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Population-level changes in lifestyle risk factors for cardiovascular disease in the Heart of New Ulm Project

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ABSTRACT

Lifestyle significantly influences development of cardiovascular disease (CVD), but limited data exists demonstrating lifestyle improvements in community-based interventions. This study aims to document how lifestyle risk factors changed at the population level in the context of Heart of New Ulm (HONU), a community-based CVD prevention initiative in Minnesota.

HONU intervened across worksites, healthcare and the community/environment to reduce CVD risk factors. HONU collected behavioral measures including smoking, physical activity, fruit/vegetable consumption, alcohol use and stress at heart health screenings from 2009 to 2014. All screenings were documented in the electronic health record (EHR). Changes at the community level for the target population (age 40–79) were estimated using weights created from EHR data and modeled using generalized estimating equation models.

Screening participants were similar to the larger patient population with regard to age, race, and marital status, but were slightly healthier in regards to BMI, LDL cholesterol, blood pressure, and less likely to smoke. Community-level improvements were significant for physical activity (62.8% to 70.5%, $p < 0.001$) and 5+ daily fruit/vegetable servings (16.9% to 28.1%, $p < 0.001$), with no significant change in smoking, stress, alcohol or BMI.

By leveraging local EHR data and integrating it with patient-reported outcomes, improvements in nutrition and physical activity were identified in the HONU population, but limited changes were noted for smoking, alcohol consumption and stress. Systematically documenting behaviors in the EHR will help healthcare systems impact the health of the communities they serve, both at the individual and population level.

1. Introduction

Multiple studies examining the relative influence of determinants of health have found that only about 10–20% of morbidity and mortality are determined by medical care, whereas 36–50% are attributable to lifestyle behaviors (*Health Policy Brief: The Relative Contribution of Multiple Determinants to Health Outcomes*, 2014). Healthful behaviors, such as getting sufficient physical activity, eating adequate fruits and vegetables, and avoiding tobacco contribute to cardiovascular disease (CVD) risk (Mozaffarian et al., 2012; Yusuf et al., 2004). The American Heart Association (AHA) underscores the critical role of lifestyle in its 2020 goals and emphasizes the need to address health behaviors at both the individual and population levels (Sacco, 2011). Lifestyle is influenced by a combination of interpersonal, societal, and environmental factors (McLeroy et al., 1988). Thus, interventions addressing behavior change require a multi-level approach to help individuals attain their highest health potential (Mozaffarian et al., 2012; McLeroy et al., 1988; Mozaffarian et al., 2015; Pearson et al., 2003; Pearson et al., 2013).

The Heart of New Ulm (HONU) is a community-based CVD prevention demonstration project (Boucher et al., 2008; Sidebottom et al., 2016; VanWormer et al., 2012). To date, HONU Project research has observed significant reductions in CVD risk factors over time in the

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target community compared to similar comparison populations (Sidebottom et al., 2016; Sidebottom et al., 2018). And while the electronic health record (EHR) has served as a reliable platform for evaluating community-based CVD interventions in HONU (Sidebottom et al., 2016; Sidebottom et al., 2018; VanWormer, 2010; Sidebottom et al., 2014), gaps remain in assessing changes in most behavioral risk factors because these are not systematically tracked in the same way as biometric risks (Friedman et al., 2013; Pike et al., 2016). There have been increasing calls to capture lifestyle information in the EHR (Institute of Medicine, 2014; Institute of Medicine, 2015; Benson et al., 2013), as this would permit healthcare systems to more precisely determine which CVD risk factors are, or are not, improving over time at both the individual patient and population levels (Estabrooks et al., 2012; Adler and Stead, 2015). The purpose of this study was to examine how lifestyle risk factors for CVD have changed over 5 years in the HONU target community.

2. Methods

2.1. Setting

HONU, initiated in 2009, is a 10-year community-based project aimed at reducing myocardial infarctions (MI) and improving modifiable CVD risk factors in the community of New Ulm, MN (Boucher et al., 2008; Sidebottom et al., 2016; VanWormer et al., 2012). HONU is a collaborative partnership between Allina Health, the Minneapolis Heart Institute Foundation and the city of New Ulm. The project operates in a predominantly rural, agricultural community. HONU interventions are generally open to the broader community, but the primary population is defined as those age 40–79 who reside in the ZIP code of 56073 (population of 16,759 with 47% residents in the 40–79 year age range according to the2010 Census). The community is racially homogeneous at 98% white and < 1% Hispanic; 91% of county residents under age 65 are insured (Community Health Status Indicators, n.d.). Healthcare in this community is provided primarily by one health system (Allina Health) that operates the New Ulm Medical Center (NUMC). Thus, there is near-complete capture of medically-attended outcomes using a single EHR system. Previous research suggests that the local EHR data provides an accurate assessment of the health of the community (Sidebottom et al., 2014).

HONU intervention components have been described in detail previously (Boucher et al., 2008; Sidebottom et al., 2016; VanWormer et al., 2012; Benson et al., 2013; Sillah et al., 2014). Interventions have focused on many of the major modifiable CVD risks (elevated blood lipids, high blood pressure, uncontrolled glucose, obesity, tobacco use, alcohol consumption, physical inactivity, low fruit and vegetable consumption) (Yusuf et al., 2004), as well as underutilization of preventive medications including aspirin, antihypertensive agents, and statins (Appendix A). Programs were developed to fill gaps where intervention options did not exist in the population and to align with guidelines from the AHA for improving cardiovascular health at the community level (Mozaffarian et al., 2012; Pearson et al., 2013). Interventions were delivered through healthcare, worksite and community settings, targeting all levels of the social-ecological model (Fig. 1) (McLeroy et al., 1988).

2.2. Sample and data collection

Lifestyle measures for this analysis came from a sample of individuals completing community heart health screenings. EHR data was used to develop survey weights (post hoc) to apply to the analytical sample of screening participants to make the sample more representative of the target population. The use of these data sets was approved by the Institutional Review Board of Allina Health.

2.2.1. Survey sample: heart health screening participants

Heart health screenings were conducted at baseline in 2009 (VanWormer et al., 2012), and repeated in 2011 and in 2014. Screenings were free and open to any adults who lived or worked in the 56073 ZIP code and were held at a variety of locations (e.g. NUMC, worksites and community centers) (VanWormer et al., 2012). HONU's first year provided a baseline community assessment, and as such, screenings were promoted heavily to attract a large volume of participants. Over 100 screenings were available to participate in 2009. Later screenings were not offered as widely or promoted as much given more limited project and staffing resources (66 events were held in 2011 and 24 in 2014 plus additional opportunities to participate via a wellness visit).

All screening visits were documented in the EHR. Screening visits lasted 30–45 min and included a self-administered survey with questions about health history and behaviors, anthropometric measures (height and weight with calculated BMI, blood pressure, waist circumference), and venipuncture conducted by the NUMC laboratory (total, HDL, LDL cholesterol, triglycerides and blood glucose). All biometric measures were recorded in the EHR per standard clinic systems workflow. Behavioral and other measures collected on the survey were scanned into a separate database and recorded outside of the record as there were no existing fields in the EHR to enter this information.

At the conclusion of the screening visit, participants were given a personal risk factor report focused on behavioral metrics that they were able to discuss with a health coach (i.e., registered dietitian or health educator). The visit was an opportunity to discuss health improvement goals, get connected to community resources and discuss whether immediate follow-up with a medical provider was necessary. A comprehensive risk factor report was mailed to their home after the blood tests were completed. The same protocol was used for the screenings in all 3 years with one difference in 2014. For the 2014 screenings individuals could either attend a community screening or participate through their annual wellness visit. For those who chose to participate through the latter option, the same biometric measures and survey completion were conducted, but no follow-up visit with a health coach.

Heart health screenings had 5221 participants in 2009, 3215 participants in 2011 and 1588 participants in 2014. For this study, data are limited to adults living in the HONU ZIP code who were age 40–79 at the time they participated (3123 in 2009, 1976 in 2011 and 1008 in 2014). Further details about the screenings have been published previously (VanWormer et al., 2012).

2.2.2. Target population: residents with EHR data

The target population in this analysis was all residents in the HONU ZIP code between 40 and 79 years old with at least one ambulatory encounter in the EHR in the biennium around the health screenings. Data may be included from visits to any Allina facility during the study time period. Extracts of data from the EHR were conducted for three time periods that generally aligned with the screenings (2008–2009, 2010–2011, and 2014–2015). Individuals were included in the extracts if they: 1) lived in the HONU ZIP code (56073), 2) were 40–79 at the start of the time period, 3) did not opt out of allowing use of their EHR data for research, and 4) had at least one ambulatory face to face visit during the extract period. The number of residents represented in the target population at each time period in the EHR data was very stable (n = 7853 in 2008–2009, n = 7933 in 2010–2011, and 7971 in 2014).

2.3. Measures

2.3.1. Heart health screenings

While screenings captured a comprehensive set of CVD measures (VanWormer et al., 2012), the current study used only a subset of measures. Smoking was assessed in a single item indicating current, former or never smoker. Alcohol consumption was measured in a single item about number of drinks per typical week and responses were categorized as high (> 14 drinks/week for men or > 7 for women),

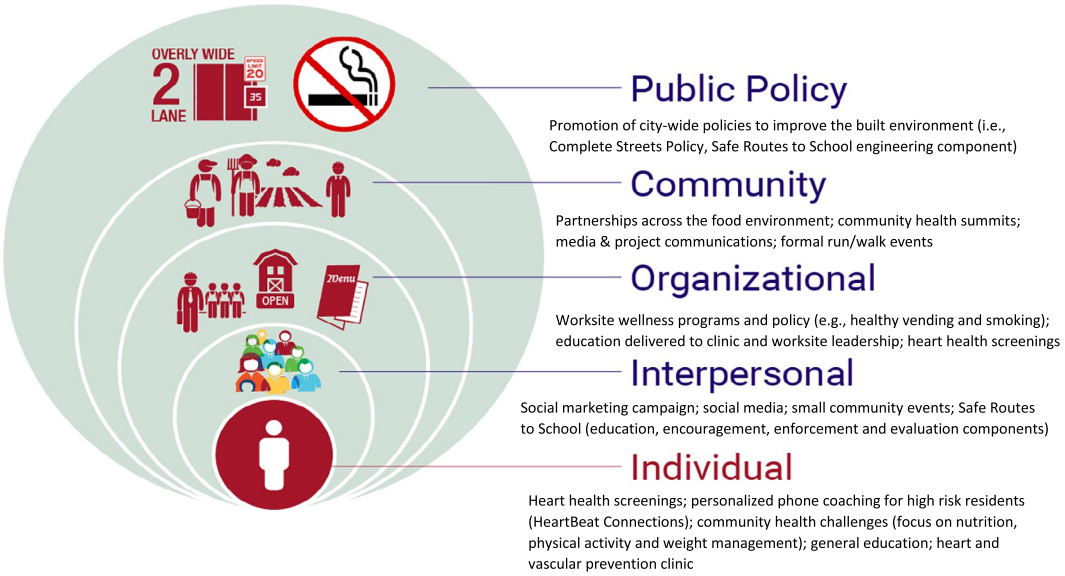

Fig. 1. HONU interventions.

moderate (1–14 drinks/week for men or 1–7 for women), and none (Saunders et al., 1993; Khaw et al., 2008). Physical activity was assessed using 4 questions developed for the Behavioral Risk Factor Surveillance system (U.S. Department of Health and Human Services Centers for Disease Control and Prevention, 2009). Questions asked about number of days and minutes per day a person does vigorous and moderate activities. These results were combined into a moderate level equivalent where vigorous minutes are doubled and categorized as sufficient for ≥150 min/week of moderate level equivalent and insufficient for < 150 min/week (Services USDoHaH, 2008). Fruit and vegetable consumption was measured in a single item assessing servings per day and categorized as sufficient (≥5) or insufficient (< 5) (Laforge et al., 1994; U.S. Department of Health and Human Services, 2005). Stress was measured using a four item scale indicating magnitude of life challenges and stress management abilities during the past month, with possible scores ranging from 0 to 16 points (8–16 points was categorized as high stress) (Cohen et al., 1983).

Four biometric measures collected at screenings were also used in this paper: BMI < 30 kg/m^2, LDL cholesterol < 130 mg/dL, total cholesterol < 200 mg/dL, and blood pressure < 140/90 mm Hg. All of these biometric measures were documented in the EHR during screening visits.

2.3.2. Electronic health record

Age, race, ethnicity, marital status, gender, smoking status, BMI, LDL cholesterol, blood pressure, diabetes status, cardiovascular disease status, and number of clinic visits came from the EHR. For values of BMI, smoking status, LDL, and blood pressure, we selected the most recent value during the two year time period and measures were coded with dichotomous cut points listed previously. An individual was categorized as having diabetes or heart disease if during the time period they had any visits with diagnoses codes indicating either of those conditions.

2.4. Analysis

Demographic and health status variables were summarized in the two cohorts (target population with EHR data and the heart health screening participants) using frequency and percentage (categorical covariates) and mean and standard deviation (continuous covariates). To examine changes in lifestyle risk factors over time, we used marginal longitudinal models, which included covariates for time period, age and gender. All models were estimated using generalized estimating equations (GEE) with an unstructured working correlation matrix, which adjusts for the within-subject correlation occurring due to repeated measures for people who have data in at least two of the three time periods. Because longitudinal models estimated using GEEs natively allow for subjects with variable follow-up, subjects without data from one or two screening time periods were still included. Models were run for each gender separately. Continuous risk factors were summarized as model-based mean ± robust standard errors, and categorical measures were reported as model-based proportions with at-goal levels for each of the risk factor at each time period.

To account for the fact that individuals participating in screenings are not necessarily representative of the target population, survey weights were developed using propensity scores. Data from the EHR and screenings were linked using medical record number. This provided the ability to identify which patients participated in screenings and which did not. Logistic regression models with screening participation as the outcome were run for each time period (2009, 2011, and 2014). Models included age, gender, smoking status, BMI < 30, LDL at goal (< 130), and BP at goal (< 140/90), number of clinic visits, diabetes (Y/N), and cardiovascular disease (Y/N). For screening participants, the inverse of their estimated probability of being screened (i.e., the inverse of their propensity score) was applied as a weight to analyze changes in lifestyle outcomes using the same longitudinal models fit using GEEs described previously.

We estimated the longitudinal trajectory of dichotomous measures of four biometric measures collected at screenings using weighted GEEs and compared those models to the age- and gender-adjusted models fit using GEE for the same measures collected from the EHR for the target population. By comparing the weighted screening sample against the actual EHR data for the target population, this analysis served as a proxy marker of accuracy of the statistical weighting process. To draw a rough comparison to the propensity score weighted models, sensitivity analyses were also run on the raw values of the lifestyle outcomes reported at the baseline and final screenings. Statistical analyses were conducted using SPSS (descriptive analysis and GEE models without weights) and SAS (for weighted models) with statistical significance considered at 2-sided alpha value of 0.05.

3. Results

The number of patients with a visit in the EHR during each of the

Table 1
New Ulm (zip 56073) residents age 40–79 who attended HONU heart health screenings or with clinic visits during each study time period.

	Heart health screening participants[a]			Individuals with visits in the electronic health record		
Time period	2009	2011	2014	2008–2009	2010–2011	2014–2015
	(n = 3123)	(n = 1976)	(n = 1008)	(n = 7853)	(n = 7933)	(n = 7971)
Age, mean (SD)	56.7 (10.1)	57.3 (9.7)	59.4 (9.8)	56.9 (10.7)	57.1 (10.5)	57.7 (10.3)
Gender, % female	58.0%	61.3%	63.4%	51.3%	51.4%	51.1%
Race, % white	96.0%	95.9%	97.5%	98.9%	98.8%	98.6%
Ethnicity, % Hispanic	0.3%	0.2%	0.3%	0.8%	0.8%	1.0%
Marital status, % married	70.7%	72.0%	74.7%	68.7%	69.3%	70.0%
Smoking, %	7.0%	6.2%	5.4%	14.2%	15.2%	16.3%
BMI, mean (SD) kg/m^2	29.5 (5.8)	29.3 (6.0)	28.4 (5.7)	30.0 (6.4)	30.0 (6.4)	30.6 (6.8)
BMI category, %						
Healthy weight (< 25)	22.9%	25.2%	30.1%	21.9%	22.0%	20.0%
Overweight (25–29)	36.2%	36.1%	35.7%	33.9%	34.4%	32.1%
Obese (30+)	40.9%	38.7%	34.1%	44.2%	43.6%	47.9%
LDL < 130 mg/dL, %	63.2%	66.1%	67.2%	69.1%	72.1%	70.9%
BP < 140/90 mm Hg, %	72.2%	78.3%	77.3%	74.9%	79.5%	82.0%

[a] All data reported in this table are sourced from the EHR; screening data was uploaded into the EHR, and as such, many values for screening participants may have come from a heart health screening.

study periods who were age 40–79 and resided in the intervention ZIP code (Table 1) is nearly identical to the population estimate from the 2010 census for residents in this age group (7855), generally indicating the target patient population is proportional to the geographic community for this age group. All data reported in Table 1 are sourced from the EHR to compare screening participants to the target patient population. Participants in the heart health screenings represented 40%, 25% and 13% of the target patient population at each time period. Screening participants were generally similar to the target group of patients with regard to age, race, and marital status, but were slightly healthier in regards to BMI, LDL cholesterol, and blood pressure. Additionally, as expected (Sidebottom et al., 2014), screening participants were about half as likely to smoke as the target patient population.

Model estimates for lifestyle risk factor trends (Table 2) showed significant improvement for physical activity and fruit/vegetable consumption, but not for smoking and stress. Notably, there was a 7.7 percentage point improvement in those getting 150+ min of moderate intensity activity, with a larger improvement among women (11 percentage point increase) compared to men (3.5 percentage point increase). The percentage of individuals eating 5+ servings of vegetables per day increased by 11.2, again with larger increases for women (12.7) compared to men (8.8). The sensitivity analysis using unweighted values of participants who attended both the 1st and the 3rd screenings (see Appendix B) was consistent with the model-based findings in that the prevalence of individuals meeting nutrition, smoking, and physical activity goals increased similarly in the two groups.

In order to assess the effectiveness of our statistical weighting process to account for differences in the screening participants and target population, we compared the estimated longitudinal trajectory using data from the screening participants to the estimated trajectory using data from the target population that was also collected in the EHR. The estimated longitudinal trajectory fit using weighted GEE from the screening data was generally comparable to the results from the models fit using data from the target population (Table 3). Estimates from both data sources showed a similar increase in controlled blood pressure and total cholesterol, while they both also demonstrate a small increase in the proportion who were obese. The general trends of interim improvement, followed by a decrease in the 3rd time period in the proportion with LDL at goal is also similar. Differences in actual prevalence levels of each risk factor were relatively small. Additionally unweighted data are provided (Table 3) to add context to how the weighting process adjusted the screening values to better align with community-level values represented in the EHR.

4. Discussion

This is the first study known to us that has integrated patient-reported and EHR-based data to provide population-level estimates of changes in lifestyle risk factors for CVD. Over the first six years of the HONU Project, achievement of adequate physical activity increased from 63% to 71%, and consumption of at least 5 servings of fruits and vegetables per day nearly doubled. No significant changes were observed in alcohol consumption, smoking, or stress levels.

Direct comparisons to other studies are complicated by differences in the environment, measures, and target populations. While many population-based initiatives (Record et al., 2015; Puska et al., 1983; Farquhar et al., 1977; Farquhar et al., 1990) offered physical activity interventions, few report on their outcomes. A review of 21 community-based interventions (Papadakis and Moroz, 2008) found only one reported a statistically significant increase in physical activity (Dowse et al., 1995). In addition to those covered in the review, a community-based intervention in the Netherlands reported a 2 h/week increase in leisure-time physical activity (e.g. walking, bicycling, and gardening) among women. They employed a range of interventions to promote physical activity, including printed guides with walking and bicycling routes and media exposure on the benefits of exercise (Wendel-Vos et al., 2009). Behavioral Risk Factor Surveillance System (BRFSS) data indicate no changes in statewide physical activity during our study period, with 2011 and 2015 results indicating a consistent 54–55% of Minnesotans reporting at least 150 min of activity each day (Centers for Disease Control and Prevention, n.d.). New Ulm may have been more active than the rest of the state at baseline (64%), but there was a statistically significant increase at the 6-year follow-up (reaching 72%), most of which occurred during the first two years of the project.

It is also difficult to compare our nutrition findings to those of other community-based interventions given the difference in targeted nutrition measures (Wendel-Vos et al., 2009; Muntoni et al., 1999) and lack of documented outcomes (Bambs et al., 2011). The Bootheel Heart Health Project, which aimed to improve modifiable risk factors in southeastern Missouri in the 1990s, assessed self-reported consumption of fruits and vegetables over five years. Their project aimed to increase fruit and vegetable consumption through heart health festivals, articles in the local newspaper, cooking demonstrations and educational programming. Despite these efforts, the project's 6 county target area did not experience an improvement in those eating 5 servings of fruits and vegetables/day (21.9% to 21.6%) ($p > 0.1$); however, the overall state of Missouri did note an improvement of 17.3% to 23.3% ($p = 0.03$)

Table 2
Estimated changes in lifestyle risk factors in the HONU target population (zip code 56073, age 40–79).

	Total, adjusted for age and gender				Males, adjusted for age				Females, adjusted for age			
	2009	2011	2014	*p*-Value	2009	2011	2014	*p*-Value	2009	2011	2014	*p*-Value
Current smoker, %	8.3	9.9	7.3	0.152	8.8	11.1	7.4	0.280	7.8	8.9	7.2	0.532
Moderate or no alcohol consumption, %	95.9	96.3	96.8	0.457	96.2	96.4	97.9	0.281	95.8	96.3	95.9	0.711
150 min or more per week of moderate intensity physical activity, %	62.8	73.5	70.5	< 0.001	65.8	76.3	69.3	< 0.001	60.8	71.5	71.8	< 0.001
Fruit and vegetable servings per day, mean (SE)	3.0 (0.04)	3.4 (0.05)	3.5 (0.07)	< 0.001	2.6 (0.06)	2.8 (0.09)	2.9 (0.11)	0.002	3.3 (0.05)	3.9 (0.06)	3.9 (0.09)	< 0.001
5 or more servings per day, %	16.9	26.3	28.1	< 0.001	12.2	17.6	21.0	0.001	20.6	32.9	33.3	< 0.001
Stress, % with low scores	88.8	90.9	90.8	0.122	91.0	92.6	93.1	0.436	87.2	89.6	89.0	0.258

(Brownson et al., 1996). North Karelia documented a 2–3 fold increase in fruits and vegetables during the project's assessment period and recognized a combination of widespread nutrition education, changes in the food industry and legislature as the means to these outcomes (Pietinen et al., 1996). Our project's findings for fruits and vegetables were similar to those of North Karelia, with a nearly two-fold increase in the proportion of community residents consuming 5+ servings of fruits and vegetables/day. Overall, the mean amount of fruits and vegetables increased by about ½ serving over the study time period. The percentage of individuals eating 5 or more servings increased from 17% in 2009 (compared to 22% in Minnesota overall (Centers for Disease Control and Prevention, n.d.)) to 28% in 2014. HONU interventions targeting fruits and vegetables ranged from grocery store tours, community health challenges focused on increased consumption, overall marketing, restaurant availability, increasing availability and access to fruits and vegetables in partnership with the farmer's market as well as individualized messaging.

In the 21 community-based intervention review, nine reported positive impacts on smoking (Papadakis and Moroz, 2008). A clinic-based intervention (Abramson et al., 1981) in Jerusalem and a population-wide CVD reduction program in Mauritius (Dowse et al., 1995) both reported 11% reductions in smoking prevalence (Abramson et al., 1981). The latter used a comprehensive anti-tobacco mass media campaign, advertising bans and increased taxes on tobacco (Dowse et al., 1995). The Franklin County initiative which focused on education, policy and enforcement initiatives, documented an increase in quit rates at higher than state levels after the initial intervention (~5 years) (Record et al., 2015). The North Karelia intervention documented a 28% reduction in smoking over 10 years, which focused primarily on training of public health nurses to promote smoking cessation and use of antismoking media campaigns (Puska et al., 1983; Korhonen et al., 1998). Estimates of community level smoking in New Ulm showed a reduction from 8.3% to 7.3% over six years. This was not statistically significant, but may be due in part to the low baseline prevalence of smoking in New Ulm and the lower participation of smokers in some HONU programs. Our strategies focused on personalized health coaching post screening visits, referrals to community resources (e.g. smoking cessation programs offered through the county), phone coaching for those at highest risk (smoking was the top priority in those who expressed a desire to quit) and referrals back to primary care for clinical smoking cessation support.

The health benefits of improving lifestyle are well-established and many national organizations include tobacco, nutrition, physical activity and obesity as their primary goals (Sacco, 2011; U.S. Department of Health and Human Services Office of Disease Prevention and Health Promotion, 2017). Population health initiatives that align with national guidelines on community-wide health interventions offer the potential to increase healthful behavior adoption. HONU's heart health screenings provided an opportunity to assess lifestyle risk factors in the community over six years, in addition to the ongoing assessment of biometric risk factors through EHR data. Our findings suggest that a community-based program, offering lifestyle interventions spanning the nutrition environment through more individualized programming such as 1:1 health coaching, can affect nutrition and physical activity in an entire community. It is important to point out that community residents may have participated in a heart health screening, but did not participate in any specific HONU interventions. Likewise, community residents may have been affected by policy change at a worksite (i.e. no smoking, healthy vending) or participated in HONU sponsored community-wide initiatives, but did not attend a community screening.

Community-based interventions that integrate policy, systems, and environmental (PSE) changes promote environments that support the ability to initiate and sustain lifestyle improvements (Knapper et al., 2015). As noted in Fig. 1, this study takes place within a broader intervention that includes environmental and policy change to promote healthful behaviors that may ultimately reduce the burden of CVD. For

Table 3
Comparison of HONU community prevalence estimates of biometric measures from weighted and unweighted screening participant data with EHR visit data[a].

	Unweighted screening data			Weighted screening data			Electronic health record data		
	2009	2011	2014	2009	2011	2014	2008/2009	2010/2011	2012/2013
	(n = 3123)	(n = 1976)	(n = 1008)	(n = 3123)	(n = 1976)	(n = 1008)	(n = 7853)	(n = 7933)	(n = 7971)
BMI < 30 kg/m^2, %	59.4	60.9	66.5	54.3	53.6	53.4	56.0	55.5	55.1
Blood pressure < 140/90 mm Hg, %	72.3	78.7	78.9	75.5	81.5	83.7	79.3	82.3	86.4
LDL cholesterol < 130 mg/dL, %	62.3	64.5	64.2	67.3	69.5	67.4	68.9	72.3	71.1
Total cholesterol < 200 mg/dL, %	50.3	54.7	53.4	54.3	58.7	57.1	59.2	64.2	64.1

[a] Data presented are for residents from ZIP code 56073, age 40–79, all models adjusted for age and sex.

example, there was focus on the nutrition environment by partnering with local restaurants, grocery stores/convenience stores, as well as local farmer's to increase availability of healthful choices. In terms of the built environment, a Complete Streets Policy was implemented to promote physical activity and efforts to implement Safe Routes to School were introduced. Several worksites implemented policies to ban smoking on workplace grounds. Many of the studies mentioned previously also had PSE efforts in place (Puska et al., 1983; Dowse et al., 1995; Korhonen et al., 1998).

This study provides some suggestive evidence of HONU's effectiveness on lifestyle risk factors, and is consistent with prior HONU evaluations of biometric CVD risk factor improvements in the community (Sidebottom et al., 2016; Sidebottom et al., 2018) These prior studies were possible due to the availability of biometric CVD risk factors in the EHR HONU is a somewhat unique project in that it is located in a community where ~90% of the population has an active EHR (Sidebottom et al., 2014). Using EHR data, we were able to apply statistical weights to the participant screening data to provide a reasonable estimate of changes in lifestyle risk factors for CVD in the target population. Systematic, consistent documentation and practical tools (Adler and Stead, 2015) to assess social and behavioral measures is increasingly called upon by national organizations because “providers cannot manage what they do not measure” (Spring et al., 2013). As healthcare systems are being held more accountable for the communities they serve, population-level data on nutrition, physical activity and medication adherence, among other behaviors, could help inform strategies to evaluate and improve the public's health (Mozaffarian et al., 2012; Friedman et al., 2013; Estabrooks et al., 2012; Spring et al., 2013).

4.1. Limitations

There are several limitations that may be relevant to interpretation of findings. Behavioral data was self-reported, which may introduce some recall or self-presentation bias concerns. That said, this data is still very valuable in assessing behaviors and potential impact on CVD (Subar et al., 2015). As previously mentioned there were differences in behavioral metrics noted in HONU vs. other large scale community programs. There was also attrition in HONU screening attendance over time, which is the source of the behavioral data. Aside from waning promotion and screening events offered, other factors that likely influenced higher participation at baseline were the novelty of screenings at that time and more opportunities to participate in similar screenings offered through their employer. The longitudinal model fitted using GEEs used in our study allow us to include data from all members regardless of missing observations, to model changes in behavior over time. Furthermore, the use of inverse probability weights corrects for the fact that those who undergo screening are not necessarily representative of the entire target population. Indeed, the longitudinal trajectory of dichotomous measures of four biometric measures collected at screenings using weighted GEEs were very similar to the estimates using data collected from the EHR for the target population (which does not have the missing data problem), which suggests the analytical approach helps mitigate the impact of missing data. A sensitivity analysis on a subset of participants attending the first and last screening further corroborated findings of improved lifestyle behaviors at the community level. Finally, given the lack of behavioral risk factors in the EHR, our prior evaluation models to compare risk factors with another (control) community could not be used to assess changes in lifestyle risk factors, as the resources necessary to collect these measures in a comparison community were unavailable.

5. Conclusions

Over a 6-year timeframe, nutrition and physical activity improved in New Ulm. Although smoking, alcohol consumption, and stress levels remained statistically unchanged, our findings were largely consistent with prior observations that showed improvements in biometric risk factors such as blood pressure and lipid profiles appear to be accelerated in the New Ulm population (Sidebottom et al., 2016; Sidebottom et al., 2018). By leveraging local EHR data and integrating it with patient-reported outcomes, healthcare systems and public health entities can forge meaningful partnerships to surveil changes in the health of the communities they serve.

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Disclosures

The authors have no conflicts of interest.

Appendix A. Interventions delivered through HONU 2009–2014

Intervention	Implementation and participation
	Individual level
Heart health screenings	Screenings were conducted at worksites and public community locations to assess heart disease risk factors; educate individuals on their risk level, and provide guidance for medical follow-up as needed. Participants also received health coaching to set goals for lifestyle risk factors and were referred to available community or HONU-specific resources to help achieve those goals. Screenings were free to all adults in the community. In 2009, 5221 residents were screened, 3215 in 2011 and 1588 participants in 2014.
HeartBeat connections	A free phone coaching program targeting patients at high cardiometabolic risk (i.e. high Framingham, Reynolds risk score or metabolic syndrome), but without heart disease. Goals were to improve use of preventive medications (such as aspirin, blood pressure, and cholesterol lowering medication) and lifestyle-related risks, such as smoking cessation, nutrition, and exercise. To integrate with primary care, documentation occurred directly in the EHR. This program served 1022 patients from August 2010–December 2013.
Weight management phone coaching	Weight management coaching targeted individuals who were referred via their Primary Care Provider or engaged in the LOSE IT TO WIN IT Community Health Challenge and had a BMI ≥ 30. Coaching focused on behavioral strategies proven to help people lose weight such as tracking food and activity, self-weighing regularly, goal-setting and engaging in relapse prevention techniques. The Weight Management Coaching program served 235 patients in 2013.
Heart & vascular prevention clinic	A program offered through NUMC in collaboration with HONU. The clinic is staffed by a nurse practitioner with specialized lipid knowledge. Individuals at high risk for heart disease as well as those with existing heart or vascular disease who need more intensive clinical management are eligible to be referred. This program was eligible to all patients served by NUMC and not limited to those in the 56073.
Community health challenges	Six Health Challenges were offered to the community following broad annual campaign themes varying in durations (6–8 week to 12 months). These programs encouraged small manageable changes related to physical activity, healthful eating, weight management and stress management. Enrollment ranged from 539 to 2236.
General education	Cooking classes, grocery store tours, smoking cessation classes, and presentations were conducted on a variety of topics. The “What's cooking New Ulm TV Show” was presented on a local cable access channel 7 times per week with over 100 new episodes produced between 2010 and 2013.
	Interpersonal
Social marketing campaign	An eight-month community-wide social marketing campaign, SWAP IT to DROP IT™, focused on 100-calorie food and beverage SWAPs for weight management was conducted throughout the community (2012 and 2013).
Social media	Facebook and Twitter strategies were implemented to reach, engage and influence friends and followers.
Small community events	New Ulm was divided into 23 districts. Volunteer leaders were trained to promote opportunities for increased physical activity, and healthy events such as a physical activity classes, walking clubs, healthy potluck, or dance-a-thon between 2010 and 2011.
	Organizational
Grand rounds	Eleven HONU Grand Rounds events were conducted for physicians and mid-level providers. Over 90% of local providers attended at least one session, with the majority attending four or more. Topics ranged from rural healthcare disparities to the treatment of metabolic syndrome and cholesterol disorders, The purpose of these events was to bring awareness to CVD risk reduction, increase knowledge on the benefits of preventive treatment therapies, and to keep providers informed about the project.
Worksite assessments	Forty-six businesses completed an assessment of their wellness policies and environment. Results included recommendations on steps to improve their worksite wellness programming and health related policies (e.g., worksite smoking and nutrition policies).
Worksite behavioral change programs	Short (6–8 weeks) and long (12-month) behavior change programs focused on weight loss, nutrition, self-care, or exercise were offered. Fourteen behavior change programs were implemented at 95 worksites from 2009 to 2013, with 4879 employees participating (may be duplicate employees across programs). Twenty-four educational presentations were conducted with 1287 employees at 16 companies. Freedom from smoking classes were conducted at two worksites.
Heart health screenings conducted at worksites	Twenty-nine worksites participated in 2009 and 28 participated in 2011. Over 3500 employees were screened. Aggregate reports were given to each worksite that showed prevalence of risk factors among employees and provided recommendations for wellness programming targeting those risk levels.
Business leader engagement and education	Annual employer summits were hosted with motivational speakers. Summits were attended by 23–35 companies over past 5 years. Seven educational events were offered through the New Ulm Area Chamber of Commerce. Attendance ranged from 18 to 22 companies.
	Community
Formal run/walk events	Three run/walk events were held per year (5 and 10K distances) with participation ranging from 150 to 600 per event.
Community health summits	Annual community-wide inspirational events focused on lifestyle changes were hosted with national motivational speakers. Attendance ranged from 250 to 700/year.
Media	An annual communications plan was developed to strategically blanket the community with CVD primary and secondary prevention messages, as well as to promote other Project activities. Both earned and paid media were used and included such things as press releases, cable access advertising, radio promotions, billboards, newspaper ads and articles. Some materials were mailed to all households in the community.
Food environment improvements	Food environment interventions included work with local restaurants, grocery stores, and convenience stores to increase the availability, identification, and selection of healthful options. The Farmers Market Promotion Program included experiential learning opportunities such as distribution of educational materials and onsite cooking demonstrations to promote the use of local foods.
Project communications	A monthly HONU Project newsletter was distributed online and in the newspaper. Articles shared success stories, promoted healthful lifestyles and highlighted key activities in the community.
	Public policy
Complete Streets	Complete Streets help to slow traffic and take all users into account when designing streets. New Ulm installed a pilot complete street in 2014 near the high school/middle school and two of the elementary schools to demonstrate the elements and benefits of adopting a Complete Streets Policy. The street included sidewalks, bike lanes, reducing the width of the driving lane to slow traffic and adding a mid-block pedestrian island to give pedestrians a safe place to cross the street.
Safe routes to school	Plan for this was developed in 2014. The SRTS Plan incorporated objectives addressing the 6 E's of the national program; Education, Encouragement, Engineering, Enforcement, Evaluation and Equity. All of the objectives were designed create a safer environment for children to walk or bike to school while providing education about safe active transportation behavior.

Appendix B. Sensitivity analysis comparing unweighted results of the full sample with unweighted results from participants completing screenings in 2009 and 2014

Unweighted changes in behavioral risk factors among all heart health screening participants (full sample)[a]

	Total, adjusted for age and gender				Males, adjusted for age				Females, adjusted for age			
	2009	2011	2014	*p*-Value	2009	2011	2014	*p*-Value	2009	2011	2014–15	*p*-Value
	(*n* = 3123)	(*n* = 1976)	(*n* = 1008)		(*n* = 1310)	(*n* = 765)	(*n* = 371)		(*n* = 1806)	(*n* = 1211)	(*n* = 636)	
Current smoker, %	7.9	7.4	5.5	< 0.001	9.0	8.4	7.1	0.159	7.1	6.7	4.5	< 0.001
Moderate or no alcohol consumption, %	95.6	96.0	96.2	0.583	95.7	96.3	97.7	0.056	96.0	95.7	95.2	0.749
150 min or more per week of moderate intensity physical activity, %	63.9	73.1	72.3	< 0.001	66.3	74.4	71.6	< 0.001	62.2	72.2	72.5	< 0.001
Fruit and vegetable servings per day, mean (SE)	2.9 (0.03)	3.5 (0.04)	3.5 (0.1)	< 0.001	2.4 (0.04)	2.9 (0.06)	2.9 (0.07)	< 0.001	3.2 (0.04)	3.9 (0.05)	3.9 (0.07)	< 0.001
5 or more servings per day, %	16.3	26.6	30.2	< 0.001	10.5	17.8	22.0	< 0.001	21.1	33.4	36.4	< 0.001
Stress, % with low scores	89.2	91.8	92.0	0.001	91.7	92.8	94.5	0.119	87.3	90.9	90.2	0.001

Unweighted changes in behavioral risk factors among the subset of heart health screening participants who attended both the 1st and 3rd screenings[a]

	Total, adjusted for age and gender			Males, adjusted for age			Females, adjusted for age		
	2009	2014–15	*p*-Value	2009	2014–15	*p*-Value	2009	2014–15	*p*-Value
	(*n* = 957)	(*n* = 957)		(*n* = 332)	(*n* = 332)		(*n* = 25)	(*n* = 625)	
Current smoker, %	4.6	3.2	0.016	5.9	4.3	0.125	3.8	2.5	0.062
Moderate or no alcohol consumption, %	95.4	96.4	0.129	96.5	98.9	0.053	94.3	94.7	0.648
150 min or more per week of moderate intensity physical activity, %	71.0	75.6	0.016	71.0	74.8	0.227	71.2	76.1	0.036
Fruit and vegetable servings per day, mean (SE)	3.2 (0.06)	3.8 (0.06)	< 0.001	2.7 (0.09)	3.2 (0.10)	< 0.001	3.5 (0.07)	4.1 (0.08)	< 0.001
5 or more servings per day, %	19.8	34.6	< 0.001	12.4	26.3	< 0.001	24.6	39.7	< 0.001
Stress, % with low scores	91.0	92.7	0.167	93.5	94.5	0.643	89.3	91.5	0.179

[a] Study sample is restricted to residents of the 56073 zip code and age 40–79.

References

Abramson, J.H., Gofin, R., Hopp, C., Gofin, J., Donchin, M., Habib, J., 1981. Evaluation of a community program for the control of cardiovascular risk factors: the CHAD program in Jerusalem. Isr. J. Med. Sci. 17 (2–3), 201–212.

Adler, N.E., Stead, W.W., 2015. Patients in context—EHR capture of social and behavioral determinants of health. N. Engl. J. Med. 372 (8), 698–701.

Bambs, C., Kip, K.E., Dinga, A., Mulukutla, S.R., Aiyer, A.N., Reis, S.E., 2011. Low prevalence of "ideal cardiovascular health" in a community-based population: the heart strategies concentrating on risk evaluation (Heart SCORE) study. Circulation 123 (8), 850–857.

Benson, G.S.A., VanWormer, J.J., Boucher, J.L., Stephens, C., Krikava, J., 2013. HeartBeat connections: a program complementing primary care integrated within a community-based. J. Am. Board Fam. Med. 26, 299–310.

Boucher, J.L., Pereira, R.F., Graham, K.J., Pettingill, R.R., Toscano, J.V., Henry, T.D., 2008. The heart of New Ulm: a vision for the future. J. Cardiovasc. Transl. Res. 1 (4), 310–316.

Brownson, R.C., Smith, C.A., Pratt, M., et al., 1996. Preventing cardiovascular disease through community-based risk reduction: the Bootheel Heart Health Project. Am. J. Public Health 86 (2), 206–213.

Centers for Disease Control and Prevention Behavioral risk factor surveillance system. Data, Trend and Maps. https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html, Accessed date: 30 April 2018.

Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. J. Health Soc. Behav. 24 (4), 385–396.

Community Health Status Indicators U.S. Department of Human Services, Centers for Disease Control and Prevention. Data from the US Census Bureau's Small Area Health Insurance Estimates. Available at. http://wwwn.cdc.gov/CommunityHealth/profile/currentprofile/MN/Brown/310021, Accessed date: 22 April 2015.

Dowse, G.K., Gareeboo, H., Alberti, K.G., et al., 1995. Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius. Mauritius Non-communicable Disease Study Group. BMJ 311 (7015), 1255–1259.

Estabrooks, P.A., Boyle, M., Emmons, K.M., et al., 2012. Harmonized patient-reported data elements in the electronic health record: supporting meaningful use by primary care action on health behaviors and key psychosocial factors. J. Am. Med. Inform. Assoc. JAMIA 19 (4), 575–582.

Farquhar, J.W., Maccoby, N., Wood, P.D., et al., 1977. Community education for cardiovascular health. Lancet 1 (8023), 1192–1195.

Farquhar, J.W., Fortmann, S.P., Flora, J.A., et al., 1990. Effects of communitywide education on cardiovascular disease risk factors. The Stanford Five-City project. JAMA 264 (3), 359–365.

Friedman, D.J., Parrish, R.G., Ross, D.A., 2013. Electronic health records and US public health: current realities and future promise. Am. J. Public Health 103 (9), 1560–1567.

Health Policy Brief: The Relative Contribution of Multiple Determinants to Health Outcomes. Health Affairs.

Institute of Medicine, 2014. Capturing Social and Behavioral Domains in Electronic Health Records: Phase 1. Washington (DC). .

Institute of Medicine, 2015. Capturing Social and Behavioral Domains and Measures in Electronic Health Records: Phase 2. Washington (DC). .

Khaw, K.T., Wareham, N., Bingham, S., Welch, A., Luben, R., Day, N., 2008. Combined impact of health behaviours and mortality in men and women: the EPIC-Norfolk prospective population study. PLoS Med. 5 (1), e12.

Knapper, J.T., Ghasemzadeh, N., Khayata, M., et al., 2015. Time to change our focus: defining, promoting, and impacting cardiovascular population health. J. Am. Coll. Cardiol. 66 (8), 960–971.

Korhonen, T., Uutela, A., Korhonen, H.J., Puska, P., 1998. Impact of mass media and interpersonal health communication on smoking cessation attempts: a study in North Karelia, 1989–1996. J. Health Commun. 3 (2), 105–118.

Laforge, R.G., Greene, G.W., Prochaska, J.O., 1994. Psychosocial factors influencing low fruit and vegetable consumption. J. Behav. Med. 17 (4), 361–374.

McLeroy, K.R., Bibeau, D., Steckler, A., Glanz, K., 1988. An ecological perspective on health promotion programs. Health Educ. Q. 15 (4), 351–377.

Mozaffarian, D., Afshin, A., Benowitz, N.L., et al., 2012. Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. Circulation 126 (12), 1514–1563.

Mozaffarian, D., Benjamin, E.J., Go, A.S., et al., 2015. Heart disease and stroke statistics—2015 update: a report from the American Heart Association. Circulation 131 (4), e29–322.

Muntoni, S., Stabilini, L., Stabilini, M., Muntoni, S., 1999. Results of a five-year community-based programme for cardiovascular disease prevention: the ATS-Sardegna campaign. Eur. J. Epidemiol. 15 (1), 29–34.

Papadakis, S., Moroz, I., 2008. Population-level interventions for coronary heart disease prevention: what have we learned since the North Karelia project? Curr. Opin. Cardiol. 23 (5), 452–461.

Pearson, T.A., Bazzarre, T.L., Daniels, S.R., et al., 2003. American Heart Association guide for improving cardiovascular health at the community level: a statement for public health practitioners, healthcare providers, and health policy makers from the American Heart Association Expert Panel on Population and Prevention Science. Circulation 107 (4), 645–651.

Pearson, T.A., Palaniappan, L.P., Artinian, N.T., et al., 2013. American Heart Association Guide for Improving Cardiovascular Health at the Community Level, 2013 update: a scientific statement for public health practitioners, healthcare providers, and health policy makers. Circulation 127 (16), 1730–1753.

Pietinen, P., Vartiainen, E., Seppanen, R., Aro, A., Puska, P., 1996. Changes in diet in Finland from 1972 to 1992: impact on coronary heart disease risk. Prev. Med. 25 (3), 243–250.

Pike, M.M., Decker, P.A., Larson, N.B., et al., 2016. Improvement in cardiovascular risk prediction with electronic health records. J. Cardiovasc. Transl. Res. 9 (3), 214–222.

Puska, P., Salonen, J.T., Nissinen, A., et al., 1983. Change in risk factors for coronary heart disease during 10 years of a community intervention programme (North Karelia project). Br. Med. J. (Clin. Res. Ed.) 287 (6408), 1840–1844.

Record, N.B., Onion, D.K., Prior, R.E., et al., 2015. Community-wide cardiovascular disease prevention programs and health outcomes in a rural county, 1970–2010. JAMA 313 (2), 147–155.

Sacco, R.L., 2011. The new American Heart Association 2020 goal: achieving ideal cardiovascular health. J. Cardiovasc. Med. (Hagerstown) 12 (4), 255–257.

Saunders, J.B., Aasland, O.G., Babor, T.F., de la Fuente, J.R., Grant, M., 1993. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption—II. Addiction 88 (6), 791–804.

Services USDoHaH, 2008. Physical activity guidelines for Americans, 2008. https://health.gov/paguidelines/guidelines/summary.aspx (2011).

Sidebottom, A.C., Sillah, A., Miedema, M.D., et al., 2016. Changes in cardiovascular risk factors after 5 years of implementation of a population-based program to reduce cardiovascular disease: the heart of New Ulm project. Am. Heart J. 175, 66–76.

Sidebottom, A.C., Sillah, A., Vock, D.M., et al., 2018. Assessing the impact of the heart of New Ulm project on cardiovascular disease risk factors: a population-based program to reduce cardiovascular disease. Prev. Med. 112, 216–221.

Sidebottom, A.C., Johnson, P.J., VanWormer, J.J., Sillah, A., Winden, T.J., Boucher, J.L., 2014. Exploring electronic health records as a population health surveillance tool of cardiovascular disease risk factors. Popul. Health Manag. 18 (2), 79–85.

Sillah, A., Sidebottom, A.C., Boucher, J.L., Pereira, R., VanWormer, J.J., 2014. Program participation and blood pressure improvement in the heart of New Ulm project, Minnesota, 2009–2011. Prev. Chronic Dis. 11, E48.

Spring, B., Ockene, J.K., Gidding, S.S., et al., 2013. Better population health through behavior change in adults: a call to action. Circulation 128 (19), 2169–2176.

Subar, A.F., Freedman, L.S., Tooze, J.A., et al., 2015. Addressing current criticism regarding the value of self-report dietary data. J. Nutr. 145 (12), 2639–2645.

U.S. Department of Health and Human Services, 2005. Dietary Guidelines for Americans, 6th edition. Washington, DC.

U.S. Department of Health and Human Services Centers for Disease Control and Prevention, 2009. Behavioral Risk Factor Surveillance System survey Questionnaire. https://www.cdc.gov/brfss/questionnaires/pdf-ques/2009brfss.pdf.

U.S. Department of Health and Human Services Office of Disease Prevention and Health Promotion, 2017. Healthy People 2020 Leading Health Indicators. https://www.healthypeople.gov/2020/leading-health-indicators/2020-LHI-Topics.

VanWormer, J.J., 2010. Methods of using electronic health records for population-level surveillance of coronary heart disease risk in the heart of New Ulm project. Diabetes Spectr. 23 (3), 161–165.

VanWormer, J.J., Johnson, P.J., Pereira, R.F., et al., 2012. The heart of New Ulm project: using community-based cardiometabolic risk factor screenings in a rural population health improvement initiative. Popul. health Manag. 15 (3), 135–143.

Wendel-Vos, G.C., Dutman, A.E., Verschuren, W.M., et al., 2009. Lifestyle factors of a five-year community-intervention program: the Hartslag Limburg intervention. Am. J. Prev. Med. 37 (1), 50–56.

Yusuf, S., Hawken, S., Ounpuu, S., et al., 2004. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet 364 (9438), 937–952.