gift cards of modest value were offered to all participants. The Institutional Review Board in Jordan approved the government-initiated program. Though not a randomized trial, this intervention was registered with ClinicalTrials.gov (NCT01596244).

2.2. The J-MCP

The Jordanian Royal Health Awareness Society staff and MoH nursing staff organized the implementation of the J-MCP. The curriculum, developed by MCI, included eight different, 2–3 hour sessions over a 4-month period conducted at local healthcare and women's centers. Cohorts of 3–8 microclinics progressed through the program together (Fig. 1). The sessions were primarily facilitated by MoH nurses, with supplemental lessons by local physicians and university professors.

The MCI model has previously been described (Zoughbie et al., 2014). Briefly, the J-MCP focused on three key areas.

1. Diabetes education. Participants were taught the pathophysiology of diabetes, with a focus on directly applicable knowledge. Building on this foundation, the curriculum detailed symptoms, signs and potential complications of diabetes.
2. Diabetes management. Most of the curriculum was focused on teaching participants disease management skills. Participants learned the importance of diet and exercise choices and practiced making better decisions over the course of the class through a stepwise process outlined in a participant workbook. The J-MCP also covered the mechanics of managing diabetes, including blood glucose measurement, foot care, use of medication, and insulin administration.
3. Microclinic management and social support. All activities were structured to encourage positive peer support and interaction in the informal spaces of homes, businesses, places of worship, and community centers where dietary and lifestyle behaviors are normally learned and reinforced. During project training sessions, Microclinics engaged in friendly competition (e.g. quiz games) to push each other towards maximal health improvement. However, although the intervention was unstructured outside of the sessions, Microclinic participants were instructed to mutually encourage each other and family members and friends to be physically active, reduce the intake of harmful foods and beverages, take their medicines at appropriate times, and monitor their blood sugar. This social network approach was designed to sustain positive life alterations and to promote them throughout the community after the conclusion of the J-MCP.

2.3. Data collection

Clinical data were collected at the start and conclusion of the 4-month program (n = 1638). A random stratified sub-sample of 315 participants (out of 1625 patients) was selected from 3 locations to

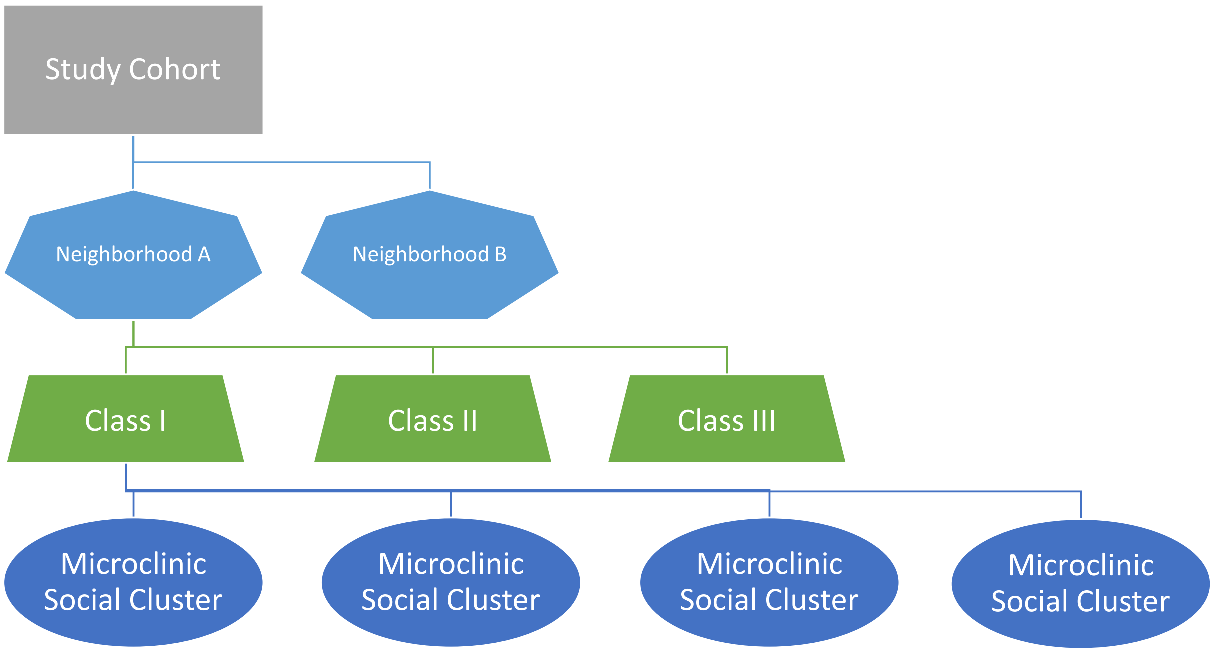

Fig. 1. Microclinic Social Network Behavioral Health Program (J-MCP) community and class structure.

participate in follow-up examinations 12 months after baseline and 24 months after baseline. This study included these individuals selected for long-term follow-up. Data collected included specific biologic markers (HbA1c, BMI, weight) and was stored in a secure location. For consistency, the same staff member obtained the clinical metrics for all individuals and all blood samples were processed at MoH central laboratory. Subsequent to this study, a formal randomized controlled trial was launched. However, no control arm was used in this study and is therefore a limitation in the current study.

2.4. Statistical analysis

To assess the long-term changes in clinical indicators and account for the hierarchical clustering of the program (i.e. individuals within microclinics, within classes, within unique geographic locations), repeated measures multi-level longitudinal linear models were run adjusting for age, gender, and the size of the microclinic. The models examined the change in weight, BMI, and HbA1c at 12- and 24-months after the program began. Multi-level models also estimated the intraclass correlations (ICCs) for assessing the degree that different social network levels contributed to body weight and glycemic trajectories from baseline to follow-up. We conducted both a) a short-term metabolic trajectory ICC analysis of the change from baseline to 4 month intervention, and b) a long-term metabolic trajectory ICC analysis of the change from baseline to 12 and 24 months. ICC was calculated as a proportion of total variance that each hierarchal nested level (microclinic groups within classroom group, classrooms within geographic site of the clinics, and clinical sites within each cohort temporal wave) contributed to the correlated change in weight and HbA1c from baseline, via our multilevel random-intercepts longitudinal models, with unstructured covariance matrix for time. Significance was 2-sided at alpha = 0.05. Analyses were conducted using STATA 11 (College Station, TX).

3. Results

Table 1 lists selected baseline characteristics of the 315 participants invited to take part in the long-term follow-up. The majority of participants were female and over the age of 55 and most microclinics had 3 or more people at baseline. Overall, 262 (83.2%) of follow-up participants had completed the entire J-MCP, while 283 (89.8%) participated in the 12-month follow-up, and 216 (69.6%) in the 24-month follow-up.

Table 1
Distribution of selected baseline characteristics of study participants.

Characteristics	(N = 315)
Gender, N (%)	
Male	99 (31.6%)
Female	213 (68.1%)
Age, N (%)	
< 40	14 (4.5%)
40 to 54	101 (32.4%)
55 or more	197 (63.1%)
Size of microclinic groups, N (%)	
1 participant[a]	21 (6.7%)
2 participants	82 (26.1%)
3 participants	135 (43.0%)
4 or more participants	56 (17.8%)
Risk factor, mean (SD)	
Weight, kg	83.4 (15.8)
BMI, kg/m^2	32.3 (7.0)
HbA1c, %	8.3 (1.9)

[a] Individuals who were unable to bring another person to the program, but were encouraged to share information at home with family/friends.

Table 2 shows the results of the multivariable multi-level repeated measures linear regression models accounting for age, gender, and the size of the microclinics. At the end of the J-MCP, these participants had lost an average of −2.8 kg (95% CI: −3.6 to −2.1), reduced their BMI by −1.1 kg/m^2 (−1.3 to −0.8), and reduced their HbA1c by −0.5% (−0.6 to −0.3). After 12-months, participants had sustained weight loss −1.8 (−2.7 to −0.9), reduction in BMI −0.7 (−1.0 to −0.4), and lowered HbA1c −0.4% (−0.6 to −0.3). Results were further maintained at 24-months with stable reductions in body weight, as well as a notable further decrease HbA1c of −1.0% (−1.1 to −0.8).

Once the effect and sustainability of the overall program was established, the repeated measure multi-level models were also used to examine the relative clustering of the weight-loss, BMI reduction, or HbA1c reduction trajectories (i.e., the intra-class correlations or ICC). This relative clustering of weight loss, for instance, was compared at

Table 2
J-MCP changes in body weight, BMI, and HbA1c after 4-months, 12 months, and 24 months after the intervention program. Mean changes presented with corresponding 95% confidence intervals. N = 311 for all analyses. All effects P < 0.05

Individual characteristics	Change in the mean weight as compared to baseline (kg)	Change in the mean BMI as compared to baseline (kg/m^2)	Change in the mean Hba1c as compared to baseline (%)
End of intervention (4 months)	−2.8 (−3.6, −2.1)	−1.1 (−1.3, −0.8)	−0.5 (−0.6, −0.3)
1 year follow-up	−1.8 (−2.7, −0.9)	−0.7 (−1.0, −0.4)	−0.4 (−0.6, −0.3)
2 year follow-up	−1.6 (−2.6, −0.5)	−0.4 (−0.8, −0.04)	−1.0 (−1.1, −0.8)

All models are adjusted for age, gender, and size of microclinic.

each level of the multi-level model (individual, microclinic, class, location, and cohort) in order to determine which level, if any, might be responsible for creating similar weight loss patterns. Said another way, the intra-class correlations were used to determine if there was a greater similarity in the weight-loss trajectories between the microclinic groups, than vs. between classes, than vs. clinic locations, than vs. cohorts waves of participants at different time of entry into the program. Therefore, the ICCs were examined from each model to identify the relative clustering of the trajectories of the clinical outcomes based on these social, geographic, and temporal groupings.

In Table 3, the relative clustering (intra-class correlations) for weight loss and BMI reduction suggest that the differences between classes and the location of the program had the largest impact on the patterns of weight loss and BMI reduction during the short intervention. Analyzing different social network levels, classroom group explained 47–51% of total variability, and geographic clinic location explained 42–48% of weight loss and BMI change trajectories during the 4 month active intervention period. The pattern of long-term weight sustainability, however, was largely determined by the microclinic social networks clusters. Indeed, during 12 and 24 month follow-up, ICC results indicated that the social clustering of the microclinic groups that explained 78% to 92% of weight loss and BMI decreases, while classroom had much more diminished role at explaining just 7.4%. In other words, the microclinics may be a large driving force behind the sustained weight loss and BMI reduction up to two years from the initiation of the program.

Similarly for HbA1c, as it was a biological measure, the microclinics, classes, and locations all had clustering of hba1c reduction during the 4-month intervention, but it largely became focused on the microclinics and classes that determined the sustainability of the HbA1c reduction at 12 and 24 months. Indeed, a full 55% of the clustering in the 12 and 24 month sustained HbA1c decreases was explained by microclinic groups, and 44% by classroom groups. Thus, the results suggest that the microclinics are very important to the sustainable improvements in clinical indicators after the intervention.

Within the study cohort, there were multiple neighborhoods hosting J-MCP groups throughout Amman, Jordan. Each neighborhood had several classroom groups. Within each classroom group, a class was comprised of Microclinic social clusters (each participant plus his/her personal social network co-participants).

4. Discussion

The 4-month J-MCP is a successful demonstration of the potential for social-network based community interventions to produce and sustain health benefits. Not only are these results encouraging for the individuals enrolled in the program, but they also highlight the potential for propagation of healthy habits throughout the broader community. In Jordan, the J-MCP produced significant decreases in BMI, weight, and HbA1c at both 12 and 24 months. And notably, microclinic social network groups appear to have a strong influence in determining the correlated trajectories of metabolic improvements, especially long term sustained weight and HbA1c change, while other concurrent classroom, geographic clinic site, and concurrent cohort membership did not appear a factor in sustained outcomes.

Moreover, during informal interactions with friends and family outside of the program activities, individuals were invited to share lessons learned with their extended social network. Future investigations could study the connection between lasting benefits and the propagation of the program throughout extended social, familial, and professional networks.

We feel these results warrant future investigation, as they may be indicative of the long-term benefit of leveraging social-networks to shape behavioral change both for individuals and communities. Christakis and Fowler investigated how behaviors leading to obesity (Christakis and Fowler, 2007), depression (Rosenquist et al., 2010a), alcoholism (Rosenquist et al., 2010b), happiness (Fowler and Christakis, 2008a), and voting behaviors (Fowler and Christakis, 2008b) were spread through social networks. Similarly, Deaken summarized the potential for group-based interventions for those with T2DM, reporting that a 1% reduction in HbA1c was associated with a relative risk reduction of 21% for diabetic outcomes and complications (Deakin, 2005). Despite the potential gains, combining longitudinal success in both weight loss and glycemic control has rarely been established (Dhindsa et al., 2003; Phung et al., 2010). The sustained results presented here serve as a model for spreading healthy behaviors through social-networks in resource-limited settings, something that could be replicated around the globe.

We acknowledge potential limitations to these results. First, though the sub-sample for long-term follow-up was a stratified random sample, these results are not derived from a randomized controlled trial or quasi-experimental study with a control arm. Thus, the lack of a formal control group is a limitation in not fully accounting for individual-level confounding factors, as well as being unable to separate temporal

Table 3
Social network analysis of intraclass correlations (ICC) for clustered biometric changes, by network levels, during the active intervention period (0 to 4 month) and during the follow-up period (0, 12-month, and 24-month follow-up).

	Relative clustering of weight loss		Relative clustering of BMI reduction		Relative clustering of Hba1c reduction	
	Intervention	Follow-up	Intervention	Follow-up	Intervention	Follow-up
Microclinic groups	< 0.01	78%	< 0.01	92%	28%	55%
Classroom groups	47%	22%	51%	7.4%	22%	44%
Geographic location	48%	< 0.01	42%	< 0.01	50%	< 0.01
Cohort temporal wave	4%	< 0.01	7%	< 0.01	< 0.01	< 0.01

confounding due to changes in individual and local conditions over time, although the sustained decreases in BMI and HbA1c among obese and diabetic populations is distinctive and should be appreciated regardless of control comparisons. We address this limitation in a forthcoming randomized trial with a formal control group. Second, participants received gift-cards as enticement for participation, so it is possible that our initial sample is not representative of the baseline Jordanian population. Third, Christakis and Fowler have faced criticism of their model of social-network based research and there are inherent limitations in the assumptions underlying social network research in general (Russell, 2010). Fourth, research on our microclinics that utilizes a randomized trial design, and determine the social network mechanism is still needed to better elucidate what impact, if any, can be directly attribute to this model. Fifth, a 3-arm trial is needed to disentangle the impacts of social networks from direct education within an intervention. Such a trial is underway and pending results. Sixth, though we have demonstrated that the J-MCP resulted in sustained benefits at 12 and 24 months, we do not know if similar outcomes will be maintained over an even longer time horizon. Finally, while this paper only reports participation in the program as the principal behavior change, in order to understand the possible mechanisms underlying observed biometric changes, more information on specific lifestyle changes are needed. Notably, it is important to understand the extent to which behavior change occurred in the following areas: dietary, exercise, self-monitoring, and medication adherence behaviors.

5. Conclusions

The potential health implications of J-MCP are wide reaching. As the worldwide T2DM burden shifts to lower-resourced countries, it is important to develop programs that can be implemented in these settings and produce lasting long-term results that are self-sustained by community social networks. Although more research is needed, result show that the J-MCP may hold such possibility for longer term sustained weight and glycemia improvements up to 12–24 months after the implementation of the program. Furthermore, if the social network forces leveraged through this program were demonstrated to hold causal weight, the model could also hold the promise of promoting the cascading spread of health improvements throughout the community, thereby extending the opportunity for enhancing the cost-effectiveness of public health interventions, and improving overall disease prevention via community propagation. Altogether, the findings hold promise of leveraging social networks for enhancing community health programs.

List of abbreviations

T2DM	type 2 diabetes mellitus
DALYs	disability adjusted life years
MCI	Microclinic International
J-MCP	Jordan Social Network Behavioral Health Microclinic Program
MoH	Jordan Ministry of Health

Ethics approval and consent to participate

The Institutional Review Board of Jordan approved the government-initiated program. Though not a randomized trial, this intervention was registered with ClinicalTrials.gov (NCT01596244).

Competing interests

The authors declare that they have no competing interests.

Consent for publication

We have consent to publish this study.

Availability of data and material

Data is available upon request.

Funding

Background research was supported by generous financial sponsorship from the World Diabetes Foundation, the Mulago Foundation, the Blum Center for Developing Economies, University of California Berkeley, and the German Embassy in Jordan. ELD and DEZ were also funded by a grant from the Robert Wood Johnson Foundation. This project is supported by a BRIDGES Grant from the International Diabetes Federation. BRIDGES, an International Diabetes Federation project, was supported by an educational grant from Eli Lilly and Company. ELD was also supported by a grant from the American Diabetes Association and a grant from the American Heart Association. The sponsors did not have a role in the design, implementation, analysis, interpretations of results, or publication oversight in this study.

Authors' contributions

ELD and DEZ led the evaluation. KTW provided leadership in program development and management. RSF provided administrative support, and NB and AI provided program management support. DEZ, JR, and ELD participated in writing this manuscript. ELD conceived and supervised the methods and social network analysis. JR and KTW contributed equally as joint second authors. All authors read and approved the final manuscript.

Acknowledgements

We express deep gratitude to the dedicated staff of the Jordan MoH and Queen Rania's Royal Health Awareness Society, and their tireless efforts to improve healthcare in Jordan. We also thank Dr. Martha Prescott for her assistance conducting an early analysis and preparing the original tables.

References

Ackermann, R.T., et al., 2008. Translating the diabetes prevention program into the community. Am. J. Prev. Med. 35 (4), 7.
Al-Maatouq, M., et al., 2010. Optimising the medical management of hyperglycaemia in type 2 diabetes in the Middle East: pivotal role of metformin. Int. J. Clin. Pract. 64 (2), 149–159.
Bahr, D.B., et al., 2009. Exploiting social networks to mitigate the obesity epidemic. Obesity (Silver Spring) 17 (4), 723–728.
Berkman, L.F., Glass, T.A., 2000. Social integration, social networks, social support, and health. In: Berkamn, L.F., Kawachi, I. (Eds.), Social Epidemiology. Oxford University Press, Oxford.
Christakis, N.A., Fowler, J.H., 2007. The spread of obesity in a large social network over 32 years. N. Engl. J. Med. 357 (4), 370–379.
Deakin, T., 2005. Group based training for self-management strategies in people with type 2 diabetes mellitus. Cochrane Database Syst. Rev. 2, CD003417.
Dennis, D.G., 2012. Weight loss/maintenance as an effective tool for controlling type 2 diabetes: novel methodology to sustain weight reduction. Diabetes Metab. Res. Rev. 28 (3), 214–218.
Dhindsa, P., Scott, A.R., Donnelly, R., 2003. Metabolic and cardiovascular effects of very-low-calorie diet therapy in obese patients with Type 2 diabetes in secondary failure: outcomes after 1 year. Diabet. Med. 20 (4), 319–324.
Fowler, J.H., Christakis, N.A., 2008a. Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham Heart Study. BMJ 337, a2338 (dec04 2).
Fowler, J.H., Christakis, N.A., 2008b. Estimating peer effects on health in social networks: a response to Cohen-Cole and Fletcher; and Trogdon, Nonnemaker, and Pais. J. Health Econ. 27 (5), 1400–1405.
Greaves, C.J., et al., 2011. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. BMC Public Health 11 (1), 119.

Iburg, Kim Moesgaard, 2017. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 390 (10100), 1345–1422.

IDF, Diabetes Atlas Group, 2015. Update of mortality attributable to diabetes for the IDF Diabetes Atlas: estimates for the year 2013. Diabetes Res. Clin. Pract. 109 (3), 461.

Katula, J.A., et al., 2011. One-year results of a community-based translation of the Diabetes Prevention Program: Healthy-Living Partnerships to Prevent Diabetes (HELP PD) Project. Diabetes Care 34 (7), 1451–1457.

Klein, R.R., 1995. Hyperglycemia and microvascular and macrovascular disease in diabetes. Diabetes Care 18 (2), 258–268.

Knowler, W.C., et al., 2002. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N. Engl. J. Med. 346 (6), 393–403.

Marinilli Pinto, A., et al., 2008. Successful weight-loss maintenance in relation to method of weight loss. Obesity (Silver Spring) 16 (11), 2456–2461.

Mokdad, Ali H., 2017. Diabetes mellitus and chronic kidney disease in the Eastern Mediterranean Region: findings from the Global Burden of Disease 2015 study. Int. J. Public Health 1–10.

Mokdad, Ali H., et al., 2016. Health in times of uncertainty in the eastern Mediterranean region, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet Glob. Health 4 (10), e704–e713.

Norris, S.L., et al., 2004. Long-term effectiveness of lifestyle and behavioral weight loss interventions in adults with type 2 diabetes: a meta-analysis. Am. J. Med. 117 (10), 13.

Paisey, R.B., et al., 2002. Five year results of a prospective very low calorie diet or conventional weight loss programme in type 2 diabetes. J. Hum. Nutr. Diet. 15 (2), 121–127.

Phung, O.J., et al., 2010. Effect of noninsulin antidiabetic drugs added to metformin therapy on glycemic control, weight gain, and hypoglycemia in type 2 diabetes. JAMA 303 (14), 1410–1418.

Rosenquist, J.N., Fowler, J.H., Christakis, N.A., 2010a. Social network determinants of depression. Mol. Psychiatry 15 (12), 1197.

Rosenquist, J.N., et al., 2010b. The spread of alcohol consumption behavior in a large social network. Ann. Intern. Med. 152 (7), 426–W141.

Russell, L., 2010. The Spread of Evidence-poor Medicine via Flawed Social-network Analysis.

Snel, M., et al., 2012. Long-term beneficial effect of a 16-week very low calorie diet on pericardial fat in obese type 2 diabetes mellitus patients. Obesity (Silver Spring) 20 (8), 1572–1576.

Thomas, A.T.A.W., et al., 2011. Four-year weight losses in the Look AHEAD study: factors associated with long-term success. Obesity (Silver Spring) 19 (10), 1987–1998.

Tuomilehto, J., et al., 2001. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N. Engl. J. Med. 344 (18), 1343–1350.

Vissenberg, C., et al., 2012. The DISC (Diabetes in Social Context) Study-evaluation of a culturally sensitive social network intervention for diabetic patients in lower socio-economic groups: a study protocol. BMC Public Health 12, 199.

Wadden, T.A., et al., 2009. One-year weight losses in the Look AHEAD study: factors associated with success. Obesity (Silver Spring) 17 (4), 713–722.

Whiting, D.R., et al., 2011. IDF Diabetes Atlas: global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res. Clin. Pract. 94 (3), 11.

Zoughbie, Daniel E., Watson, Kathleen T., Bui, Nancy, Farraj, Rami S., Prescott, Marta R., Ding, Eric L., 2014. Long-term bodyweight and glucose management effects of the Microclinic Social Network Health Behavioral Program in Amman, Jordan: 2-year results. Lancet Glob. Health 2, S19. https://doi.org/10.1016/S2214-109X(15)70041-0.