How to Cite:
Dorri, N., Afrooz, G., Noohi, F., & Pourhosein, R. (2021). Appliance of medical genogram and social network theory in cardiovascular health promotion intervention and non-laboratory-based risk monitoring: A clinical trail. *International Journal of Health Sciences*, *5*(S2), 754–769. https://doi.org/10.53730/ijhs.v5nS2.13879

Appliance of medical genogram and social network theory in cardiovascular health promotion intervention and non-laboratory-based risk monitoring: A clinical trail

Negin Dorri
Ph.D. Health Psychology, University of Tehran, Tehran, Iran
Corresponding author email: negin.dorri@ut.ac.ir
https://orcid.org/0000-0003-2285-4974

Gholamali Afrooz
Distinguished Professor, Faculty of Psychology and Educational Sciences, University of Tehran. Tehran. Iran

Feridoun Noohi
Professor of Cardiology, Rajaie Cardiovascular Medical and Research Center, Tehran, Iran

Reza Pourhosein
Professor, Faculty of Psychology and Educational Sciences, University of Tehran. Tehran, Iran

***Abstract*---**Objective: This study aims to determine the number of patients, as well as their nuclear and extended family members with or without established cardiovascular disease, at the baseline age of ≤20 along with the family members under 20 years old, who could benefit from a potential sociocultural, environmental and household related cardiovascular health promotion interventions in a social tie network, which enriches the explanation of human behavior by explicitly taking its social structure into account. Methods: This study is a part of a clinical trial-educational family-centered health intervention on patients undergoing percutaneous coronary intervention and their household members. Ethical clearance was obtained from Iran National Committee for Ethics in Biomedical Research, and approved by the Iranian Registry of Clinical Trials. The study was conducted from October 2021 to March 2022. It involved a total of 33 patients. The demographic information was gathered from a self-administered questionnaire and the information was analysed via medical genogram and social network analysis model at individual

and group level. Results: Overall, via only 33 patients and their significant other (n=66), we got access to the medical history of 429 nuclear and extended family members. Out of 429 family members, disclosing the participants, 21 individuals were under age of 20, between ages of 21 and 40 (n=101), 41 to 60 (n=176) and from 61-80 (n= 103) and 14 family members over 81 years old, who could benefit from a potential cardiovascular health promotion intervention. Conclusion: Our study indicates that lifestyle-related controllable risk factors namely, smoking, obesity, drug use and alcohol consumption increases after the age of 30, and could be prevented early in life.

***Keywords*---**cardiovascular health promotion, cardiovascular risk monitoring, medical genogram, social networks theory.

Introduction

Cardiovascular diseases (CVDs), stating conditions related to the blood vessels and the heart, [1,2] are the paramount causes of disability-adjusted life years (DALY), premature and mature mortality globally. [3-11] According to the world health organisation (WHO), CVDs with a constant age reduction in its prevalence-both gender included, are a major public-health concern, with the estimation of $1044 billion USD direct and indirect costs, only a decade from 2020. [12-14] The nature of CVDs, starting early in life, lies within modifiable and non-modifiable risk factors. However, considerable guidelines including, the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) comparative risk assessment (CRA), the American Society for Preventive Cardiology (ASPC) and the European Society of Cardiology (ESC), indicate that, more than 80% of CVD-related prevalence and incidence can be exceedingly preventable and delayed by lifestyle modifications, non-pharmaceutical and risk management.[15-17] Hence, in 2010 the American Heart Association (AHA), highlighted the importance of primordial preventive strategies towards cardiovascular health (CVH), through favourable lifestyle changes approaches and risk monitoring, at a nation, subnational and primary care level. [18-21]

The concept of risk monitoring, first established by the United States' Framingham Heart Study; the Framingham risk score (FRS), forming a predictive analytics algorithm, in order to estimate individuals CVD's developmental risk within 10 years. [22-23] Continuously, since the FRS various risk prediction tools, namely, the British QRISK and JBS, the Scottish ASSIGN, the European SCORE, the AHA's ASCVD and the WHO risk prediction tools, in attempt to pre-treatment, targeting the environmental inter-correlated risk factors, with the solitary aim of CVD primary prevention has been developed. [24-25]

Moreover, except for the positive family history (FH+) and the body mass index (BMI), modifiable and non-modifiable risk factors, including, age of ≤30, gender differences, smoking status, hypertension (systolic and diastolic blood pressure), total-cholesterol-to-low and high density lipoproteins (LDL-C, HDL-C), glucose and diabetes mellitus (DM) screening, defined as laboratory-based variables by WHO, are the mutual required aspects of the mentioned tools. However, due to

varies determinations, the measurement of laboratory-based variables, may not always be assessable. [26-31]

Hence, the 2019 WHO CVD non-laboratory-based risk chart, with the goal of whole-of-society approach at a macro-level, has limited its CVD-risk variables to the baseline age of ≤20, sex, tobacco use, systolic blood pressure (SBP) and BMI, and only obliges DM, LDL-C and HDL-C tests, once the CVD-risk score is greater than 10% or beyond. [32-35] Consequently, the accessibility and the cost-efficiency of the non-laboratory-based risk chart, has allowed the policy-makers and healthcare systems to monitor and reach a wider range of population, and imply different lifestyle interventions, at a meso- and micro-level, toward public health. [36-38]

Public health has been defined as "what we do together as a society to ensure the conditions in which everyone can be healthy". [39-40] Therefore, in addition to healthcare legislators, by enchanting a holistic approach into consideration, family's being the most important form of social units, play a significant role toward achieving health, throughout life. [41-46] Hence, the purpose of the present pilot study, using gathered demographic information, not only from the patients but also from the family members (FMs), by application of social network theory (social network analysis) and the use of medical genogram, is to detect the number of FMs with or without established CVDs, at the baseline age of ≤20 as well as the FMs under 20 years old, who could benefit from a potential sociocultural, environmental and household related CVH interventions in a social tie network, which enriches the explanation of human behavior by explicitly taking its social structure into account.

Description of the Intervention and Methods

Medical Genogram

A medical genogram is a computer generated graphical pedigree illustrating using symbols, representation an image of a family's structure, on various data such as biological relationships and medical conditions that can be used specially to access disease risk. In order to outline the importance of environmental and genetic risk factors of CVDs to the participant, and to assist in the assessment, planning, and family intervention, and to allow knowing what members constitute the family we used medical genogram on the first session and as the studie's demographic information gathering.

The medical genogram interview was conducted with 33 pilot participants. In this study, medical genogram symbols, represents participant's FMs, demographic information including, date of birth and death, the history of non-communicable diseases (heart-related conditions, Cancer, Diabetes Mellitus), obesity, hypertension, smoking status and other drugs and alcohol consumption among first- and second degree relatives. For the construction of the medical genogram, notes were taken in chronological order, meaning from the oldest to the youngest FM, from left to right and from top to bottom in each generation. The patient was defined as the index person (IP) and IP's wife, presented as significant other

(IPSO). In an attempt to quantify and further define the reported history, the participants were asked to review the final medical genogram. [47-51]

Social Network Analysis Model

Social network analysis (SNA), is a set of theories and methods used to define how a whole group of individuals and their interrelation and behavioral patterns such as, information seeking, social norms and lifestyle (e.g. eating habits), have an impact on one another. SNA, are calculated at both individual and network level. In this study, the individual level, is used to define each person's position from the IP and IPSO, and at the group level (nuclear and extended family members). SNA measures the emergence of connectedness among family members, with the assumption of how these relationships (closeness) and word-of-mouth influence healthy behaviors.

Moreover, the nodes are the individuals, the links (lines) are social connections between the hospital, IP, IPSO, nuclear and extended family members (NF, EF). Furthermore, we used "decade" as our baseline age division, and color coded IP, IPSO, NF and EF accordingly. "H" represents the Hospital. The green nodes are the household members of IP and IPSO (the children), and the grey nodes represent IP's (on the left side) and IPSO's (on the right side) siblings and parents. Note: the departed FMs are not included in the visual SNA (Figure 1).

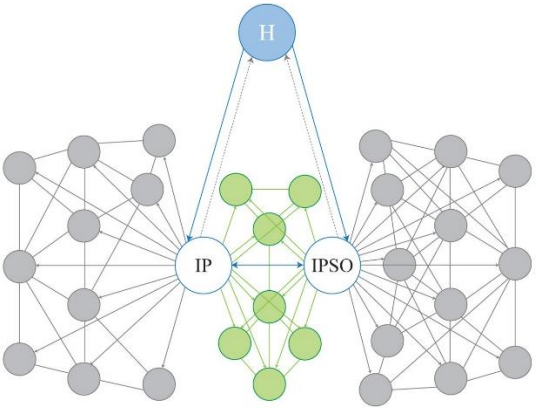


Figure 1. Group Social Networks visualize Analysis for each participant

During the first and second session (week 1), pilot participants, filled a questionnaire, based on family relations (parents, siblings and children). Study participants (wife's), who were not in the hospital on the data collection days, received a data collection telephone call within one week. The final social network diagram, where nodes were labeled with FMs age (eliminated from the published article), in order for the IP to detect the FM, was sent to the IP via WhatsApp Messenger and discussed the accuracy of it, on the last session. [52-53]

SNA Individual Level

The SNA's individual level (agent-centric) of this study has been divided into two groups. The gathered data regarding the demographic information and the history

of NCDs of the IP, and IPSO are presented in table 1 and 2, in the same particular order.

SNA Group Level

The SNA's group structure of the current study, maps the interaction of the IP's house hold members (nuclear family) as well as the extended FM's for both IP and IPSO, through SNA's visualization analysis (Figure 2). For the extended FMs, we collected demographic data as well as medical history of chronic conditions from the IP and IPSO (Table 3). Notably, some information such as the year of births and deaths not recalled by the participants were counted as the study's missing data. [54-55]

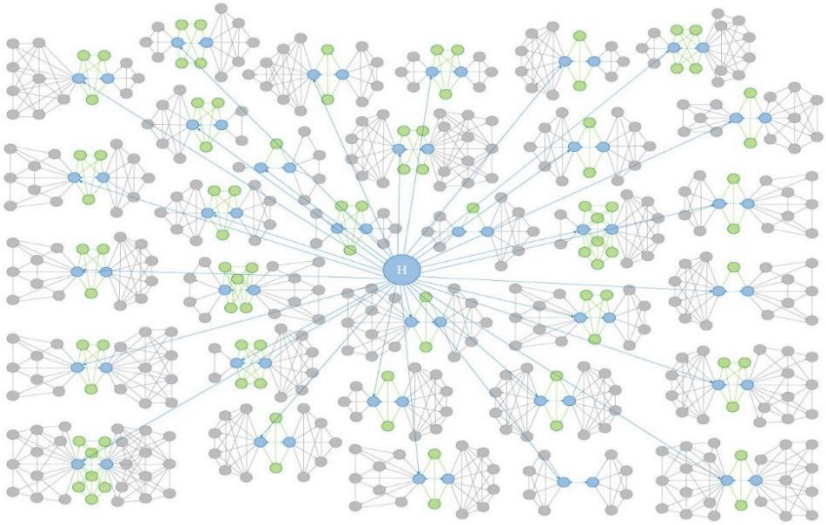


Figure 2. IP's and IPSO's Group Social Networks visualize Analysis
Note: The departed members are not included in social networks analysis

Results

General Information at Individual Level.

Table 1 and 2, presents general data such as age, occupation, level of education, smoking status, alcohol or any other drug consumption, obesity and NCDs of the IP and IPSO, respectively.

Table 1. Descriptive Statistics of Total Patients

Variables	Levels	Median (IQR)/ Frequency (%)	P-values
Age	Median (IQR)	56.0 (50.0, 59.0)	<0.001
	41-50	8 (24.20)	
	51-60		

Table 2. Descriptive Statistics of Total Patient's Significant Other

Variables	Levels	Median (IQR)/ Frequency (%)	P-values
Age	Median (IQR)	50.0 (44.0, 55.0)	<0.001
	31-40		

	61-70	17 (51.50) 8 (24.20)			41-50 51-60 61-70	1 (3.00) 13 (39.40) 17 (51.50) 2 (6.10)	
Education	Primary Secondary University	15(46.88) 12 (37.50) 5 (15.63)	0.355	Education	Primary Secondary University	23 (69.69) 5 (15.15) 5 (15.15)	0.018
Occupation	Employed Unemployed	21 (72.41) 8 (27.59)	0.016	Occupation	Employed Unemployed	4 (12.12) 29 (87.88)	<0.001
CVD*	Yes No	21 (63.64) 12 (36.36)	0.117	CVD	Yes No	2 (6.06) 31 (93.94)	<0.001
Cholesterol*	Yes No	16 (48.48) 17 (51.52)	0.862	Cholesterol	Yes No	8 (24.24) 25 (75.76)	0.003
Hypertension	Yes No	12 (36.36) 21 (63.64)	0.117	Hypertension	Yes No	3 (9.09) 30 (90.91)	<0.001
Diabetes	Yes No	3 (9.09) 30 (90.91)	<0.001	Diabetes	Yes No	5 (15.15) 28 (84.85)	<0.001
Cancer	Yes No	0 (0.00) 33 (100.00)	<0.001	Cancer	Yes No	0 (0.00) 33 (100.00)	<0.001
Overweight	Yes No	2 (6.10) 31 (93.90)	<0.001	Overweight	Yes No	7 (21.21) 26 (78.79)	0.001
Smoking	Yes No	10 (30.3) 23 (69.70)	0.024	Smoking	Yes No	10 (30.3) 23 (69.70)	<0.001
Drug Use	Yes No	8 (24.20) 25 (75.80)	0.003	Drug Use	Yes No	8 (24.20) 25 (75.80)	0.003
Alcohol*	Yes No	7 (21.21) 26 (78.79)	0.001	Alcohol	Yes No	4 (12.12) 29 (87.88)	0.001
Note: Pearson's Chi-squared Test was used to compare percentage of levels							
*CVD: Cardiovascular Disease. *Cholesterol: High Blood Cholesterol Level. *Alcohol: Alcohol Consumption.							

General Information at Group Level

Table 3 presents number of NF and EF members linked to the IP and IPSO at a group level. The age distribution of NF and EF members linked to the IP and IPSO are presented in table 4.

Table 3. Number of NF, EF members linked to the IP and IPSO at a Group Level

Group ID	IP to NF*	IP to EF*	IPSO to EF	Total	Group ID	IP to NF	IP to EF	IPSO to EF	Total
A	3	4	4	11	R	1	6	7	14
B	2	11	9	22	S	4	3	5	12
C	2	7	4	13	T	2	3	6	11
D	3	7	4	14	U	2	9	5	16
E	4	2	6	12	V	2	5	5	12
F	2	5	7	14	W	2	6	5	13
G	4	6	11	21	X	3	2	3	8
H	7	2	6	15	Y	3	5	6	14
I	4	3	8	15	Z	3	5	9	17
J	3	5	4	12	Aa	3	7	5	15
K	5	4	7	16	Ba	3	5	2	10

L	2	4	8	14	Ca	5	10	12	27
M	3	3	3	9	Da	3	8	3	14
N	2	7	6	15	Ea	2	6	3	11
O	1	1	4	6	Fa	-	4	4	8
P	2	6	6	14	Ga	1	3	5	9
Q	3	6	10	19				N*= 429	

*NF: IP's Nuclear Family Member (Children). *EF: IP's Extended Family Member.
*N represents the number of NF and EF, linked to IP and IPSO (n=66), whom are not included in the total.

The demographic information of FMs with a chronic condition (CVD, high cholesterol level, DM, cancer), as well as positive controllable risk factors of the IP's and IPSO's household members (children), and extended FM (parents and the siblings), are presented in Table 4. Notably, the departed members were excluded from SNA's visual representation, but were presented on medical genogram diagram. Moreover, according to Figure 5, the frequency of high cholesterol level, diabetes mellitus, and hypertension was highest among individuals aged 61-70.

Age	IP to NF	IP to EF	IPSO to EF	Total
	n	n	n	
1-10	6	-	-	6
11-20	15	-	-	15
21-30	30	1	6	37
31-40	25	15	24	64
41-50	5	36	45	86
51-60	-	51	53	104
61-70	-	33	35	68
71-80	-	13	22	35
81-90	-	5	7	12
91+	-	-	2	2
				N*= 429

*N represents the number of NF and EF, linked to IP and IPSO (n=66), whom are not included in the total.

Table 4. The Age Distribution of NFs and EFs of IP and IPSO

In addition, cardiovascular disease, smoking status, and alcohol consumption, were more prevalent in those 51-60 years of age. Patients with cancer were mostly in the age group of 71-80 years, and those with overweight were mostly in the age group of 40-50 years. The presented data illustrates lifestyle-related controllable risk factors namely, smoking, obesity, drug use and alcohol consumption increase after the age of 30, and could be prevented early in life.

Table 4. Descriptive statistics of the IP's and IPSO's nuclear and extended family members.

Age	Cardiovascular disease	High Blood Pressure	High Blood Fat	Diabetes	Cancer*	Overweight	Smoke	Drug	Alcohol consumption
<= 10	1 (2.50)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
11 - 20	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (6.06)	0 (0.00)	0 (0.00)	0 (0.00)
21 - 30	1 (2.50)	0 (0.00)	0 (0.00)	1 (3.23)	0 (0.00)	4 (12.12)	3 (6.12)	0 (0.00)	3 (16.67)
31 - 40	2 (5.00)	1 (3.03)	2 (4.55)	3 (9.68)	1 (8.33)	5 (15.15)	10 (20.41)	1 (16.67)	4 (22.22)
41 - 50	6 (15.00)	2 (6.06)	7 (15.91)	2 (6.45)	1 (8.33)	7 (21.21)	13 (26.53)	2 (33.33)	3 (16.67)
51 - 60	10 (25.00)	8 (24.24)	4 (9.09)	8 (25.81)	2 (16.67)	6 (18.18)	18 (36.73)	2 (33.33)	6 (33.33)
61 - 70	12 (30.00)	12 (36.36)	16 (36.36)	10 (32.26)	2 (16.67)	5 (15.15)	4 (8.16)	0 (0.00)	1 (5.56)
71 - 80	6 (15.00)	8 (24.24)	13 (29.55)	7 (22.58)	5 (41.67)	4 (12.12)	1 (2.04)	0 (0.00)	1 (5.56)
81 - 90	2 (5.00)	2 (6.06)	2 (4.55)	0 (0.00)	1 (8.33)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)
91+	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Total	40 (100.00)	33 (100.00)	44 (100.00)	31 (100.00)	12 (100.00)	33 (100.00)	49 (100.00)	6 (100.00)	18 (100.00)

Note: Pearson's Chi-squared Test was used to compare percentage levels.

Departed members are not included in the given data. *Cancer survivals and current FMs fighting cancer are both included.

The presented data illustrates lifestyle-related controllable risk factors namely, smoking, obesity, drug use and alcohol consumption increases after the age of 30, and could be prevented early in life.

Discussion

In 2007, WHO issued the Guidelines for Evaluation and Management of CVD's Risk Factors, which clearly pointed out that the incidence and mortality of CVD's were closely related to individual's lifestyle (LS) patterns regardless of gender and age. [56-57] Ideal CVH has been proposed by the AHA and used to measure population health. The seven risk factors (Life's Simple 7) that people can improve through LS changes, included four health behaviors (stop smoking, eat better, get active, and lose weight) and three health factors (manage blood pressure, control cholesterol, and reduce blood sugar). [58-61]

At present, plenty of relevant studies shown that LS interventions is one of the most important aspects of primary and secondary prevention of CVD's. Elimination of mentioned modifiable risk factors including unhealthy lifestyle allows for prevention of 80% of CVD cases and individuals with desirable lifestyle factors (not smoking, physically active, healthy diet, BMI < 25) are expected to have a 67–72% lower risk of developing heart failure. [62-63]

Health promotion interventions are very common method used to encourage individuals to adopt a healthier LS.[64] Since LS interventions aim to implement subjects behavioral change, the knowledge about the link between behavior and health (or risk awareness) is an important factor to inform choices about healthy behaviors. Moreover, the science of behavior change seeks to improve the understanding of underlying mechanisms of human behavior change by promoting and a basic mechanism of action research by use of an experimental medicine. In addition, trans-cultural studies, have long established the powerful role of environmental and cultural dimensions in behavioral change. [65-69]

Pro-active public health approaches focused on sociocultural and 'upstream' population-wide policies are increasingly recognized as being potentially powerful, rapid, equitable and cost-saving. [70-72] While the role of public health system must involve strong leadership, partnerships, funding, relevant data, and a foundational infrastructure, challenges may best be achieved as practitioners

consider the influence of policies and practices on families and households. Hence, the process that has been called health promotion no longer focuses on individuals alone, but now leads strengthening the social resources of individuals as well as improving the resources present in the social environment and units. “Public health begins at home”, proposes that the family should be considered as the basic unit of health production at the societal level, a context in public health practice, and an essential part of public health policy, studies, and interventions. [73-74]

Contemporary health promoting involving the FMs can establish scaffolds for shaping simple health behaviors (e.g. changes in meal preparation) in which individuals are born and receive resources for their growth and development. [75-77] family involvement has been defined as “a relationship between health care providers working together to promote and support active patient and public involvement in health care and to strengthen their influence on health care decisions at an individual and collective level”. [78] Therefore, lifestyle changes are likely to be more effective when delivered to the whole family than to individuals as it works within the framework of biologic and sociocultural relationships to affect risk reduction. [79-82]

Conclusion

This pilot study was conducted to assess the number of people living in the same household as our patients and their extended FMs who could potentially benefit from a health promotion intervention (in spite of their age) and a CVD’s non-laboratory-based risk measurement for individuals at the baseline age of ≤20. The aim of this study was to make healthcare accessible not only to the patients but also to a wider society in order to detect and break the chain of unhealthy habits. Therefore, the future aim of the healthcare team is to make sure that every time a patient walks out of the hospital, our team members know that they have all contributed not only to the patient’s treatment success, but also passed on their knowledge to a greater population.

References

1. Abdul Rahman Jazieh, Susan Volker, Saadi Taher; Involving the Family in Patient Care: A Culturally Tailored Communication Model. Global Journal on Quality and Safety in Healthcare 1 November 2018; 1 (2): 33–37. doi: https://doi.org/10.4103/JQSH.JQSH_3_18
2. Arsyad DS, Westerink J, Cramer MJ, et al. Modifiable risk factors in adults with and without prior cardiovascular disease: findings from the Indonesian National Basic Health Research. BMC Public Health. 2022;22(1). doi:10.1186/s12889-022-13104-0
3. Avesta L, Rasoolzadeh S, Naeim M, Kamran A. Prevalence of Cardiovascular Disease Risk Factors in the Women Population Covered by Health Centers in Ardabil. Moreira TMM, ed. International Journal of Hypertension. 2022; 2022:1-8. doi:10.1155/2022/2843249
4. Banks E, Welsh J, Joshy G, Martin M, Paige E, Korda RJ. Comparison of cardiovascular disease risk factors, assessment and management in men and women, including consideration of absolute risk: a nationally representative

cross-sectional study. BMJ Open. 2020;10(12): e038761. doi:10.1136/bmjopen-2020-038761
5. Barnes MD, Hanson CL, Novilla LB, Magnusson BM, Crandall AC, Bradford G. Family-Centered Health Promotion: Perspectives for Engaging Families and Achieving Better Health Outcomes. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. January 2020. doi:10.1177/0046958020923537\
6. Bayoumy K, Gaber M, Elshafeey A, et al. Smart wearable devices in cardiovascular care: where we are and how to move forward. Nat Rev Cardiol. 2021;18(8):581-599. doi:10.1038/s41569-021-00522-7
7. Benjamin EJ, Virani SS, Callaway CW, Chamberlain AM, Chang AR, Cheng S, et al. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. Circulation. 2018;137(12):e67–492.
8. Bokhare SF, Zainon WMNW, Talib AZ. A Study on Visual Representation of Medical Family Tree Using Genograms. Advances in Intelligent Systems Research. Published online 2013. doi:10.2991/visio-13.2014.1
9. Cené CW, Johnson BH, Wells N, Baker B, Davis R, Turchi R. A Narrative Review of Patient and Family Engagement: The "Foundation" of the Medical "Home". Med Care. 2016;54(7):697-705. doi:10.1097/MLR.0000000000000548
10. Chia YC, Gray SYW, Ching SM, Lim HM, Chinna K. Validation of the Framingham general cardiovascular risk score in a multiethnic Asian population: a retrospective cohort study. BMJ Open. 2015;5(5): e007324-e007324. doi:10.1136/bmjopen-2014-007324
11. Clay AM, Parsh B. Patient- and Family-Centered Care: It's Not Just for Pediatrics Anymore. AMA J Ethics. 2016;18(1):40-44. Published 2016 Jan 1. doi: 10.1001/journalofethics.2016.18.1.medu3-1601
12. Curry SJ, Krist AH, Owens DK, et al. Risk Assessment for Cardiovascular Disease with Nontraditional Risk Factors. JAMA. 2018;320(3):272. doi:10.1001/jama.2018.8359
13. Davidson KW, Scholz U. Understanding and predicting health behaviour change: a contemporary view through the lenses of meta-reviews. Health Psychol Rev. 2020;14(1):1-5. doi:10.1080/17437199.2020.1719368
14. DeSalvo KB, Wang YC, Harris A, Auerbach J, Koo D, O'Carroll P. Public Health 3.0: A Call to Action for Public Health to Meet the Challenges of the 21st Century. NAM Perspectives. 2017;7(9). doi:10.31478/201709a
15. DeSalvo KB, Wang YC, Harris A, Auerbach J, Koo D, O'Carroll P. Public Health 3.0: A Call to Action for Public Health to Meet the Challenges of the 21st Century. Prev Chronic Dis. 2017;14: E78. Published 2017 Sep 7. doi:10.5888/pcd14.170017
16. Doughty, K.N., Del Pilar, N.X., Audette, A. et al. Lifestyle Medicine and the Management of Cardiovascular Disease. Curr Cardiol Rep 19, 116 (2017). https://doi.org/10.1007/s11886-017-0925-z
17. Eeva-Leena Ylimäki, Outi Kanste, Hanna Heikkinen, Risto Bloigu, Helvi Kyngäs.The effects of a counselling intervention on lifestyle change in people at risk of cardiovascular disease, European Journal of Cardiovascular Nursing, Volume 14, Issue 2, 1 April 2015, Pages 153–161, https://doi.org/10.1177/1474515114521725

18. Gaye B, Canonico M, Perier MC, et al. Ideal Cardiovascular Health, Mortality, and Vascular Events in Elderly Subjects: The Three-City Study. J Am Coll Cardiol. 2017;69(25):3015-3026. doi: 10.1016/j.jacc.2017.05.011
19. GBD 2017 Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017 [published correction appears in Lancet. 2019 Jan 12;393(10167):132] [published correction appears in Lancet. 2019 Jun 22;393(10190):e44]. Lancet. 2018;392(10159):1923-1994. doi:10.1016/S0140-6736(18)32225-6
20. GBD 2019 Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1223-1249. doi:10.1016/S0140-6736(20)30752-2
21. Gesell SB, Barkin SL, Valente TW. Social network diagnostics: a tool for monitoring group interventions. Implementation Science. 2013;8(1). doi:10.1186/1748-5908-8-116
22. Guo L, Zhang S. Association between ideal cardiovascular health metrics and risk of cardiovascular events or mortality: A meta-analysis of prospective studies. ClinCardiol. 2017;40(12):1339-1346. doi:10.1002/clc.22836
23. Hall R, Saukko PM, Evans PH, Qureshi N, Humphries SE. Assessing family history of heart disease in primary care consultations: a qualitative study. Family Practice. 2007;24(5):435-442. doi:10.1093/fampra/cmm037
24. Hanson CL, Crandall A, Barnes MD, Magnusson B, Novilla MLB, King J. Family-Focused Public Health: Supporting Homes and Families in Policy and Practice. Front Public Health. 2019; 7:59. Published 2019 Mar 20. doi:10.3389/fpubh.2019.00059
25. Hao J, Critchley-Thorne R, Diehl DL, Snyder SR. A Cost-Effectiveness Analysis Of An Adenocarcinoma Risk Prediction Multi-Biomarker Assay For Patients With Barrett's Esophagus. ClinicoEconomics and Outcomes Research. 2019;Volume 11:623-635. doi:10.2147/ceor.s221741
26. HEARTS technical package for cardiovascular disease management in primary health care: risk based CVD management. Geneva: World Health Organization; 2020.Licence: CC BY-NC-SA 3.0 IGO.
27. Helfer T, Faeh D, Luijckx E, Frey S, Berg A, Peter KA. The Connection between Health Promotion, Prevention, and Psychosocial Health: An Innovative Action Model. The Open Public Health Journal. 2020;13(1). doi:10.2174/1874944502013010850
28. Hosein A, Stoute V, Chadee S, Singh NR. Evaluating Cardiovascular Disease (CVD) risk scores for participants with known CVD and non-CVD in a multiracial/ethnic Caribbean sample. PeerJ. 2020;8: e8232. Published 2020 Mar 9. doi:10.7717/peerj.8232
29. Institute of Medicine, Committee on the Learning Health Care System in America, McGinnis, M. J., Stuckhardt, L., Saunders, R., & Smith, M. (2013). Best Care at Lower Cost: The Path to Continuously Learning Health Care in America (1st ed.). National Academies Press.
30. Jeemon P, Harikrishnan S, Ganapathi S, et al. Efficacy of a family-based cardiovascular risk reduction intervention in individuals with a family history of premature coronary heart disease in India (PROLIFIC): an open-label,

single-centre, cluster randomised controlled trial. Lancet Glob Health. 2021;9(10): e1442-e1450. doi:10.1016/S2214-109X (21)00319-3
31. Jeemon P, Harikrishnan S, Sanjay G, et al. A PROgramme of Lifestyle Intervention in Families for Cardiovascular risk reduction (PROLIFIC Study): design and rationale of a family based randomized controlled trial in individuals with family history of premature coronary heart disease. BMC Public Health. 2017;17(1):10. Published 2017 Jan 5. doi:10.1186/s12889-016-3928-6
32. Kariuki JK, Gona P, Leveille SG, Stuart-Shor EM, Hayman LL, Cromwell J. Cost-effectiveness of the non-laboratory based Framingham algorithm in primary prevention of cardiovascular disease: A simulated analysis of a cohort of African American adults. Preventive Medicine. 2018;111:415-422. doi:10.1016/j.ypmed.2017.12.001
33. Karmali KN, Persell SD, Perel P, Lloyd-Jones DM, Berendsen MA, Huffman MD. Risk scoring for the primary prevention of cardiovascular disease. Cochrane Database of Systematic Reviews. Published online March 14, 2017. doi: 10.1002/14651858.cd006887.pub4
34. Karmali KN, Persell SD, Perel P, Lloyd-Jones DM, Berendsen MA, Huffman MD. Risk scoring for the primary prevention of cardiovascular disease. Cochrane Database of Systematic Reviews. Published online March 14, 2017. doi: 10.1002/14651858.cd006887.pub4
35. Lawton J, Tamis-Holland J, et al. 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization. J Am Coll Cardiol. 2022 Jan, 79 (2) e21–e129. https://doi.org/10.1016/j.jacc.2021.09.006
36. Li J, Liu F, Yang X, et al. Validating World Health Organization cardiovascular disease risk charts and optimizing risk assessment in China. The Lancet Regional Health - Western Pacific. 2021;8:100096. doi:10.1016/j.lanwpc.2021.100096
37. Lindbohm JV, Sipilä PN, Mars N, et al. Association between change in cardiovascular risk scores and future cardiovascular disease: analyses of data from the Whitehall II longitudinal, prospective cohort study. The Lancet Digital Health. 2021;3(7): e434-e444. doi:10.1016/s2589-7500(21)00079-0
38. Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L, Greenlund K, Daniels S, Nichol G, Tomaselli GF, Arnett DK. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. Circulation. 2010 Feb 2;121(4):586-613.
39. Luke DA, Harris JK. Network Analysis in Public Health: History, Methods, and Applications. Annual Review of Public Health. 2007;28(1):69-93. doi: 10.1146/annurev.publhealth.28.021406.144132
40. Michaelson V, Pilato KA, Davison CM. Family as a health promotion setting: A scoping review of conceptual models of the health-promoting family. PLoS One. 2021;16(4):e0249707. Published 2021 Apr 12. doi: 10.1371/journal.pone.0249707
41. Michie, S., van Stralen, M.M. & West, R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. Implementation Sci 6, 42 (2011). https://doi.org/10.1186/1748-5908-6-42
42. Nielsen, J.B., Leppin, A., Gyrd-Hansen, D.e. et al. Barriers to lifestyle changes for prevention of cardiovascular disease – a survey among 40–60-

year old Danes. BMC Cardiovasc Disord 17, 245 (2017). https://doi.org/10.1186/s12872-017-0677-0
43. Nordet P, Mendis S, Dueñas A, et al. Total cardiovascular risk assessment and management using two prediction tools, with and without blood cholesterol. MEDICC Rev. 2013;15(4):36-40. doi:10.37757/MR2013V15.N4.9
44. O'Flaherty M, Buchan I, Capewell SContributions of treatment and lifestyle to declining CVD mortality: why have CVD mortality rates declined so much since the 1960s? Heart 2013; 99:159-162.
45. Ofori SN, Odia OJ. Risk assessment in the prevention of cardiovascular disease in low-resource settings. Indian Heart Journal. 2016;68(3):391-398. doi: 10.1016/j.ihj.2015.07.004
46. Olvera Lopez E, Ballard BD, Jan A. Cardiovascular Disease. [Updated 2021 Aug 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK535419/
47. Ommerborn MJ, Blackshear CT, Hickson DA, et al. Ideal Cardiovascular Health and Incident Cardiovascular Events: The Jackson Heart Study. Am J Prev Med. 2016;51(4):502-506. doi: 10.1016/j.amepre.2016.07.003
48. Oyenuga AO, Folsom AR, Lutsey PL, Tang W. Association of Life's Simple 7 with reduced clinically manifest abdominal aortic aneurysm: The ARIC study. Vasc Med. 2019;24(3):224-229. doi:10.1177/1358863X19829226
49. Paige E, Welsh J, Agostino J, Calabria B, Banks E, Korda RJ. Socioeconomic variation in absolute cardiovascular disease risk and treatment in the Australian population. Prev Med. 2018; 114:217-222. doi: 10.1016/j.ypmed.2018.07.011
50. Pandya A, Weinstein MC, Gaziano TA. A comparative assessment of non-laboratory-based versus commonly used laboratory-based cardiovascular disease risk scores in the NHANES III population. PLoS One. 2011;6(5):e20416. doi:10.1371/journal.pone.0020416
51. Pandya A, Weinstein MC, Salomon JA, Cutler D, Gaziano TA. Who needs laboratories and who needs statins?: comparative and cost-effectiveness analyses of non-laboratory-based, laboratory-based, and staged primary cardiovascular disease screening guidelines. Circ Cardiovasc Qual Outcomes. 2014;7(1):25-32. doi:10.1161/CIRCOUTCOMES.113.000397
52. Park, H., Lee, KS. The association of family structure with health behaviour, mental health, and perceived academic achievement among adolescents: a 2018 Korean nationally representative survey. BMC Public Health 20, 510 (2020). https://doi.org/10.1186/s12889-020-08655-z
53. Peltzer K, Pengpid S. Prevalence, risk awareness and health beliefs of behavioural risk factors for cardiovascular disease among university students in nine ASEAN countries. BMC Public Health. 2018;18(1):237. Published 2018 Feb 13. doi:10.1186/s12889-018-5142-1
54. Prior SJ, Campbell S Patient and Family Involvement: A Discussion of Co-Led Redesign of Healthcare Services J Particip Med 2018;10(1): e5 doi:10.2196/jopm.8957
55. Prior SJ, Campbell S Patient and Family Involvement: A Discussion of Co-Led Redesign of Healthcare Services J Particip Med 2018;10(1): e5 doi:10.2196/jopm.8957
56. Pronk N, Kleinman DV, Goekler SF, Ochiai E, Blakey C, Brewer KH. Promoting Health and Well-being in Healthy People 2030. J Public Health

Manag Pract. 2021;27(Suppl 6): S242-S248. doi:10.1097/PHH.0000000000001254
57. Radan, A., & Ivelić, R. (2021). The impact and contribution of family in the care of patient in the hospital. Cardiologia Croatica, 16(11–12), 330. https://doi.org/10.15836/ccar2021.330
58. Randell Wexler, Adam Pleister, Subha V. Raman & James R. Borchers (2012) Therapeutic Lifestyle Changes for Cardiovascular Disease, The Physician and Sportsmedicine, 40:1, 109-115, DOI: 10.3810/psm.2012.02.1957
59. Ribeiro SB, Souza AMA e, Monteiro ARM, et al. Family Organization in the Care of Pediatric Heart Transplant Patients: The Genogram as an Investigative Tool. Health. 2015;07(11):1409-1418. doi:10.4236/health.2015.711155
60. Rossello X, Dorresteijn JA, Janssen A, et al. Risk prediction tools in cardiovascular disease prevention: A report from the ESC Prevention of CVD Programme led by the European Association of Preventive Cardiology (EAPC) in collaboration with the Acute Cardiovascular Care Association (ACCA) and the Association of Cardiovascular Nursing and Allied Professions (ACNAP). European Heart Journal: Acute Cardiovascular Care. Published online June 25, 2019:204887261985828. doi:10.1177/2048872619858285
61. Roth GA, Mensah GA, Johnson CO, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990-2019: Update from the GBD 2019 Study [published correction appears in J Am Coll Cardiol. 2021 Apr 20;77(15):1958-1959]. J Am Coll Cardiol. 2020;76(25):2982-3021. doi: 10.1016/j.jacc.2020.11.010
62. Saha, Sanjib, Ulf-G Gerdtham, and Pia Johansson. 2010. "Economic Evaluation of Lifestyle Interventions for Preventing Diabetes and Cardiovascular Diseases" International Journal of Environmental Research and Public Health 7, no. 8: 3150-3195. https://doi.org/10.3390/ijerph7083150
63. Saqr M, Alamro A. The role of social network analysis as a learning analytics tool in online problem based learning. BMC Medical Education. 2019;19(1). doi:10.1186/s12909-019-1599-6
64. Souza ÍP de, Bellato R, Araújo LFS de, Almeida KBB de. Genogram and Eco-map as Tools for Understanding Family Care in Chronic Illness of the Young. Texto & Contexto - Enfermagem. 2016;25(4). doi:10.1590/0104-07072016001530015
65. Stanaway JD, Afshin A, Gakidou E, et al. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet. 2018;392(10159):1923-1994. doi:10.1016/s0140-6736(18)32225-6
66. Studziński K, Tomasik T, Krzysztoń J, Jóźwiak J, Windak A. Effect of using cardiovascular risk scoring in routine risk assessment in primary prevention of cardiovascular disease: an overview of systematic reviews. BMC Cardiovascular Disorders. 2019;19(1). doi:10.1186/s12872-018-0990-2
67. Ten things to know about ten cardiovascular disease risk factors. American Journal of Preventive Cardiology. 2021; 5:100149. doi: 10.1016/j.ajpc.2021.100149

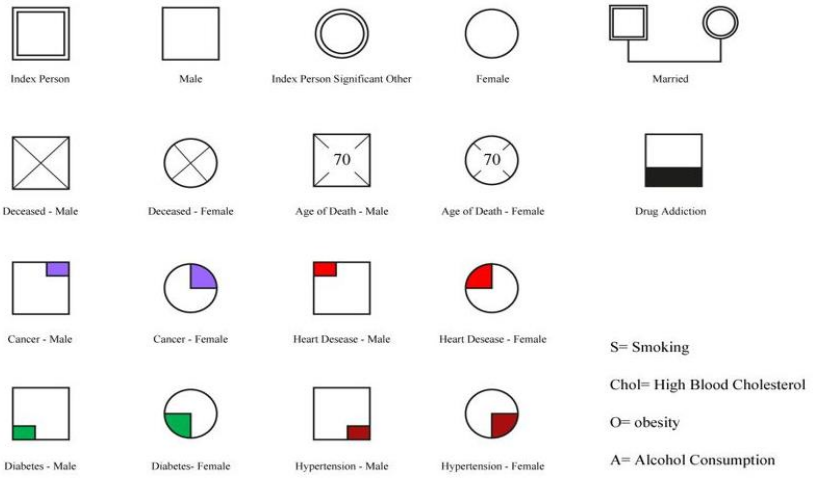
68. Teo KK, Rafiq T. Cardiovascular Risk Factors and Prevention: A Perspective from Developing Countries. Canadian Journal of Cardiology. 2021;37(5):733-743. doi: 10.1016/j.cjca.2021.02.009
69. Thornton RLJ, Yang TJ, Ephraim PL, Boulware LE, Cooper LA. Understanding Family-Level Effects of Adult Chronic Disease Management Programs: Perceived Influences of Behavior Change on Adolescent Family Members' Health Behaviors Among Low-Income African Americans with Uncontrolled Hypertensions. Front Pediatr. 2019; 6:386. Published 2019 Jan 10. doi:10.3389/fped.2018.00386
70. Virani SS, Alonso A, Aparicio HJ, et al. Heart Disease and Stroke Statistics-2021 Update: A Report from the American Heart Association. Circulation. 2021;143(8): e254-e743. doi:10.1161/CIR.0000000000000950
71. Virani SS, Alonso A, Aparicio HJ, et al. Heart Disease and Stroke Statistics-2021 Update: A Report from the American Heart Association. Circulation. 2021;143(8): e254-e743. doi:10.1161/CIR.0000000000000950
72. Virani SS, Alonso A, Aparicio HJ, et al. Heart Disease and Stroke Statistics-2021 Update: A Report from the American Heart Association. Circulation. 2021;143(8): e254-e743. doi:10.1161/CIR.0000000000000950
73. Wang B, Jinsong Li, Hong Y, et al. Effect of Cardiac Rehabilitation Therapy Combined with WeChat Platform Education on Patients with Unstable Angina Pectoris after PCI. M.A B, ed. Journal of Healthcare Engineering. 2022; 2022:1-6. doi:10.1155/2022/7253631
74. Wang S, Petzold M, Cao J, Zhang Y, Wang W. Direct Medical Costs of Hospitalizations for Cardiovascular Diseases in Shanghai, China. Medicine. 2015;94(20):e837. doi:10.1097/md.0000000000000837
75. Wang Y, Xian Y, Chen T, Zhao Y, Yang J, Xu B, Li W. Effect of Lifestyle Changes after Percutaneous Coronary Intervention on Revascularization. Biomed Res Int. 2020 Feb 14; 2020:2479652. doi: 10.1155/2020/2479652. PMID: 32149092; PMCID: PMC7042514.
76. WHO CVD Risk Chart Working Group. World Health Organization cardiovascular disease risk charts: revised models to estimate risk in 21 global regions. Lancet Glob Health. 2019;7(10): e1332-e1345. doi:10.1016/S2214-109X (19)30318-3
77. World Health Organization. (2020) . Hearts: technical package for cardiovascular disease management in primary health care. World Health Organization. https://apps.who.int/iris/handle/10665/333221. License: CC BY-NC-SA 3.0 IGO
78. World Health Organization. Non-communicable diseases. World Health Organization. Published April 13, 2021. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases
79. World Health Organization. Regional Office for South-East Asia. (2013) . Family as centre of health development: Report of the regional meeting, Bangkok, Thailand, 18-20 March 2013. WHO Regional Office for South-East Asia. https://apps.who.int/iris/handle/10665/205062
80. Wölfer R, Faber NS, Hewstone M. Social network analysis in the science of groups: Cross-sectional and longitudinal applications for studying intra- and intergroup behavior. Group Dynamics: Theory, Research, and Practice. 2015;19(1):45-61. doi:10.1037/gdn0000021
81. Yusuf S, Joseph P, Rangarajan S, et al. Modifiable risk factors, cardiovascular disease, and mortality in 155 722 individuals from 21 high-

income, middle-income, and low-income countries (PURE): a prospective cohort study [published correction appears in Lancet. 2020 Mar 7;395(10226):784]. Lancet. 2020;395(10226):795-808. doi:10.1016/S0140-6736(19)32008-2

82. Zubatsky M, Brieler J. A Health Systems Genogram for Improving Hospital Transitions to Primary Care. The Annals of Family Medicine. 2018;16(6):566-566. doi:10.1370/afm.2318

Appendix

1. Medical Genogram symbols used in this study.



2. Group Aa's Medical Genogram.