

Cardiovascular health promotion among Nepalese mothers with young children:

Need assessment, development, implementation, and
impact of the HARDIC trial

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A doctoral thesis at a university in Sweden is produced either as a monograph or as collection of papers. In the latter case, the introductory part constitutes the formal thesis, which summarizes the accompanying papers. These have either been published or are manuscripts at various stages (in press, submitted, or in manuscript).

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To my beloved daughters - Sofia and Polina

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ABSTRACT

Background

Nutritional transition toward a high-fat and high-energy diet, decreasing physical activity level, and poor knowledge about cardiovascular health contribute to a rising burden of cardiovascular disease in low-income countries such as Nepal. Dietary and physical activity behaviors are formed early in life and influenced by family, particularly by mothers in the social context of Nepal.

Aims

This Thesis aimed to understand a community's perception of cardiovascular health from the patients' viewpoint. More specifically, it aimed to assess knowledge, attitude, and practice (KAP) including perceived barriers of mothers with young children regarding their own diet and physical activity and also how mothers perceived their children's behavior. Based on these findings, the Thesis aimed to develop and implement a health promotion intervention tailored to the mothers' needs and assess its impact on mothers' KAP and their children's behavior.

Methods

A mixed methods research approach was applied in the Jhaukhel-Duwakot Health Demographic Surveillance Site (JD-HDSS). Qualitative studies were conducted to identify beliefs, perceived barriers, and level of awareness regarding cardiovascular disease among cardiometabolic patients, and also to explore perceptions of mothers with young children regarding diet and physical activity. A quantitative baseline study evaluated KAP regarding diet and physical activity of all mothers with young children in the study area. A health promotion intervention targeting mothers was developed and applied in the randomly selected intervention area. A follow-up study assessed the impact of the intervention among mothers in the intervention and control areas. A process evaluation was applied throughout the implementation process.

Results

In-depth interviews with the cardiometabolic patients revealed inadequate awareness of cardiovascular disease in the community. Focus group discussions with mothers showed gaps in mothers' perceptions and practices regarding their children's diet and physical activity. The baseline study found that mothers with higher education scored higher for KAP, and children's behavior score reflected their mother's education level. Overall, respondents in JD-HDSS had "good" knowledge, "good" attitude, and "poor" practice (57%, 44.6%, and 90%, respectively). The process evaluation showed that participants were satisfied with course content and the training modality of the intervention. The follow-up study revealed significant improvement in the mothers' KAP and children's behavior in the intervention area compared to the control area.

Conclusions

The successful implementation of the intervention to improve cardiovascular health proves the feasibility of health promotional activities in a Nepalese community.

Keywords: Attitude, cardiovascular disease, diet, health promotion, knowledge, mothers, peer education, physical activity, practice, young children

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SAMMANFATTNING PÅ SVENSKA

Bakgrund: Förändringar i matvanor och fysisk aktivitet tillsammans med dålig kunskap om hjärthälsa bidrar till ökande börda av hjärtsjukdom i låginkomstländer som Nepal. Hur vi äter och rör på oss grundläggs tidigt i barnaåren och påverkas av familjens vanor. I Nepal har särskilt mammorna en viktig roll i sammanhanget.

Syfte: Avhandlingen ville förstå hur samhället ser på och förstår hjärthälsa och har därför undersökt hjärtpatienters samt mammors kunskap om hjärthälsa. Resultaten användes därefter för att utveckla en hälsofrämjande utbildningsinsats, anpassad till mammorna och deras behov. Den hälsofrämjande utbildning genomfördes och dess effekt undersöktes som en förändring av mammornas kunskap, attityd och beteende i relation till hjärthälsa och deras barns beteende.

Metoder: Arbetet utfördes i byarna Jhaukhel och Duwakot utanför Kathmandu. Uppfattningar, upplevda hinder och medvetandegrad om hjärtsjukdom hos hjärtpatienter samt kunskap och förhållningssätt till hjärtsjukdom hos mammor med unga barn undersöktes med kvalitativa metoder. Mammors kunskap, attityd och beteende i relation till hjärthälsa gjordes därefter med kvantitativ metodik. Slutligen utvecklades och genomfördes en hälsofrämjande utbildning i Duwakot (Jhaukhel slumpades till kontroll). Därefter bedömdes hälsoutbildningens effekt och processen hur utbildningen togs fram.

Resultat: Både hjärtpatienter och mammor visade att kunskapen i befolkningen om hjärtsjukdom är låg. Mammornas uppfattning av hjärtsjukdom var inte kopplad till hur de agerade när det gäller barnens kost och fysiska aktivitet. Mammor med högre utbildning hade högre kunskap och bättre attityd och beteende; barnens beteende speglade mammornas utbildningsnivå. I relation till hjärtsjukdom hade 57% av studiedeltagarna bra kunskap, 45% bra attityd och 90% dåligt beteende. Mammorna var nöjda med processen hur hälsoutbildningen hade tagits fram. Hälsoutbildningen hade avsedd effekt; mammornas kunskap, attityd och beteende i relation till hjärthälsa och deras barns beteende förbättrades signifikant.

Slutsats: Den framgångsrika hälsofrämjande utbildningsinsatsen är ett effektivt sätt att förbättra hjärthälsan och kan därmed bidra till framtida minskning av hjärtsjukdom i låginkomstländer som Nepal.

LIST OF PAPERS

This thesis is based on the following papers, which will be referred to in the text by their Roman numerals.

- I. Oli N, Vaidya A, Subedi M, Krettek A.
Experiences and perceptions about cause and prevention of cardiovascular disease among people with cardiometabolic conditions: findings of in-depth interviews from a peri-urban Nepalese community.
Glob Health Action 2014; 7: 24023.
- II. Oli N, Vaidya A, Subedi M, Eiben G, Krettek A.
Diet and physical activity for children's health: a qualitative study of Nepalese mothers' perceptions.
BMJ Open 2015; 5:e008197.
- III. Oli N, Vaidya A, Pahkala K, Eiben G, Krettek A.
Knowledge, attitude and practice on diet and physical activity among mothers with young children in the Jhaukhel-Duwakot Health Demographic Surveillance Site, Nepal.
Submitted
- IV. Vaidya A*, Oli N*, Eiben G, Krettek A.
The Heart-health Associated Research, Dissemination and Intervention in the Community (HARDIC) Trial for Nepalese Mothers regarding Diet and Physical Activity: A Process Evaluation.
(* Equal contribution)
Kathmandu Univ Med J 2017; 58(2):107-116.
- V. Oli N, Vaidya A, Eiben G, Krettek A.
Impact of health promotion regarding diet and physical activity among Nepalese mothers with young children: The Heart-health Associated Research, Dissemination and Intervention in the Community (HARDIC) Trial.
Manuscript

PRELUDE

During my medical university studies in Russia, I was interested in cardiovascular diseases. However, like many medical students, I focused more on the clinical aspect of disease and underestimated the importance of prevention.

In 2005, my shift from Russia to Nepal opened an opportunity to explore another culture and tradition. It was a new experience for me, and I observed and learned many things that were not very important to me before. I found that Nepal has amazing traditional foods, which are healthy and tasty. I felt that combining Nepal's traditional diet with closeness to nature should make people less vulnerable to heart disease and other metabolic conditions. However, Nepal's rapid sociodemographic change also applies to people's lifestyle. It made me really sad to see mothers buying potato chips and other junk food in the morning, before school, and giving them instant noodles almost every day as snacks. Equally heartbreaking was seeing that most small children were developing an addiction to mobile devices. Most parents felt completely fine or helpless about this.

Once, my elder daughter, who was then 5 years old, invited a neighborhood friend to our house. When offered the children homemade cookies, my daughter's friend simply refused to eat them, explaining that she only liked instant noodles and packaged chips. Such situations developed in me a strong will to do something about Nepali children's diet and physical activity on a bigger platform. As a mother of two children, I always try to maintain a healthy lifestyle for my children. I wanted people to realize that not everything about the developed world's modern lifestyle is healthy. Because of globalization, I realized that many food items, which have been present in the Nepalese diet for centuries, are now seen as food for the "poor" while expensive food is promoted as healthy. I was always restraining myself from saying something to mothers who didn't allow their children to play outside or in the sand because they were afraid that the children would hurt themselves or that their clothes would be dirty.

Meanwhile, I completed my Master in Public Health degree in 2011 and started to work at a medical college. There, I began my career in

cardiovascular health, researching the behavioural risk factors of noncommunicable diseases among the urban poor in a slum area of Kathmandu. I also joined the Health Demographic Surveillance Study Site in Bhaktapur, Nepal, which was operated by Kathmandu Medical College and Nepal Medical College in collaboration with the Nordic School of Public Health and the University of Gothenburg, Sweden. Soon, I enrolled in the PhD program at the University of Gothenburg as a part-time student. For my PhD research project, I decided to focus on diet and physical activity among mothers with young children, as mothers are the main role model for their children. Now, I could fulfill my wish to inform mothers about the importance of thinking about children's heart health, beginning in early childhood; teaching them about a healthy diet ;and telling them that their children are not getting smart just because they are learn to play digital games in early childhood.

My almost 5-year PhD journey was enjoyable and challenging at the same time. The major earthquake that hit Nepal in 2015 almost jeopardized my initial plan regarding intervention. I felt that it was inappropriate to teach mothers not to feed their children with junk food when their houses had been destroyed, when they had no choices about food, and when everyone was living with fear of another earthquake. Fortunately, my study area was not affected as severely, and I decided to explore the possibility of continuing with my initial plan. I was happy to learn that mothers were still eager to participate in the intervention.

My biggest reward was seeing local mothers' enthusiasm during training and while teaching their neighboring mothers. I felt a sense of accomplishment when I learned that some of their children stopped eating junk food after the mothers read the training manual.

When I developed the intervention package, I wanted to make it simple enough to be used by local health workers or mothers and applied on a national or sub-national level. I strongly feel that the HARDIC intervention package can be incorporated into PEN, the government's essential package of cost-effective interventions for prevention and control of noncommunicable diseases. It is indeed a positive sign that the Ministry of Health has already shown some interest in that possibility.

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ABBREVIATIONS

CVD	cardiovascular disease
DiD	difference in differences
FGD	focus group discussion
HARDIC	Heart-Health Associated Research, Dissemination and Intervention in the Community trial
HBM	Health Belief Model
HIC	high-income country
IDI	in-depth interview
JD- HDSS	Jhaukhel-Duwakot Health Demographic Surveillance Site
KAP	knowledge, attitude, practice
LMIC	low- and middle-income country
LOC	locus of control
NCD	noncommunicable disease
PEN	Package of Essential Noncommunicable Diseases
SCT	Social Cognitive Theory
WHO	World Health Organization

1 INTRODUCTION

1.1 NONCOMMUNICABLE DISEASES AS A GLOBAL PUBLIC HEALTH PROBLEM

The burden of noncommunicable diseases (NCDs) is rapidly increasing across the world. According to the World Health Organization (WHO), NCDs including cardiovascular disease (CVD), diabetes, chronic respiratory diseases, and cancer are responsible for more than two thirds of deaths worldwide (1). Among these, one quarter is attributed to CVD (2). Decades ago, NCDs were perceived as a problem only in high-income countries (HICs) (3). Today, they are the main drivers of morbidity, disability, and mortality in low- and middle-income countries (LMICs), where nearly 80% of deaths are caused by NCDs (1, 4). Projections suggest that NCDs will increase by more than 50% in LMICs by 2030 (5).

Eliminating common behavioral risk factors such as tobacco use, unhealthy diet, physical inactivity, and the harmful use of alcohol could prevent almost 80% of heart disease, stroke, and type 2 diabetes and over one third of cancers (6). Moreover, metabolic changes (e.g., elevated blood pressure, increased blood sugar and lipids, and obesity) are commonly seen as the outcome of such unhealthy behaviors. Furthermore, coexistence of behavioral and metabolic risk factors in the same person increases that individual's total risk of developing complications of CVD such as heart attacks and strokes (7).

1.2 IMPACT OF DIET AND PHYSICAL INACTIVITY ON CVD DEVELOPMENT

In recent decades, global changes in health-related behaviors such as diet and physical activity have led to an increased prevalence of CVD (8, 9). No doubt, diet has an impact on developing CVD, and dietary modification is seen as important keystone of CVD prevention (3). For instance, low intake of fruits and vegetables attribute to 11% of ischemic heart disease (10). Furthermore, 2.7 million deaths each year are attributed to low fruit and vegetable consumption (3). Moreover, high salt consumption leads to high blood

pressure and cardiovascular risk (11). High consumption of saturated fats and trans fatty acids increases the risk of CVD (12).

Physical inactivity is responsible for 6%–10% of major NCDs such as CVD, type 2 diabetes, and breast and colon cancers worldwide (13). Low physical activity increases the risk of CVD including high blood pressure and diabetes. In fact, the impact of physical inactivity is even higher for ischemic heart disease (30%). Furthermore, physical inactivity accounts for 9% of premature deaths (13). Every year, 1.9 million people die as a result of physical inactivity (3).

1.3 IMPORTANCE OF EARLY PREVENTION OF CVD

In relation to CVD, we usually consider the adult population but rarely think about children as individuals at risk (14). Although morbidity and mortality from NCDs mainly occur in adulthood, exposure to risk factors begins in early life (6). Moreover, environment before birth and in early childhood influences cardiovascular health in adulthood (15, 16). Unhealthy lifestyles do not suddenly appear in adulthood; rather, the foundation is laid early in life. In fact, both healthy and unhealthy habits related to diet and physical activity form in early childhood and continue into adulthood (7, 15). The family food environment is crucial for establishing children's behavior (e.g., dietary habits) (17). The food environment is formed by parental knowledge about nutrition, parents' feeding practices and cooking skills, accessibility and availability of food, and children's individual characteristics (18). Parents, especially mothers in Nepal (19), are responsible for creating a family environment and lifestyle that will affect children throughout life (20). In fact, parent's good knowledge of nutrition associates with healthier diet (i.e., consuming more servings of vegetables and fruits and fewer servings of fried food and sweets). Parental support for physical activity positively associates with children's physical activity (21). Moreover, the alarming rise in both obesity and type II diabetes among children suggests that preventive programs should target the young population (22).

Experiences from HICs show that well-planned, community-based promotion programs can delay death from NCDs such as CVD by several decades, thus

avoiding premature deaths among middle-aged people (14, 23). Compared to interventions for middle-aged populations with short-term outcome, interventions early in life have the beneficial and long-term potential to decrease the CVD epidemic (15, 24, 25).

1.4 LOW- AND MIDDLE-INCOME COUNTRIES FACE EPIDEMIOLOGICAL TRANSITION

Epidemiological transition, defined here as a shift in disease pattern from high burden of nutritional disorders and infectious diseases toward NCDs, is happening in most LMICs (26). While urbanization and industrialization, which improve standards of living and increase services, are mainly responsible for this transition, they also may contribute to health deterioration (27). For example, changing lifestyle in terms of diet and physical activity patterns has already contributed to the rise of CVD in LMICs (28).

Like most LMICs, Nepal, faces a nutritional transition as it shifts from traditional diet to the universal high-energy dense diet (i.e., “western diet”) (8). These changes include increased consumption of fat, especially saturated animal fat, as well as sugar and other refined carbohydrates. The amount of processed food is increasing, and intake of whole grains, fruits, and vegetables, which contain dietary fiber, is decreasing (29, 30).

Apart from dietary pattern, there is also an ongoing shift from labor-intensive occupations and leisure activities toward sedentary work and leisure time. Additionally, availability of new power-operated equipment and devices contribute to increased physical inactivity. Physical activity during travel has declined because people increasingly use automated vehicles rather than walk or cycle (9, 31).

Compared to the gradual changes in HICs, the globalization of dietary changes and increased physical inactivity is occurring much more rapidly (i.e., within a few decades) in LMICs. Along with a high prevalence of other behavioral risk factors such as smoking and alcohol consumption, unhealthy living conditions, and limited access to quality health care, the globalization of diet and inactivity fuels the rising prevalence of CVD in LMICs (14, 32-34).

1.5 CVD AND RISK FACTORS IN NEPAL

Like many other LMICs, Nepal is facing epidemiological transition and experiencing a double burden of communicable diseases and NCDs (35, 36). Among the NCDs, CVDs are the most common cause of hospitalization in Nepal (37). The WHO's STEPwise approach to Surveillance, last conducted in Nepal in 2013, demonstrates a high prevalence of behavioral risk factors among the Nepalese population (38). For example, the majority of adults in Nepal (98%) does not consume the WHO-recommended five servings of fruits and vegetables per day (38). Based on body mass index, 21.6% of Nepalese people are overweight and 4% are obese (38), a three-fold rise in obesity compared to 2008 (39). Between 2008 and 2013, the proportion of people with 3–5 risk factors increased from 0.4% to 15% (38, 39). Additionally, the urban poor show a high prevalence of behavioral risk factors (40).

1.6 NEPAL AND ITS SOCIOGEOGRAPHICAL AND ETHNIC DIVERSITY

Nepal borders India to the east, south, and west and China to the north. It is a landlocked country with a population of approximately 26.6 million (41). A monarchy for approximately 240 years, Nepal became a federal democratic republic in 2008. Geographically, Nepal is divided into three distinct ecological belts: the northern Himalayan Mountains, the middle hills and valleys, and the southern plains (Terai) (42). The capital of Nepal, Kathmandu, lies in the hills of the Kathmandu Valley. The Constitution of Nepal (2015) divided the country into seven provinces, which are further divided into 744 local levels including 481 village municipalities, 246 municipalities, 13 sub-metropolises, and 4 metropolises (43). Wards are smaller administrative units within a village or municipality, and each village and municipality has 9 or 9–35 wards, respectively (42).

According to the latest national census (2011), Nepal has 126 caste or ethnic groups (41). Chhetri is the prevailing caste/ethnic group (16.6%), followed by Brahmin, Magar, Tharu, Tamang, Newar, Kami, Musalman, Yadav, and Rai. Altogether, Nepal has 123 languages. The official language of the country is Nepali and it is the mother tongue of about half of the population (42).

Seventy-six percent of households work in agriculture, making it the country's major occupation. Nepal's Central Bureau of Statistics estimates that the urban population is 59.3% (43). According to the Nepal Living Standard Survey (2010–2011), about 25% of the Nepalese population lives below the poverty line (41).

1.7 HEALTH DEMOGRAPHIC SURVEILLANCE TO SUPPORT CVD RESEARCH IN NEPAL

Nepal lacks consistent and accurate prospective data regarding CVD. To address this issue, our research group established Health Demographic Surveillance System (HDSS) in 2010 in two neighboring villages (Jhaukhel and Duwakot) located in the Bhaktapur district on the outskirts of Kathmandu (44, 45). The Jhaukhel-Duwakot Health Demographic Surveillance Site (JD-HDSS) was established as a collaborative effort between the Nordic School of Public Health NHV, Sweden; Kathmandu Medical College, Nepal, and Nepal Medical College, Nepal (44).

Besides the regular censuses that explore overall health trends in this peri-urban community, several studies conducted in JD-HDSS show a high burden of cardiovascular risk factors (46–48). Women are physically less active compared to men (45.1 % vs. 38.3%) (48). Smoking is more prevalent among men (33.5%) than women (14.7%) (47). Additionally, a majority of the respondents consumes only half of the WHO-recommended five servings of fruits and vegetables per day (46). Such census and other CVD-related data provide an appropriate platform for future interventions to improve health in JD-HDSS.

1.8 HEALTH PROMOTION AND CVD IN NEPAL

Concerned with improving health by influencing lifestyle, health promotion includes health education, creating supportive environments, community participation and empowerment, and building public health policy (49). Considering multiple factors that affect health and the diversities present in the concept of health, several different approaches to health promotion are

feasible, including medical, behavior change, educational, empowerment, and social change (50).

To bring Nepal as close as possible to attaining the Millennium Development Goals, the government had to focus its activities mainly on infectious diseases and maternal and child health issues, with special emphasis on undernutrition (35). Health promotion was an important strategy to successfully reduce mothers' and children's mortality as well as control and even eliminate many infectious diseases (51). However, Nepal is facing a rapid increase in overweight and obesity among adults, children, and adolescents, due largely to unhealthy diet and low physical activity (52-54). Diabetes and hypertension are more common among overweight children compared to children with normal weight (55, 56). Even though CVD have now begun to receive attention from the Nepalese government, most of its efforts focus disproportionately on early diagnoses and treatment (i.e., secondary prevention) and do not prioritize primordial and primary prevention. However, after endorsing the Sustainable Development Goals (SDGs) in 2015 (57), the government has begun to prioritize health promotion for NCDs (58). The Multi-sectoral Action Plan for the Prevention and Control of NCDs (2014–2020) aims to strengthen the health system for NCD prevention and control, emphasizing health promotion and early detection of disease (59). Furthermore, Nepal initiated the Package of Essential NCDs (PEN) in 2016 as a pilot program that includes an essential package of cost-effective interventions for integrated management of diabetes, kidney disease, hypertension, and CVD (60). However, Nepal's health research sector still lacks studies that explore cardiovascular health knowledge, attitude, and practice (KAP) in the communities, an essential starting point for cardiovascular health promotion. Barriers and facilitators for healthy lifestyles are underexplored because most ongoing research (e.g., the WHO STEPs survey) focuses on the manifestation of CVD or their risk factors (35, 38, 39).

As behavioral risk factors are the major contributors to the CVD burden, a behavior change approach that encourages individuals to take responsibility for their own health and adopt a healthy lifestyle is the most appropriate approach for promoting cardiovascular health. Indeed, health promotion programs in Iran and some sub-Saharan African countries demonstrate positive impacts on

behavioral CVD risk factors such as diet and physical activity (61, 62). Past experience from health promotion activities in developed countries shows that targeting the whole population for a heart-healthy lifestyle potentially has greater public health impact compared to strategies that focus on high-risk people (23). Nonetheless, various health promotion approaches that target risk factors such as smoking and alcohol consumption insufficiently combat their high prevalence (38, 63).

Recently, more CVD-related health promotion activities target the community level. For example, a health promotion intervention that featured community-based lifestyle to address hypertension in a Western Nepal municipality efficiently reduced blood pressure (64). However, health promotional activities need greater focus on diet and physical inactivity, which are important risk factors for CVD.

2 AIM

The overall aims of this Thesis were to explore the needs of a Nepalese community regarding heart-healthy diet and physical activity and to develop and assess the impact of a health promotion intervention. The intervention focused on enhancing knowledge and attitude toward healthy diet and physical activity among mothers with young children. This was done not only to enable mothers to improve their own practice but also to promote healthy behavior among their children. Hence, I developed the Heart-Health Associated Research, Dissemination and Intervention in the Community (HARDIC) project, which includes a health promotion intervention that targeted mothers with young children.

The specific aims of this Thesis were to

- understand the community's perception of cardiovascular health from the patients' viewpoint; identify beliefs, perceived barriers, and level of awareness regarding CVD (Paper I);
- explore perceptions of mothers with young children regarding healthy diet and physical activity to increase understanding of the facilitators and barriers to maintaining healthy behavior. Further, to explore the perceived roles of mothers in developing healthy lifestyles for their children and mothers' needs for an intervention (Paper II);
- explore mothers' KAP regarding diet and physical activity, and mothers' perception regarding their young children's behavior toward diet and physical activity (Paper III);
- develop and implement a health promotion intervention regarding diet and physical activity among mothers with young children, and conduct a process evaluation of the program implementation (Paper IV); and
- assess the impact of the intervention on mothers' KAP and children's behavior regarding diet and physical activity by comparing pre- and post-intervention findings (Paper V).

3 CONCEPTUAL FRAMEWORK OF THE THESIS

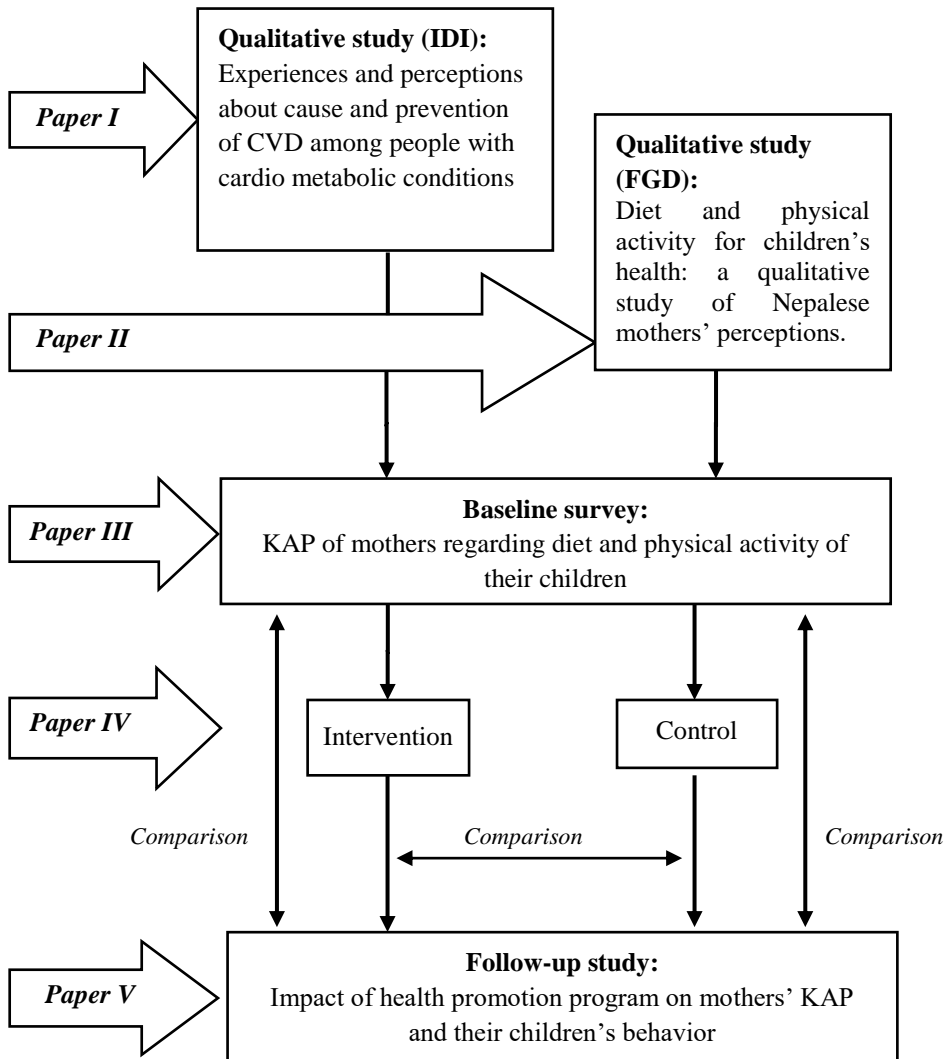


Figure 1. Conceptual framework of the thesis: HARDIC project. CVD, cardiovascular disease; IDI, in-depth interview; FGD, focus group discussion; KAP, knowledge, attitude and practice

4 THEORETICAL FRAMEWORK

Lacking a clear understanding of targeted health behaviors, health promotional programs may not be successful. Hence, researchers must consider health behavior theories adopted from behavioral and social sciences when they plan and implement health programs (65). I applied the peer education concept for developing and implementing the HARDIC health promotion program. It is important that peers in the intervention become empowered and can be role models for other members of the community, motivating them to adopt behavioral changes (66, 67). Importantly, explaining and modifying the health-related behavior of the target population requires an understanding of behavioral theories and concepts.

For the purpose, I applied the individual level theories such as Health Belief Model (HBM), locus of control, perceived control, and Social Cognitive Theory (SCT) (Figure 2) (68). Moreover, after improving mothers' KAP and their children's behavior regarding diet and physical activity, I wanted locally selected and trained peer mothers to disseminate the knowledge and skills to all eligible mothers (fellow mothers) in the intervention community. Therefore, I applied Diffusion of Innovation Theory, which acts at the community level (68).

Health Belief Model

HBM is one of the first and most widely used theories to explain health behavior by understanding individuals' beliefs about health. It was developed by social psychologists in the USA in the 1950s (65, 68). HBM suggests that an individual's willingness (readiness) to modify his/her own behavior is based on the belief that (i) she/he is susceptible to the condition (perceived susceptibility); (ii) the condition has serious consequences (perceived severity); (iii) taking action would reduce susceptibility (perceived benefit); and (iv) the benefits of taking action outweigh the costs or barriers (perceived barriers). Thus, HBM helps address problem behavior by evoking a health concern and motivates individuals to engage in behavioral changes (49, 65).

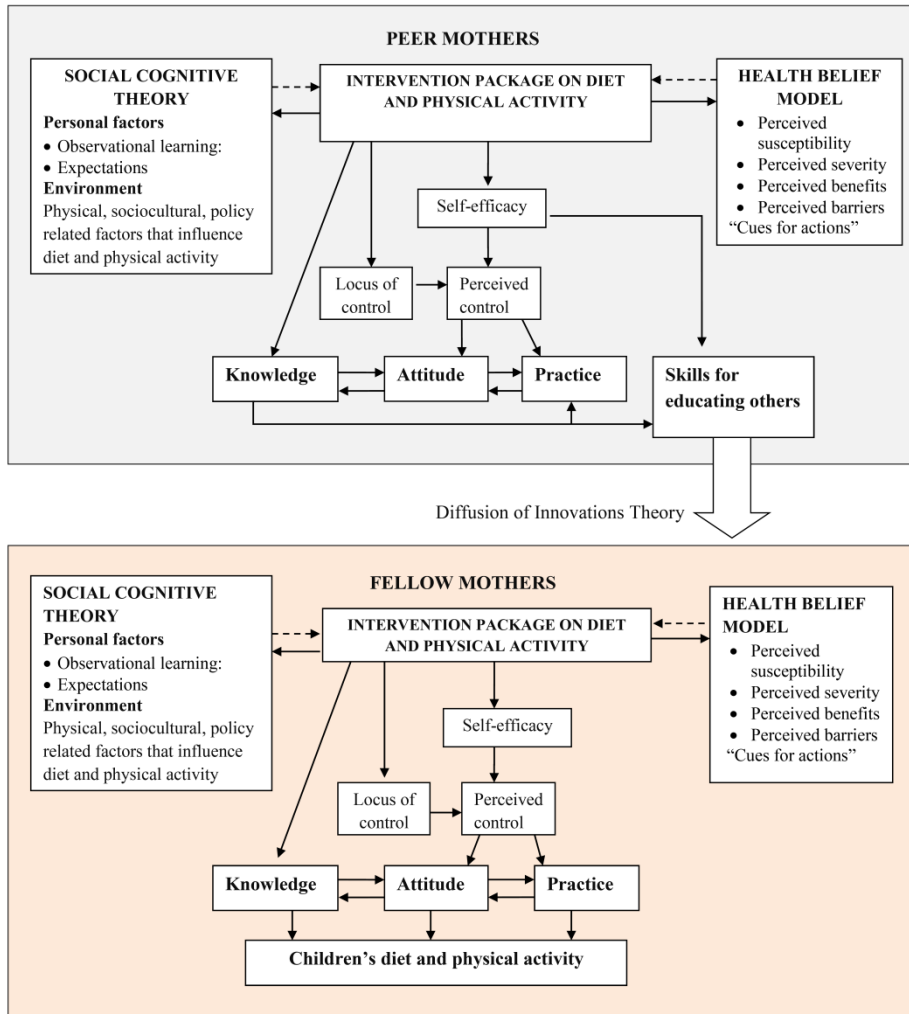


Figure 2. Health behavior theories used in this Thesis.

This figure shows the key role of mothers' knowledge about diet and physical activity and its influence on their self-efficacy through personal factors and environment (SCT) and also through the different constructs of the HBM. In turn, self-efficacy and locus of control directly and indirectly affect mothers' practice regarding children's lifestyle and perceived control, respectively. Knowledge and skills peer mothers obtained from the research team during training will be disseminated to other mothers (Diffusion of Innovations Theory).

Social Cognitive Theory

Developed by Albert Bandura, SCT states that there is an interaction between personal factors of the individual, environmental factors, and human behavior, wherein each influences the other (65, 68, 69). “Observational learning,” an important component of the theory, is the ability to learn by observing the behaviors of others and the rewards received for different behaviors. Among them, self-efficacy (i.e., confidence in one’s ability to take actions and overcome barriers) is an important component (68). Thus, SCT recognizes the importance of social norms, social modeling, and environmental influence on health behavior.

Locus of control

LOC describes individuals’ expectations regarding the effect of behavior on their own health. LOC also implies whether a person believes that her/his health is dependent upon internal or external factors (internal and external LOC, respectively) (70). Individuals are more motivated to change their behavior when they have internal LOC (i.e., they think their health outcomes depend on their own actions). When the individual perceives that reinforcement happens because of actions by “powerful others” or due to chance (i.e., external LOC), she/he is less likely to change her/his behavior. In the context of health behavior, “powerful others” are medical doctors or other health personnel (71).

Perceived control

Perceived control (i.e., the perception that one can take action to get desired outcomes) links with greater likelihood of making behavioral changes. Low personal control can lead to apathy and is less likely to bring positive changes in the individuals’ behavior. In fact, health LOC and self-efficacy are viewed as components of perceived control (72). Self-efficacy refers to the perception that the self has the skills or abilities to enact or be involved in a particular behavior. Hence, people have a sense of perceived control when they believe that they control or change their own behavior (internal LOC) and also have ability to make those changes (self-efficacy) (71, 72).

Diffusion of Innovation Theory

There are two main concepts of the Diffusion of Innovation Theory- diffusion and dissemination. Thus the theory explains the diffusion which is a process for communicating any innovation through certain channels over time among members of the community. On the other hand, dissemination is planned, and systematic efforts are made to maximize the scaling up and adaptation of new program by the community. Some innovation can be diffused fast but some of them are never adopted. Among the factors that influence adaptation of the innovations are characteristics of individuals and settings. Settings such as geographical, societal, cultural, political, and globalization can influence the diffusion process (68).

5 METHODOLOGICAL CONSIDERATIONS

5.1 OVERVIEW OF THESIS PAPERS

An overview of the Thesis papers included in this Thesis is given in Table 1.

Table 1. Overview of Thesis papers

Paper	Design and method	Study participants	Tools	Data collection period	Data analysis
I	Qualitative; IDI	N=13; patients with confirmed heart disease, hypertension, or diabetes mellitus	IDI guideline	May–July 2013	Qualitative content analysis
II	Qualitative; FGD	N=61; women with children aged 5–10 years old	FGD guideline	April–August 2013	Qualitative content analysis
III	Quantitative; cross-sectional	N=962; women with children aged 1–7 years	KAP questionnaire	September–November 2014	Scoring; frequency, median, interquartile range, Chi-square test; Kruskal-Wallis test
IV	Quantitative; process evaluation	47 peer mothers and 391 fellow mothers; women with children aged 1–9 years	Tracking forms, feedback form, immediate impact assessment questionnaire	August–November 2016	Recruitment, participation and completion rates in percentages; McNemar test
V	Quantitative, cross-sectional	N=1276; women with children aged 1–9 years	KAP questionnaire	January – February 2017	Frequency, DiD analysis

DiD, difference in differences; FGDs, focus group discussions; IDI, in-depth interviews; KAP, knowledge, attitudes, practices.

5.2 RESEARCH DESIGN

My Thesis, the HARDIC project, includes needs assessment, development, and implementation of an intervention in the community, and also assesses impact. Implementation of the HARDIC intervention was accomplished through a community-based, randomized, controlled trial on diet and physical activity to promote heart health.

To achieve these objectives, I used a mixed methods approach that includes both qualitative and quantitative studies. Within the mixed methods approach, I chose Exploratory Sequential Design, a two-phase sequential design that starts with qualitative exploration of the topic, followed by a quantitative phase (73). The purpose of two-phase exploratory design is to (i) conduct one or several qualitative studies, and (ii) develop and conduct quantitative research on the basis of the results. Thus, Papers I and II used qualitative methodology. As both papers intended to explore perceptions and beliefs of the community regarding CVD, a qualitative methodology was appropriate. In Paper I, I conducted IDIs with people with previously diagnosed cardiometabolic conditions to explore their perceptions and beliefs regarding their disease, lifestyle, perceived barriers, and facilitators of their disease management. Paper II focuses on mothers with young children. I used FGDs to assess mother's perceptions regarding their children's lifestyles.

Based on the results the qualitative studies in Papers I and II, I designed a cross-sectional quantitative study (Paper III) to evaluate mothers' KAP regarding diet, physical activity, and their perceptions of their children's behavior. Based on the findings the qualitative (Papers I and II) and quantitative (Paper III) studies, I developed the HARDIC health promotion package, which included health education and community participation with empowerment of local mothers. Set at two levels, the HARDIC intervention was based on the peer-education concept. I did process evaluation of the intervention (Paper IV). Next, I conducted another cross-sectional quantitative study (follow-up) in the community to evaluate the impact of the intervention on mothers' KAP and their children's behavior regarding diet and physical activity. I enrolled all eligible mothers in the community to evaluate

dissemination of knowledge and skills obtained through intervention to the rest of the mothers in the community (Paper V).

5.3 STUDY SITE

The studies in this Thesis were conducted in JD-HDSS, which consists of two villages—Jhaukhel and Duwakot—in the mid-hills of the Bhaktapur district, 13 kilometers outside Kathmandu, the capital of Nepal (44). In compliance with its Constitution, Nepal has converted many villages, including Jhaukhel and Duwakot, into municipalities (43). The location of community hospitals run by Kathmandu Medical College and Nepal Medical College in those communities was one of the reasons for choosing this particular site. Also, these communities are a prototype of urbanizing Nepalese communities and could serve as a good setting for CVD-related research.

Jhaukhel and Duwakot are similar in background demographic characteristics such as ethnicity and culture. Most households have piped water, electricity, and modern communication facilities, and a road connects the villages to the Bhaktapur–Kathmandu highway. Compared to data from the 2010 Census, the total population and number of households in the JD-HDSS increased in 2012 due to rising in-migration. Thus, 16,918 people lived in 3,505 households in 2012 compared to 13,669 people and 2,712 households in 2010 (44, 45). A majority of the population at JD-HDSS belongs to the castes Newar (36.5%), Chhetri (30.4%), and Brahmin (23.4%). Nearly 97% of the population follows Hinduism. Less than 11% work in agriculture, 20% are service holders, 25% are students, 2% are unemployed, and the rest have other occupations such as governmental service, temporary work, etc. About one fifth (18.2%) of individuals ≥ 6 years are illiterate. The crude death rate in JD-HDSS is 3.9 per 1,000 populations per year, and NCDs such as hypertension, diabetes mellitus, and cancer are the major causes of death (45). I chose JD-HDSS for the HARDIC trial because previous research there was already related to CVD and its risk factors. Those studies revealed a high prevalence of behavioral risk factors and poor knowledge regarding CVD, and also established a good platform for further health promotion intervention (44-48).

5.4 INTERVENTION

For the intervention, I used a lottery method to randomly select Duwakot and Jhaukhel as the intervention and control communities, respectively. Each village in Nepal is divided into nine administrative clusters (wards). To minimize contamination bias, I selected five wards in Duwakot that did not border the control area (Figure 3). The control area includes all nine wards in Jhaukhel.

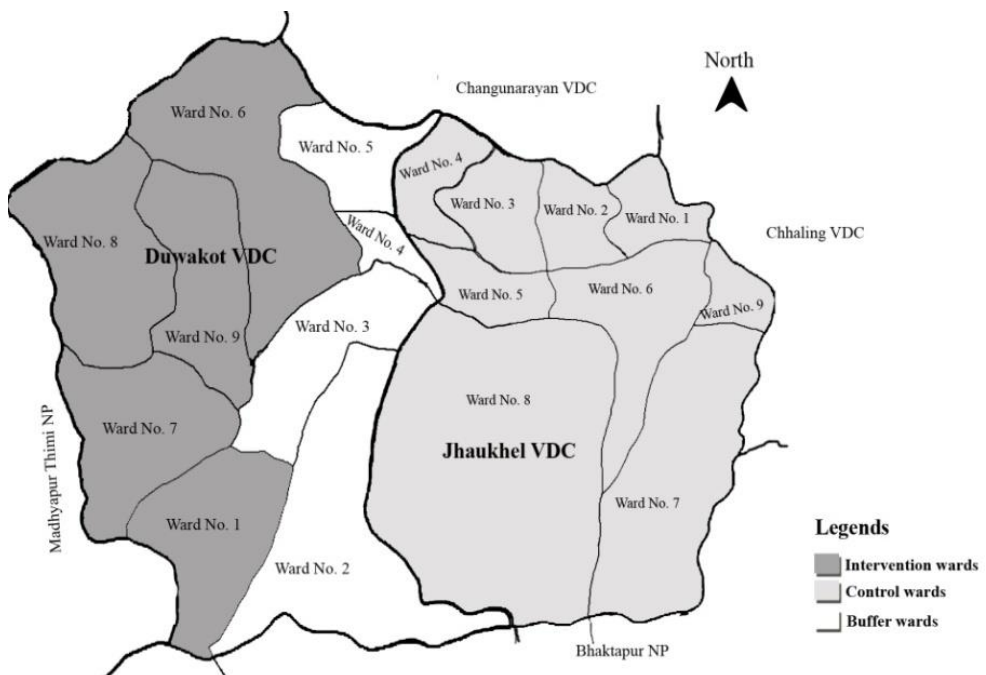


Figure 3. Map of Jhaukhel-Duwakot Health Demographic Surveillance Site: Duwakot- intervention wards (1, 6, 7, 8, and 9) and buffer zone (wards 2, 3, 4, and 5); Jhaukhel-control wards. VDC, village development committee

I developed the HARDIC intervention based on the concept of peer education. From baseline, I identified 440 eligible mothers in the five intervention wards in Duwakot. I decided to recruit 40 local mothers (peer mothers) who would

later conduct health educational classes in their households to teach other eligible mothers (400 fellow mothers) living in the peer mothers' neighborhood in the ratio of 1:10. Considering the possibility of dropouts, I recruited 55 peer mothers for initial training. My recruitment criteria for peer mothers included willingness to participate in the program, availability during the entire intervention period, and communicability. Moreover, I selected mothers from different places in all five intervention wards to ensure that they would cover all eligible fellow mothers from the entire intervention area. I interviewed and recruited mothers with help of local female community health volunteers. Figure 4 illustrates the recruitment and participation of peer and fellow mothers.

Mothers eligible for the intervention had children aged 1–9 years. Because the baseline study preceded the intervention by 2 years, I extended the upper limit of eligible age for children to include all mothers who participated in the baseline. Implementation was delayed due to the major earthquake that hit Nepal in April 2015. Also, I maintained the baseline selection of 1 year as the lower age limit of the children to intervene with the maximum number of mothers with young children who potentially could benefit from the HARDIC intervention. By the end of the training period, all peer mothers had interacted with neighboring eligible mothers regarding the objectives of the intervention and accumulated a list of approximately 10 fellow mothers who were willing to participate in the intervention (educational classes given by peer mothers). Altogether, 47 peer mothers and 391 fellow mothers participated in the intervention.

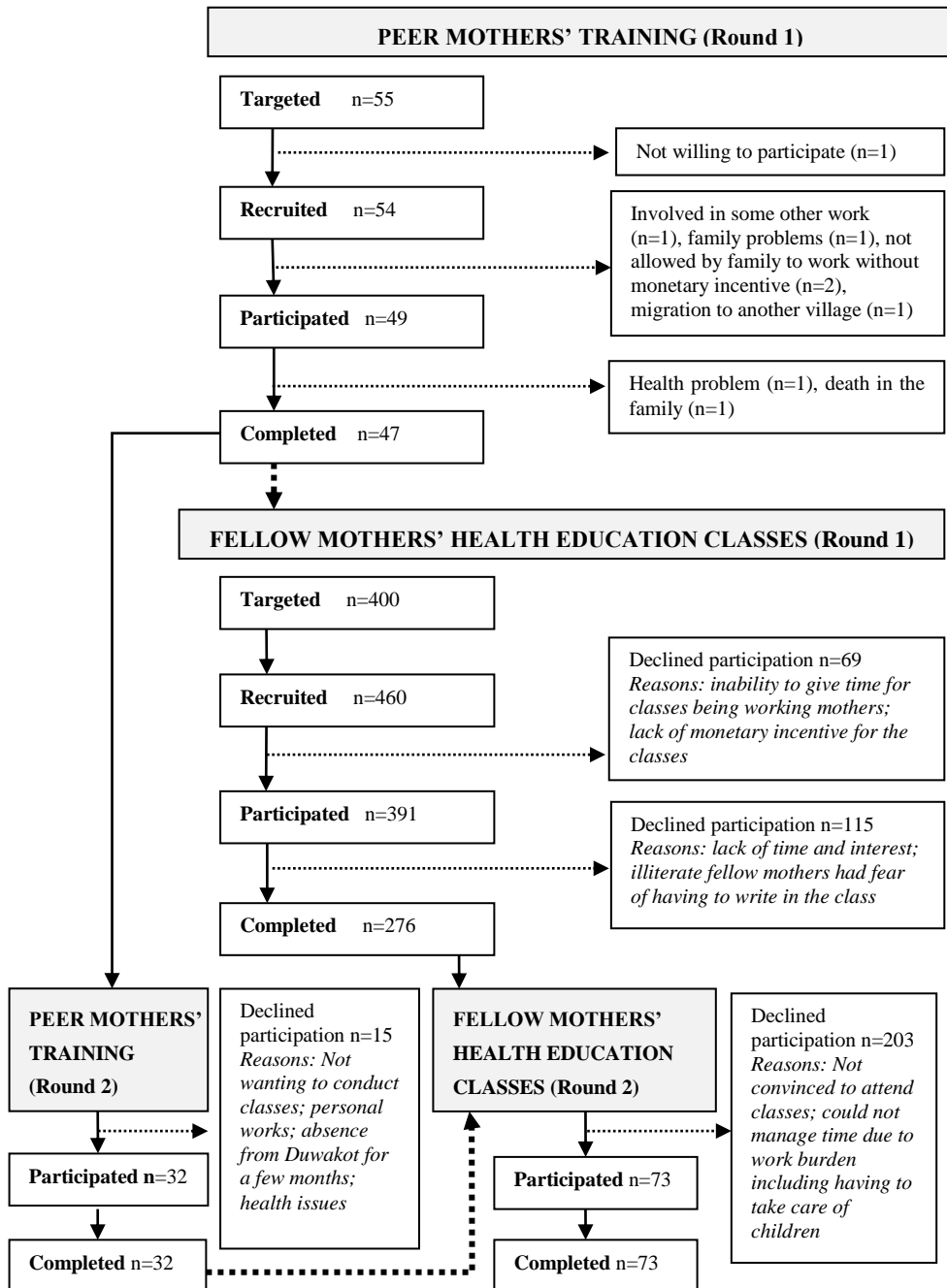


Figure 4. Recruitment and participation of peer and fellow mothers.

Intervention tools development

I developed the HARDIC intervention package with help of national and international guidelines regarding diet and physical activity and with the expertise of our international collaborators (74-76). Moreover, I tailored the intervention package to the local context of Nepal, based on our previous findings with mothers in the community (77, 78). The HARDIC intervention package is a health promotion program that consists of health education with community participation, which is applied to the mothers through the peer education approach.

The health education intervention had seven modules, which covered basic aspects of heart disease, diet, and physical activity. The modules included (i) food and cardiovascular health; (ii) fiber, fruit, and vegetables; (iii) fats; (iv) salt; (v) sugar and soft drinks; (vi) obesity; and (vii) physical activity. I developed a manual, a set of flip charts covering the different modules, and a poster. All health education materials were developed in English and translated into Nepali language.

Intervention implementation

The intervention was divided into two rounds and based on the peer education approach. I planned the intervention in two rounds. In Round 1, local female community health volunteers in each intervention ward in Duwakot selected peer mothers for the intervention, and I finalized the mothers after interviewing them. I divided all selected peer mothers into two groups and, along with my colleague and supervisors, conducted training for 4 hours per day for 6 consecutive days. Each group of peer mothers received similar training during August–September 2016. Training consisted of interactive lectures, practical and demonstration sessions, discussions, group activities, practice sessions, and assignments. The peer mothers also learned about communication skills and practiced using learning materials such as flipcharts. Additionally, we gave home assignments for the 1-month gap between Rounds 1 and 2. We told the mothers to prepare a healthy food for the family for one day and to send healthy snacks to school with their child/children (or at home

in case of vacation). We also asked them to begin a gradual reduction of their children's screen time.

By the end of the training, we asked each peer mother to prepare and finalize a list of approximately 10 fellow mothers who they thought would like to take education classes. With the help of supervisors, peer mothers prepared a schedule for two 1–1.5-hour health education classes per week. Within 2 weeks after completing Round 1, each peer mother conducted four health education classes for fellow mothers of their neighborhood. The health educational classes were based on the same modules that had been used in the peer mothers' training and used the developed flipcharts, posters, and manuals for teaching purposes.

In Round 2 (October–November 2016), we provided peer mothers with a recapitulation of the modules they learned in Round 1. We also discussed the home assignments that peer mothers had been given. Peer mothers followed same pattern when they taught fellow mothers.

5.5 STUDY POPULATION AND SAMPLING

Paper I

For the first qualitative study in which I conducted IDIs, I used purposive sampling to recruit patients with confirmed heart disease, hypertension, or diabetes mellitus who had been diagnosed at least 1 year earlier. Respondents were males and females older than 20 years living in the JD-HDSS for at least 1 year prior to the study. I enrolled only stable patients who were not admitted at the time of the study. Initially, I selected respondents from the KMC Community Hospital register and recruited additional patients through other respondents. None of those who were approached refused to be interviewed. Table 2 shows the demographic characteristic of all 13 respondents.

Table 2. Demographic characteristics of in-depth interview participants

Respondent (R)	Age (years)	Sex	Ethnicity	Education	Occupation	Disease
R1	74	Male	Newar	No formal education	Retired farmer	Hypertension
R2	39	Female	Brahmin	No formal education	Housewife	Hypertension
R3	50	Male	Brahmin	Masters level	Teacher	Valve replacement
R4	58	Male	Newar	Grade 10	Retired government employee	Ischemic heart disease
R5	40	Female	Brahmin	Grade 4	Housewife	Hypertension
R6	70	Female	Newar	No formal education	Housewife	Hypertension
R7	79	Male	Newar	Grade 8	Farmer and traditional healer	Hypertension
R8	45	Female	Newar	No formal education	Housewife	Hypertension and diabetes
R9	62	Male	Chhetri	Grade 10	Ex-army	Hypertension and diabetes
R10	66	Male	Chhetri	Grade 10	Ex-army and homeopathy	Ischemic heart disease
R11	79	Female	Chhetri	No formal education	Housewife	Ischemic heart disease
R12	57	Female	Kirat	No formal education	Shop owner	Arrhythmia
R13	54	Female	Chhetri	No formal education	Farming	Ischemic heart disease

Paper II

Paper II explored the perceptions of mothers with young children regarding CVD prevention and establishing a healthy lifestyle in childhood. Hence, I conducted another qualitative study using FGDs. I enrolled women with school-age children aged 5–10 years, using convenient sampling. Because education influences both knowledge level and perceptions of health (21), I stratified participants into three categories for the FGDs: no formal education, education up to grade 10 (i.e., secondary level), and higher education, (i.e., >

grade 10). Therefore, I conducted 2 FGDs for each education category (altogether 6 FGDs with 61 women). Table 3 shows the characteristics of FGD participants.

To recruit participants, I contacted local health workers in Duwakot and Jhaukhel, who prepared a list of participants covering different localities and education levels. Local health workers met and reminded participants about an FGD the evening before it was held.

Table 3. *Characteristics of participants in focus group discussions*

FGD	Village	Mothers, n = 61	Age range (years)	Mothers' educational status	Children per participant (median)	Age range of children (years)
1	Duwakot	11	23–38	> grade 10	1	3–8
2	Duwakot	12	21–38	< grade 10	2	5–17
3	Duwakot	7	22–36	No formal education	2	4–16
4	Jhaukhel	10	21–36	< grade 10	2	5–15
5	Jhaukhel	12	20–32	No formal education	2	4–18
6	Jhaukhel	9	21–35	> grade 10	1	5–13

Paper III

Based on the qualitative study (Paper II), where mothers reported that they are better able to influence diet and physical activity level in younger children compared to older children, I decided to target mothers with children aged 1–7 years for the baseline and the future intervention. This choice was also supported by the literature (79).

I created a list of all mothers with at least one child aged 1–7 years, using the JD-HDSS 2012 database. I excluded mothers with hearing or mental disorders as well as those with mentally ill children or children whose health condition required a special diet and physical regime. All eligible mothers who were willing to participate were included in the study.

Paper IV

This process evaluation paper analyzed peer and fellow mothers who had been recruited for the intervention (Paper IV). Altogether, 47 peer mothers and 391 fellow mothers had participated in the intervention.

Paper V

This follow-up study, conducted 3 months after the intervention, enrolled all mothers with children aged 1–9 years in Duwakot (five intervention wards) and all wards in Jhaukhel (control area). The study excluded mothers with hearing or mental disorders or those with mentally ill children or children whose health condition required a special diet and physical regime. I also excluded mothers who lived in the community for only 2–3 months due to seasonal work (e.g., in brick kilns).

5.6 TOOLS

Paper I

I conducted IDIs to collect data for Paper I, and I developed an IDI guideline to moderate the interviews. Additionally, I used a digital audio recorder and notepads. I pre-tested the IDI guide on two hypertensive patients (a 39-year-old female and a 74-year-old male) and later included them in the study and its final analysis because only minor changes were needed after the completion of pretesting.

The guide included open-ended questions and started with general questions like:

- *“What does health mean to you?”*
- *“Who do you think is responsible for your health? Why do you think so?”*
- *“Which health problems are more common in your community? Can you explain why?”*

To explore patients' disease history, I used open-ended questions, followed by questions designed to explore the respondents' knowledge and perception about heart disease and risk factors. Examples of such questions include:

- *“Please tell me how you understand heart disease?”*
- *“Why do you think people get heart disease?”*
- *“Do you think physical activity affects health? Can you explain how?”*
- *“Do you think culture (food habits, festivals) affects heart health? Can you explain how?”*

The guide also included questions about respondents' attitude toward healthy lifestyle and behavioral changes post-diagnosis. When required, I asked probing questions to ensure that the objectives of the study were fully addressed.

Paper II

With the help of relevant literature, I developed a guideline for FGDs (80-83). After discussing the content with other team members, I piloted the guideline in Changanarayan, a neighboring community with sociocultural characteristics similar to those of the study area. Necessary corrections were done accordingly. Digital audio recorder and notepads were the other tools used during FGDs.

The guideline focused on mother's perceptions regarding their children's diet and physical activity. It began with open-ended questions regarding mothers' perceptions about healthy behavior in general, and eventually narrowed the discussion toward cardiovascular health-related behavior. The guideline also addressed respondents' perceptions regarding their own role in family health, particularly children's health. Furthermore, it elicited mothers' knowledge regarding healthy food and fast food through questions such as:

- *“How do you understand “fast food”?”*
- *“What would you say are healthy foods? [please mention some examples of healthy food]”*

Similarly, the guideline addressed children's food preferences and physical activity—their likes and dislikes and included open-ended questions about the children's physical activity pattern. Other questions explored mothers' perceived ability to control their children, possible barriers, and facilitators for children's healthy lifestyle. Examples include:

- “Do you think parents (especially mothers) should control children's food choices and consumption?”
- “Do you think you can influence your children's physical activity?”
- “Do you encourage your child to be physically active?”

When necessary, I asked probing questions to ensure that all issues of the guideline were addressed correctly.

Paper III

Based on the results of Paper I, Paper II, and other publications, I developed a structured questionnaire to explore mothers' KAP on diet and physical activity as well as their children's behavior as perceived by the mothers (84, 85). To further clarify the questions, I used pictures with examples of common physical activities in the community.

The *knowledge* section aimed to explore respondents' knowledge of healthy and unhealthy diets, physical activity, and their effects on cardiovascular health. For example, questions regarding knowledge about healthy diet (e.g., “What do you consider to be a healthy dietary habit for you?”) were presented in a multiple response format that included options such as “eating hygienic food irrespective of content,” “eating less sugar/sugary foods,” “using less fat in cooking,” and “consuming more fruits and vegetables,” etc. The knowledge section also included open-ended questions (e.g., “What is junk food?”). The section about knowledge of physical activity included both open-ended and closed questions (e.g., “What is the role of physical activity for our health?”).

To explore mothers' *attitude* toward their own and their children's diet and physical activity, I used the 5-point Likert scale for most questions. I provided different statements on diet and physical activity and asked mothers to choose

between “strongly agree,” “agree,” “neutral”, “disagree,” “strongly disagree.” For example, the food questions included statements such as “healthy food is not tasty;” “healthy food is enjoyable;” “healthy food is for sick people;” “if you love your child, you should please him/her by buying favorite sweets.” Other questions focused on respondents’ attitude toward their children’s diet and physical activity. Furthermore, I asked respondents about perceived barriers that prevent them and their children from eating a healthier diet and being more physically active.

The next section of the questionnaire aimed to explore mothers’ own *practice* and practice toward their children regarding diet and physical activity. Moreover, I studied how mothers perceived their children’s dietary and physical activity behavior. The section about mothers’ physical activity practice was adopted from the GPAQ (86).

To obtain information about mothers’ perception of their children’s diet-related behavior and physical activity, I asked mothers how their children spend pocket money, the type of food children consume as snacks and during main meals, favorite food items and drinks, how often children consume soft drinks or prepackaged juices, how they walk to school, and how much time their children spend watching a screen, etc.

I tailored the questionnaire to the local context and discussed it within our research group. The questionnaire was translated from English into the Nepali language and back-translated to English. Pre-testing of the questionnaire was done for 85 mothers with children aged 1–7 years (9% of the total number of eligible mothers in the study site) in Changunarayan, a neighboring and socioculturally similar village. Necessary changes in the questionnaire were done according the pretesting outcome. Additionally, I checked the questionnaire for internal consistency (Cronbach’s alpha = 0.7).

Paper IV

I conducted through process evaluation during the entire intervention. I prepared several forms to access different components of the evaluation (Table 4). To measure the immediate impact of training on knowledge about diet and

physical activity for peer mothers and fellow mother, I asked them to answer 25 single-answer, multiple choice questions.

Table 4. *Process evaluation components and their brief descriptions*

Context	Description
Fidelity	Larger physical, social, and political environment that either directly or indirectly affects an intervention program
Adherence	Extent to which delivery of an intervention adheres to the protocol or program model as intended by the developers of the intervention
Reach	Proportion of intended priority audience that participates in the intervention
Recruitment	Number of mothers actually recruited (of the total targeted)
Participation	Number of recruited mothers who participated in training/education classes
Completion	Number of peer mothers who completed training/education classes; reasons for withdrawal
Course content	Difficulty; comprehensiveness; best liked/least liked content
Methods	Appropriateness; best liked/least liked method
Program exposure/ dose delivered	Amount of program delivered in relation to the amount prescribed by the program model; number of rounds, number of days per round, number of sessions/classes per day, duration of each session/class
Quality of delivery	Amount of program delivered in relation to amount prescribed by the program model; number of rounds, number of days per round, number of sessions/classes per day, duration of each session/class
Participant respon- siveness	Manner in which participants react to or engage in a program (e.g., participants' level of interest; perceptions about relevance and usefulness; and level of engagement/enthusiasm)
Acceptability, satis- faction, demand	Extent to which a new idea, program, process, or measure was judged as suitable, satisfying, or attractive and likely to be used
Feasibility, sustainability, and scaling-up	Amount/type of resources; factors affecting (ease/difficulty); facilitators/barriers; ability of participants to carry out interventions; carried out with intended participants using existing means, resources, and circumstances and without outside intervention; integrated within an existing system
Immediate Impact	Pre-training assessment, post-training assessment, change between pre-test/posttest, positive/negative effects on target participants

Paper V

To evaluate the impact of the HARDIC intervention on mothers' KAP and their children's behavior regarding diet and physical activity, I used the same questionnaire that I had used during the baseline study (Paper III).

5.7 DATA COLLECTION

Paper I

Data was collected through face-to-face IDIs in JD-HDSS during May–July 2013. I conducted the interviews in the local Nepali language and another PhD student took notes. Altogether, I conducted 13 IDIs with patients and each interview lasted about 1 hour. I explained the objectives of the study and the rights of the respondents. All respondents participated until the end of the study. Repetition of data was considered as the saturation point.

Paper II

Data collection was done in JD-HDSS during April–August 2013. Altogether, I conducted 6 FGDs (61 women). The number of participants in each FGD varied from 9 to 12. Each FGD lasted about 2 hours. All the FGDs were conducted in Nepali language. FGDs were conducted in different settings such as the Duwakot health post, NMC community hospital and the private homes of local health workers.

I started each FGD with general questions (e.g., how many children did the respondents have, children's grades, gender). Even though I had this information before the FGDs started, I found that asking such questions worked well toward building rapport. When necessary, I asked probing questions to explore issues covered in the guideline. All women participated until the end of the discussions. All FGDs were recorded using a digital tape recorder. Furthermore, nonverbal communications and group dynamics were carefully noted by a notetaker.

Paper III

In deference to the traditional and cultural aspects of Nepalese society, I interviewed and recruited nine female enumerators from Duwakot and Jhaukhel. Criteria for recruitment included education (level completed=grade 10 and above) and previous experience in data collection. I also recruited one main supervisor and two field supervisors who were Bachelor in Public Health graduates with previous fieldwork experience. I conducted 3 days of training for supervisors. Thereafter, I and the trained supervisors conducted training on data collection for the enumerators (5 hours per day 6 days).

Using the questionnaire, the enumerators interviewed all listed eligible mothers through door-to-door visits in September–November 2014. If there was more than one eligible mother in a household, enumerators used a lottery method to select one interviewee. If a selected mother was absent during the household visit, the enumerators contacted her by phone and met with her at her convenience.

Paper IV

One main supervisor and three field supervisors continually assisted the mothers and monitored the implementation of the intervention. To assess the immediate impact of health education training on the peer mothers' knowledge, we gave them a questionnaire with 25 questions just before training started. The same questionnaire was used at the end of the training. Similarly, field supervisors used the same questionnaire to assess the knowledge of fellow mothers before and after health education classes administered by peer mothers.

Paper V

I conducted a community-wide follow-up survey in Duwakot (five intervention wards) and Jhaukhel (control area) to assess the impact of the health promotion intervention on mothers' KAP regarding diet and physical activity. I also assessed the potential impact of the intervention on children's diet and physical activity.

I recruited nine enumerators with previous experience in data collection. With assistance from one main supervisor and three field supervisors, I trained the enumerators on data collection for 2 days (4 hours per day). The enumerators conducted door-to-door visits to all households with eligible mothers during January–February 2017. If there was more than one eligible mother in a household, enumerators used a lottery method to select one interviewee. If a selected mother was absent during the household visit, the enumerators contacted her by phone and met with her at her convenience.

5.8 DATA MANAGEMENT AND ANALYSIS

Paper I and II

Data of both qualitative studies (Papers I and II) were present in the tape recordings and notes taken during interviews and discussions. I manually analyzed both qualitative papers using qualitative content analysis (87, 88) and focusing on manifest content (i.e., obvious and visible components). Initially, audio-recorded data were transcribed verbatim and translated from the Nepali language into English. Additionally, notes taken during interviews and discussions were translated and used for analysis. Another PhD student and I read the transcripts separately and repeatedly to obtain a sense of the whole. Both of us analyzed the transcripts separately. To reach a consensus, we discussed the extracted codes, categories, subcategories, and sub-subcategories. Table 5 and Table 6 detail the content analysis for Papers I and II, respectively.

Table 5. *Example of qualitative content analysis showing meaningful units, their condensation and abstraction in Paper I.*

Res-pondent	Meaningful units	Condensed meaningful units	Codes	Sub sub-categories	Sub categories	Categor-ies
R7	Causes of heart disease are smoking and excessive alcohol	Smoking and excessive alcohol cause heart disease	Smoking Alcohol excess	Smoking Alcohol	Risk factors	Heart disease linked to diet and other health behaviors
R13	Festivals affect health and heart due to greater consumption of alcohol and high-fat, spicy, and oily foods.	Festivals affect the heart due to high consumption of alcohol, spices and fat.	Festivals	Effect of tradition and culture	Sociodemo-graphic environment	

Table 6. Example of extracting meaningful units, their condensation and abstraction in Paper II

FGD	Meaningful units	Condensed Meaningful units	Codes	Sub-categories	Categories
1	Fast food is unhealthy and available outside the home (e.g., in restaurants or the market)	Outside food is fast food, which is unhealthy	Fast food is unhealthy	“Outside” food is fast food	Mother’s general perceptions regarding healthy and unhealthy food
5	Healthy food is not tasty and is usually cooked only for sick members of the family	Healthy food is only for sick people	Mothers’ beliefs	Mothers believe that healthy food is not tasty	healthy and unhealthy food

FGD, focus group discussion.

Paper III

Data was entered into Epidata 3.1 software, then transferred and analyzed using SPSS, version 22.0. I scored knowledge questions as 1 and 0 for correct and incorrect answers, respectively. I scored attitude questions from 1 to 5 (from strongly disagree to strongly agree), giving maximum scores for positive attitude about healthy diet and physical activity (89). I converted responses to mothers’ practice regarding physical activity into metabolic equivalent of task (MET)–minutes/week according to the GPAQ Analysis Guide; categorized mothers’ physical activity as high, moderate, or low; and scored them 2, 1 and 0, respectively. Mothers who were sedentary for 3 hours or more per day received 0 points, compared to 1 point for mothers who were sedentary for less than 3 hours per day.

In families with more than one child aged 1–7 years, I selected the oldest child for data analysis of behavior. I also scored children’s behavior. I calculated four composite scores by combining relevant scores—3 for mothers KAP and 1 for children’s behavior. Moreover, I sorted the mothers’ KAP scores into three categories based on the percentage of the maximum possible scores: “poor” (0%–50%), “fair” (51%–75%), or “good” (76%–100%). Similarly, children’s behavior scores were sorted into “poor”, “fair,” or good” categories. The maximum possible scores for mothers’ knowledge, attitude, and practice

were 73, 192, and 17, respectively. The maximum score for children's behavior was 110.

I wanted to determine relationship between mothers' KAP and demographic variables such as age, religion, ethnicity, average monthly household income, mothers' education, and occupation. Moreover, I was interested to see possible associations between children's behavior scores and their mother's level of education, occupation, and household income. Therefore, I applied the Kruskal-Wallis test. I checked data for normal distribution using the Shapiro-Wilk test and found a non-normal distribution. Therefore, I calculated the median and interquartile range (IQR) for KAP scores regarding diet and physical activity and compared the results between Duwakot and Jhaukhel using Mann-Whitney U test. I also applied Chi-squared test to compare categories of KAP scores between both villages. $P < 0.05$ was considered significant.

Paper IV

I used descriptive statistics to analyze demographic variables of peer and fellow mothers who participated in the intervention. As an outcome of process evaluation, I used the recruitment and attendance sheets to calculate the recruitment, participation, and completion rates of the peer and fellow mothers and expressed in percentages. I applied the McNemar test to compare the immediate impact of the training and education classes on mothers' knowledge in pre-test and post-test questions. Feedback regarding training was obtained qualitatively and expressed in text.

Paper V

Data was entered and analyzed using the Statistical Package for the Social Sciences (SPSS), version 23.0 (IBM, Armonk, New York, USA). I scored mothers' KAP responses the same way as for Paper III. I analyzed KAP scores as continuous variables, calculated the median (IQR), and compared the intervention area with control and KAP median (IQR) in the intervention area at baseline and follow-up. Due to non-normal data distribution, I analyzed children's behavior scores using Mann-Whitney U test. Furthermore, I applied

the Chi-squared test to compare the sociodemographic variables of mothers in the intervention and control area at baseline and at follow-up. $P < 0.05$ was considered statistically significant.

The main objective of Paper V was to explore post-intervention changes in diet and physical activity of all eligible mothers in the community as a whole (not individuals). Therefore, using a control group ensured that any unmeasured confounders would not affect mothers' KAP. I assumed that in the absence of our intervention both villages would receive similar health-related information, which is provided by the regular health system of Nepal. Hence, I applied the difference in differences (DiD) model to estimated changes between the villages. DiD is commonly used to evaluate implementation of healthcare programs at the community level (90, 91). I derived DiD estimates from a linear regression model. I compared outcomes at follow-up and baseline between intervention and control areas. The change in outcomes related to implementation of the intervention can be estimated from the difference at baseline and follow-up and also in the intervention area and the difference at baseline and follow-up in the control area. Subtraction of those differences in outcome is the "DiD" that identifies the actual effect of the health promotion program (90).

5.9 ETHICAL CONSIDERATIONS

The Institutional Review Board at KMC gave ethical approval for Paper I. Approval for Papers II–V was given by the Nepal Health Research Council (NHRC) (No. 150/2014). I obtained verbal consent from each respondent in Papers I–V. Notably, community people in Nepal often hesitate to give written consent because they are suspicious that their signatures would be misused. I explained the objectives of the studies to all respondents (Papers I and II); enumerators or field supervisors did the same for Papers III–V. Furthermore, I obtained additional consent for tape recording and notetaking (Papers I and II). Confidentiality and anonymity were ensured during the trial. No external observers were present during data collection (Papers I–V). There were no apparent risks for respondents. Respondents were informed that they were free to leave the study at any time. They could also skip questions that made them

uncomfortable. At the end of the interview or FGD (Papers I and II), I addressed all health-related queries raised by the respondents.

I kept all hard data locked in my office, accessible only to the research team (Paper I–V). Only the research team had access to digital data and notes (Papers I and II). We did not use the names of respondents in any published articles or reports. Digital data was kept in two personal computers—mine and another that belonged to a PhD student who was member of the research team.

Additionally, I provided each respondent with 300 Nepalese Rupees (NPR) (1 USD = 101.6 NPR) as an incentive for participation in the follow-up survey (Paper V). Mothers from the control area received government-published pamphlets on NCDs and behavioral risk factors during the follow-up survey.

6 RESULTS

6.1 Paper I

Experiences and perceptions about cause and prevention of cardiovascular disease among people with cardiometabolic conditions: findings of in-depth interviews from a peri-urban Nepalese community.

I conducted 13 IDIs with patients who had been diagnosed with cardiometabolic conditions for more than one year. I explored patients' perceptions regarding causes and preventability of heart diseases. Table 7 shows examples of quotes from Paper I.

Perceptions about general health, heart disease, and their risk factors

Most respondents valued their health and linked health with ability to work without difficulties, and many believed that health is their own responsibility. However, some respondents thought that health is determined by God. They shared that “sugar” (diabetes mellitus) and “pressure” (high blood pressure) are more common health problems in their community.

All respondents reported risk factors such as unhealthy diet, physical inactivity, smoking, and excessive alcohol consumption for developing heart diseases. However, respondents stated that they became aware of the risk factors only after being diagnosed with heart disease. Respondents considered diet, particularly oily and fatty food, as the main risk factor for heart disease. Although many respondents also mentioned smoking and alcohol as risk factors, they were not sure about the impact these had on health in general and the heart specifically. The respondents also felt that traditional and cultural festivals contribute to the high burden of heart disease because people usually consume more oily and spicy food as well as alcohol during such occasions.

Respondents also linked physical inactivity, body weight, high blood pressure, and stress with heart disease. However, their opinions varied. They also mentioned the impact on in developing heart disease by environmental factors (e.g., pesticides and air pollution caused by nearby brick factories).

Table 7. Examples of quotes from Paper I

Categories	Quotes of respondents
Perceptions about general health, heart disease, and risk factors	<p>R 10: “. . . from doctors . . . I was more aware about heart disease after my diagnosis. Previously I knew about heart disease but . . . I thought . . . I won’t get it so why worry.”</p> <p>R 12: “. . . I think excessive fatty meat (‘boso’) . . . and oil content . . . and fatty diet (‘Chillo khana’) . . . is harmful for heart and health.”</p> <p>R 6: “...Walking around (‘heend-dool’) has good effect on health . . . on heart . . . when we walk daily, it maintains the pressure of our body . . . and we will be free from disease.”</p>
Personal distress, financial difficulties, and family support	R 13: “When my family came to know I had a heart problem they were tense. It was very hard for them to manage money for my treatment, they were also about to sell land for my treatment...”
Lifestyle modifications are well understood but difficult to follow	R 2: “Being a diseased person...there are several hindrances ... In gatherings, I can’t eat as I like due to my disease...”
Awareness of heart disease is too little, too late	<p>R 5: “Only those who have suffered ... talk about heart disease ... the rest of the people are less concerned about it.”</p> <p>R 9: “Awareness should be created among the people ...for example, to the children in school ... to the elderly in a place where they can gather ... to the parents of the children ...”</p>

Personal distress, financial difficulties, and family support

All respondents experienced depression and stress at the time of diagnosis, caused by the necessity of lifestyle modification, lifelong medication, perceived inability to work, and fear of surgery or death. Most of the respondents were well supported by their family. Almost all respondents shared that their disease condition was a financial burden to them and their families.

Lifestyle modifications are well understood, but difficult to follow

All respondents accepted the importance of lifestyle changes, reduced consumption of salt, oily and fatty food, minimizing smoking and alcohol

consumption (if they smoked or drank alcohol), and exercises. However, many felt it was difficult to sustain those modifications for a long time.

Awareness of heart disease is too little, too late

All respondents believed that people in their community do not have adequate awareness about heart disease. They emphasized the importance of community awareness programs that risk factors and promote healthy lifestyle.

6.2 Paper II

Diet and physical activity for children's health: a qualitative study of Nepalese mothers' perceptions.

Concept of health, personal behavior, and healthy/unhealthy food

Respondents shared that health depends on personal behavior and that healthy behavior leads to good health. Many mothers understood healthy behavior as maintenance of personal hygiene and keeping the house, food, and water clean. Some respondents mentioned that smoking, excessive alcohol consumption, and salty and oily food are unhealthy behaviors. In particular, more-educated respondents associated unhealthy food with heart disease. A few respondents felt that to avoid heart disease, people should consume less meat and more fruits and vegetables. Additionally, most knew that pesticides and antibiotics are hazardous to health. However, the respondents did not link lack of physical activity with unhealthy behavior until they were asked probing questions about physical activity. Almost all participants believed that homemade food is healthy, irrespective of preparation, and defined fast food as "all foods which are available outside." Moreover, most of them believed that healthy food is not tasty and hence, it should be cooked only for sick people who had been advised by their doctor to consume less salt, oil, and fat.

Mothers' perceptions about their children's diet and physical activity

Most of the mothers were concerned that their children like fast food, and even if they ate homemade food they preferred it to be oily, spicy, or deep fried. Among children's favorite drinks they mentioned sugar-sweetened carbonated

drinks as well as tetra-packed juices. On the other hand, a few mothers shared that their children prefer healthy homemade food because their family does not consume fast food and also does not encourage children to eat it.

Most of the mothers did not prioritize their children's physical activity. Instead, they put more emphasis on their studies, feeling that playing is an excuse for the children to skip homework. Furthermore, mothers univocally said that it was very common for their children to spend their free time watching cartoons and playing computer games. Many respondents shared that they did not allow their children to play outside for safety reasons.

Perceived self-ability to control children's behavior

All respondents admitted that they are responsible for shaping the lifestyle of their family and children. However, only a few mothers had tried to control their children's fast food consumption and screen time and some felt it was impossible. A few mothers admitted their own fault in their children's fast food preferences and high screen because mothers often chose what was easier over what was better for their children. However, mothers did not say that parents themselves should participate or encourage children to be more physically active.

Perceived barriers and facilitators for healthy lifestyle in children

Mothers mentioned their low decision-making power as a barrier for healthy lifestyle, especially mothers living in joint families. Some respondents shared they have to cook oily, salty, and deep-fried food to accommodate the preferences of elderly family members. Many respondents mentioned grandparents as a barrier because they often spoiled the children by buying them fast food and soft drinks in spite of the mother's effort to give them healthy food. Environmental factors such as food advertisements were also mentioned as barriers by many respondents. Additionally, absence of safe playgrounds in the community was seen as a major obstacle for getting adequate physical activity.

Most respondents felt that improving their knowledge about diet and physical activity would help them develop a healthy lifestyle for their children.

Respondents concluded that early childhood is the right time to develop children’s lifestyle. Table 8 shows examples of quotes from Paper II.

Table 8. *Examples of quotes from Paper II*

Categories	Quotes of respondents
Concept of health, personal behavior, and healthy/unhealthy food	FGD 3: “Drinking habit, smoking habit...they cause heart disease also, it is due to stress...and tension.” FGD 1: “We know that the product that is produced at home is healthy...and market products are unhealthy.”
Mothers’ perceptions about their children’s diet and physical activity	FGD 4: “I have to put extra sugar in his milk...otherwise (he) won’t drink...wants to eat chowmein...doesn’t eat food in the morning and evening [regular main meal]...doesn’t like vegetables...eats fruits, creamy biscuits, ‘chau-chau’[instant noodles]...prefers ‘pasal ko khana’ [ready-made food available in shops] than home-food.” FGD 3: “If they play more, they’ll be injured...[they] can break limbs...so I don’t want them to play outside more...”
Perceived self-ability to control children’s behavior	FGD 4: “I do not know how to stop my child from eating fast food...he doesn’t like rice and vegetables, he always asks for money to buy something outside in the local shops...”
Perceived barriers and facilitators for healthy lifestyle in children	FGD 6: “I know that too much salt and oil in the food is bad for health, but my father-in-law likes such food...and we live with them (in-laws)...so I need to cook this way...” FGD 2: “...we have to teach them before they stop listening to us...at age 7–8 it is already difficult ...” FGD 1: “I think they (in-laws) will listen to me more...if I get some training in cooking in healthy ways”.

6.3 Paper III

Knowledge, attitude, and practice on diet and physical activity among mothers with young children in the Jhaukhel-Duwakot Health Demographic Surveillance Site, Nepal

The enumerators visited 1,062 eligible mothers in the JD-HDSS and invited them to participate in the study. The response rates were 93.5% and 91.8% in

Duwakot and Jhaukhel, respectively. Altogether, 962 mothers (90.6%) completed forms that were used for analysis. Among them, 673 mothers were from Duwakot and 289 from Jhaukhel.

Demographic characteristics

Respondents' median age (IQR) was 29 years (6) in Duwakot and 28 years (6) in Jhaukhel. Almost half of the mothers had been educated through grades 5–10 (48.3%), followed by mothers who completed more than 10 grades (28.9%) and those who completed less than 5 grades (22.8%). A majority of the respondents were housewives (73.3%). About 46% of the mothers reported a monthly household income of 10,000–20,000 NPR (1 USD = NPR 106).

Furthermore, I compared mothers from Duwakot and Jhaukhel according to age distribution, educational status, and religion and found that the distribution was similar in both villages. However, the villages differed regarding mothers' ethnicity, occupation, average monthly income of the household, and type of family ($p < 0.05$).

Mothers' KAP scores

After categorizing the respondents' scores into “poor,” “fair,” and “good” groups, I found that 57% had good knowledge, 45% had good attitude, and most (90%) had poor practice. Table 9 shows the mothers' median (IQR) scores and distribution according KAP categories.

Table 9. Median and Inter-quartile range, and category of mothers according to their KAP scores regarding diet and physical activity

	Maximum possible score	Median (IQR) score	Category of mothers by their KAP scores		
			Poor (<50%)	Fair (50%–75%)	Good (>75%)
Knowledge	73	56 (9)	8 (0.8)	406 (42.2)	548 (57)
Attitude	192	142 (20)	3 (0.3)	531 (55.2)	428 (44.5)
Practice	17	7 (2)	864 (89.8)	98 (10.2)	0 (0.0)

IQR: Inter-quartile range; KAP: Knowledge, attitude and Practice

Additionally, I compared mothers' KAP between the two village components of JD-HDSS. Median (IQR) scores for mothers' knowledge were 57 (10) in Duwakot and 57 (9) in Jhaukhel ($p=0.771$). Median (IQR) scores for attitude were 142 (20) in Duwakot and 143 (18) in Jhaukhel ($p=0.588$). Furthermore, mothers' practice scores were 7 (2) and 7 (2) in Duwakot and Jhaukhel, respectively ($p<0.001$). I observed no significant differences between Duwakot and Jhaukhel regarding mothers' knowledge and attitude and children's behavior. However, more mothers in Duwakot had "poor" practice compared to those in Jhaukhel ($p=0.032$).

Association of mothers' KAP scores with demographic variables

I found that mothers' KAP scores positively associated with their education level and household income. Moreover, analysis showed that mothers who worked as farmers and labors had lower KAP scores, followed by housewives. Table 10 shows the association between KAP score, education, income, and occupation.

Table 10. Association of mothers' KAP scores and their education, income and occupation

Demographic variables	Knowledge mean (SD)	P-value*	Attitude mean (SD)	P-value*	Practice mean (SD)	P-value*
Education (n=962)						
< 5 grade	50.2 (7.3)		129 (13.0)		6.4 (1.4)	
5–10 grade	56 (6.4)	< 0.001	141.9 (13.0)	< 0.001	6.8 (1.4)	< 0.001
> 10 grade	60.2 (4.9)		148.9 (11.0)		7 (1.5)	
Income (NPR) (n=904)[#]						
< 10,000	54.3 (6.8)		137.9 (14.9)		6.7 (1.3)	
10,000–19,999	55.5 (7.6)		140.8 (14.6)		6.7 (1.4)	
20,000–29,999	58.4(6.1)	< 0.001	145 (13.1)	< 0.001	7.1 (1.4)	0.111
30,000–39,999	58.4 (6.1)		145.7 (12.0)		6.9 (1.5)	
> 40,000	58.2 (7.1)		143.9 (13.2)		6.6 (1.7)	
Occupation (n=962)						
Farming	51(6.1)		130 (15.3)		6.5 (0.9)	
Office	61 (4.7)		150.4 (9.5)		7.3 (1.4)	
Labor	50 (7.9)	< 0.001	132.9 (15.4)	< 0.001	6.5 (1.1)	0.001
Self-employed	58.8 (6.0)		144.7 (12.4)		7.1 (1.6)	
Housewife	55.9 (7.0)		141.1 (14.2)		6.7 (1.4)	

*Obtained from an χ^2 test; #NPR, Nepalese rupees (1 USD=NPR 106, approximately)

Mothers' perceived barriers and supportive factors for healthy diet and physical activity

Table 11 lists the most common barriers to healthy diet and physical activity mentioned by mothers.

Table 11. *Mothers' self-perceived barriers to healthy diet and physical activity*

Barriers	%
<i>Barriers to healthy eating</i>	
Healthy food is expensive	71.7
It is difficult to give up food I like	70.0
Taste preference of other family members	69.0
Lack of knowledge on healthy food	68.4
Busy lifestyle	62.6
No cooking skills	60.8
<i>Barriers to being more physically active</i>	
Lack of leisure time	84.4
Caring for children/old people	81.7
Feeling lazy	79.1
Lack of parks and playgrounds	75.6
Embarrassed in front of others	65.6

Children's behavior scores and their association with mothers' demographic variables

There were 444 girls (46.2 %) and 518 boys (53.8%) in Duwakot and Jhaukhel. Median (IQR) score for children's behavior, as perceived by their mothers, was 72 (6). Only four children (0.4%) had "good" behavior, almost all (99.5%) had "fair" behavior, and one child (0.1%) had "poor" behavior regarding diet and physical activity. I found that the children's diet scores increased ($p < 0.001$) and their physical activity scores decreased ($p < 0.001$) in relation to an increase in their mothers' level of education. On the other hand,

monthly household income and mothers' occupation ($p=0.41$ and $p=0.39$, respectively) did not associate with children's behavior.

Correlation between mothers' KAP and children's behavior

I found that mothers' knowledge had a moderately positive correlation with their attitude ($r=0.6$, $p=0.001$). However, mothers' practice weakly correlated with their knowledge ($r=0.2$, $p=0.001$) and attitude ($r=0.2$, $p=0.001$). Moreover, children's diet and physical activity-related behavior correlated poorly with mothers' knowledge ($r=0.009$, $p=0.003$), attitude ($r=0.012$, $p=0.001$), and behavior ($r=0.007$, $p=0.008$).

6.4 Paper IV

The Heart-health Associated Research, Dissemination and Intervention in the community (HARDIC) trial for Nepalese mothers regarding diet and physical activity: a process evaluation

Demographic characteristics of the mothers who participated in the intervention

Among the peer mothers, a majority were Chhetris (59.2%), followed by Newars (26.5%) and Brahmins (14.3%). None of the mothers were from ethnic minority groups. However, among fellow mothers, Chhetris, Newars, and Brahmins constituted 46.0%, 25.6%, and 11.3%, respectively, while the remainder (17.1%) belonged to ethnic minorities including Tamang, Magar, and Rai. Half (51%) of the peer mothers had studied beyond grade 10 compared to 20% of the fellow mothers. One peer mother was illiterate compared to 13.4% of fellow mothers. Almost 60% of the peer mothers and half (51.2%) of the fellow mothers were housewives. Around 29% of peer mothers and 28% of fellow mothers did agro-related work. Among those who owned a personal business or a shop, 12.3% were peer mothers and 10.7% were fellow mothers.

Reach: recruitment, participation, and completion

During implementation of the intervention, I also assessed different components of the process evaluation. I calculated recruitment, participation,

and completion rates (Table 12). Common reasons for dropout among fellow mothers included harvest season, inability to attend classes due to work requirements, lack of monetary incentive for the classes, and fear of having to write in the class as many of the fellow mothers were illiterate.

Table 12. Recruitment, participation, and completion rates of mothers who enrolled in the intervention

	Round I (4 classes)		Round II (1 class)	
	Peer mothers	Fellow mothers	Peer mothers	Fellow mothers
Recruitment rate (%)	98	115*	-	-
Participation rate (%)	91	85	68	26
Completion rate (%)	96	71	100	100

*More than calculated fellow mothers were recruited considering possible dropouts.

Course content, training methods, and materials

A majority of peer mothers (70%) and fellow mothers (75%) found the course content both easy to follow and comprehensive. Furthermore, peer mothers found the training methods (i.e., lectures, practical sessions, and group discussions) either very appropriate (60%) or appropriate (40%) because the important issues were explained in a clear way. All mothers thought that the training manual was either good (55%) or very good (45%) because the manual was written in simple language, making it easy to understand. Likewise, almost all peer mothers (98%) appreciated the flipcharts because they contained pictures and would be very useful for teaching fellow mothers. Fellow mothers also thought that the flipcharts described everything clearly and in a simplified way. Thus, a majority of peer mothers and fellow (90%) mothers were satisfied with the training and classes. Moreover, during training peer mothers identified their own barriers to healthy lifestyle and discussed possible solutions (Table 13). By the end of the training about 57% of peer mothers planned to apply knowledge into practice and felt confident about teaching others.

Table 13. Perceived barriers to healthy diet and adequate physical activity by the peer mothers and solutions contemplated by them to overcome the barriers

Perceived barriers	Contemplated solutions
Diet	
Wide misconceptions	Mothers' awareness; increase awareness among children about junk food because they insist that parents should buy it.
Adverse children's behavior including stubbornness	Bring children with you when visiting the market to buy vegetables and fruits.
Resistance from other family members and guests over taste	Cook food that is suitable to eat by every member of the family, from old to children; provide fruits, lemon juice and water rather than bottled juice to guests and request guests not to bring junk food while visiting.
Social pressure including tendency to show off and copying others	Do not copy others; do not follow advertisement.
Cultural practices	Continue right practices and discourage wrong practices
Junk food provided as a token of love or handed as a prize for achievement	While showing love, promote giving food cooked at home rather than junk food from the market; Parents should not promote children using junk food by saying we will give something when you do your assigned task or after following good work.
Mother's laziness	Cook something healthy and do not serve junk food, even when there is feeling of laziness or tiredness.
Lack of adequate time to cook, particularly when making different kinds of food	Cook breakfast by yourself no matter how busy you are.
Inconvenience in getting healthy food while going out or travelling	Carry fruits and cooked food from home while going outside for a long time.
Unaffordable food/poor socioeconomic status	No immediate solution
Physical activity	
Lack of space to play	Roaming in different places
Lack of safe place to play	Parents should spend time with their children.
Pressure of school homework	Let them experience outside environment.
Stubbornness of children to play with gadgets	Make rules and regulations; make children aware of physical activity and try to gradually involve them in physical activities.
Lack of friends to play with	Try to set an example yourself; involve children in your work
Tendency to show off gadgets, etc., and copying others	Distinguish which is wrong and right; tell stories, jokes, or scientific facts to children instead of making them watch television; slowly decrease wrong practices at home

Immediate impact of the intervention

To measure the immediate impact of the training on knowledge about diet and physical activity for peer mothers, I asked participants to answer 25 single-answer, multiple choice questions. Their answers demonstrated improved knowledge. Similarly, I used the same questions to assess the knowledge of fellow mothers before and after education classes conducted by peer mothers. Moreover, the mothers felt empowered to implement the knowledge into real practice because their self-esteem had been enhanced by the training. During feedback sessions, many peer mothers stated that compared to the past, their children had (i) begun to show less interest in junk food and had started to eat green vegetables; (ii) become conscious of the amount of salt they ate and had started to use less salt and sugar; and (iii) taken up the habit of eating fruit every day.

6.5 Paper V

Impact of health promotion regarding diet and physical activity among Nepalese mothers and their young children: the Heart-health Associated Research, Dissemination and Intervention in the Community (HARDIC) trial.

Study population

Altogether, 962 mothers had participated in the baseline study in JD-HDSS (Paper III). During the intervention phase, the four wards of Duwakot that bordered Jhaukhel were considered a buffer zone to avoid contamination with the control area. This exclusion of four wards reduced the number of eligible mothers available for the follow-up study to 733: 444 in five intervention wards in Duwakot and 289 in all nine wards in Jhaukhel (control area). However, during follow-up I found that the eligible number of mothers had increased to 1,276 (626 in Duwakot and 650 in Jhaukhel) due to the extended age range of eligible mothers and other demographic reasons that are explained in the discussion section.

Thus, the median age (IQR) of the mothers at baseline was 28 years (5) and 30 years (7) at follow-up ($P < 0.001$). Age range was 19–48 years at baseline and

18–48 years at follow-up. I also calculated the median (IQR) age of the children, which was 3 years (3) at baseline and 5 years (4) at follow-up ($P < 0.001$). There were 45.3% girls at baseline, which was not significantly different from the distribution of girls and boys at follow-up.

Change of mothers’ knowledge, attitude, and practice regarding diet and physical activity from baseline to follow-up

After analyzing mothers’ responses to knowledge, attitude, and practice questions, I found that mothers in the intervention area had improved their KAP compared to mothers in the control area. To illustrate this, I calculated percent changes from baseline to follow-up for some of the important questions in Duwakot and Jhaukhel (Figures 5–7).

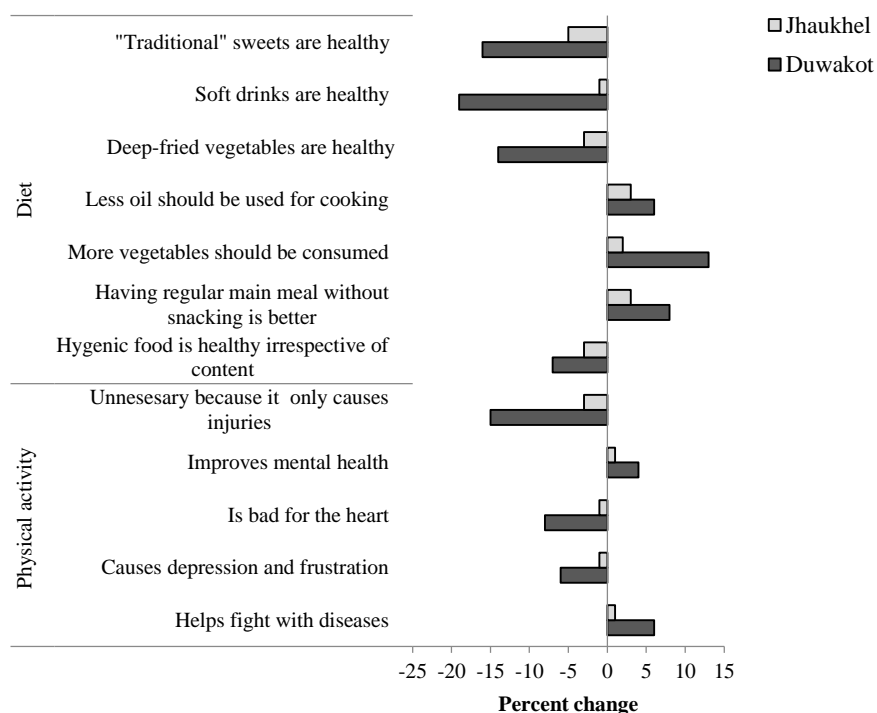


Figure 5. *Percent change in mothers’ knowledge about diet and physical activity in Duwakot and Jhaukhel from baseline to follow-up. “Traditional” sweets are made with flour and deep-fried in oil*

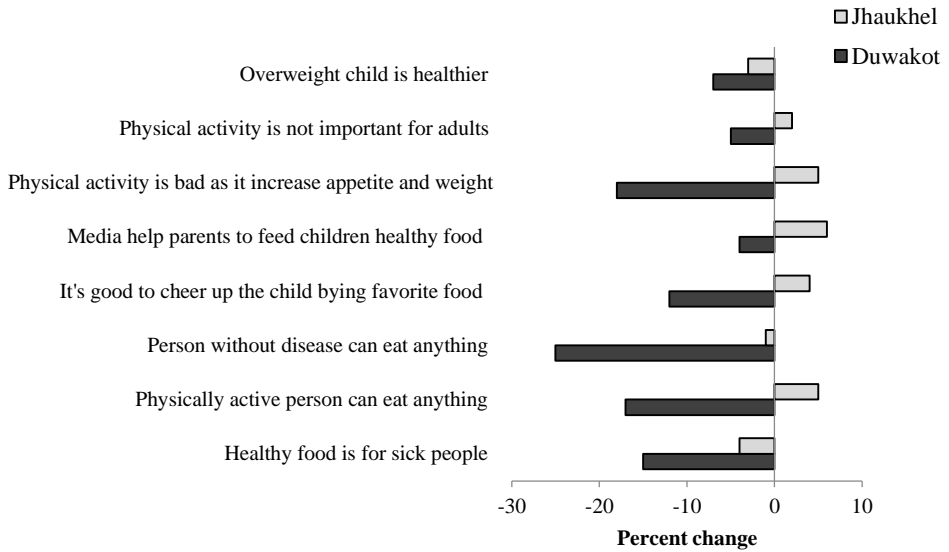


Figure 6. *Percent change in mothers' attitude on diet and physical activity in Duwakot and Jhaukhel from baseline to follow-up.*

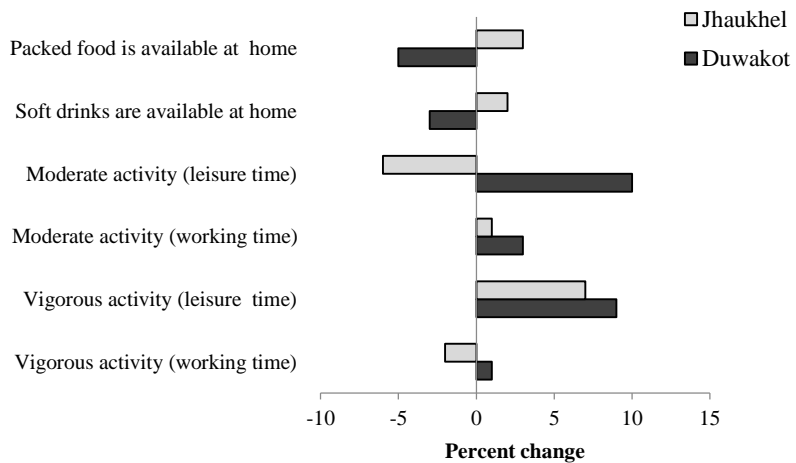


Figure 7. *Percent change in mothers' practice on diet and physical activity in Duwakot and Jhaukhel from baseline to follow-up.*

Mothers' KAP scores

I further analyzed KAP scores as continuous variables. At baseline, the median (IQR) for scores knowledge, attitude, and practice in Duwakot were 56 (10), 141 (22), and 7 (2), respectively. In Jhaukhel, the medians (IQR) for KAP scores were 57 (9), 143 (18), and 7 (2), respectively. The median (IQR) at follow-up for KAP in Duwakot were 62 (9), 150 (19), and 10 (2) compared to 58 (8), 145 (17), and 4 (3) in Jhaukhel.

Additionally, I analyzed KAP scores according to category and found that more mothers improved their KAP on diet and physical activity at follow-up in the intervention area compared to the control area and to baseline. Thus, the percentage of mothers with “good” KAP increased (Table 14).

Table 14. Percentage of mothers with “good” KAP in intervention (Duwakot) and control (Jhaukhel) villages at baseline and follow-up

	Baseline		Follow-up	
	Duwakot, %	Jhaukhel, %	Duwakot, %	Jhaukhel, %
Knowledge	50.5	58.1	81.3	63.2
Attitude	42.6	44.6	63.3	48
Practice	0	0	9.1	0

Children's behavior

To evaluate the potential impact of the health promotion intervention, I compared the children's median behavior scores regarding diet and physical activity in the intervention and control areas at baseline and follow-up. The median (IQR) score of children's behavior in the intervention area remained the same at 72 (7) at baseline and follow-up. The median behavior score (IQR) in the control area was 72 (6) at baseline and 67 (6) at follow-up. Moreover, less than 1 % of the children had “good” behavior in both villages at baseline and follow-up.

DiD analysis of the health promotion intervention's effect

I calculated the effect of the intervention using DiD estimates from a linear regression model (Table 15). Mothers' KAP scores improved significantly in the intervention area compared to control. Based on DiD estimates, children in the intervention area improved their behavior regarding diet and physical activity.

Table 15. *Effect of the health promotion intervention on mothers' KAP and children's behavior scores regarding diet and physical activity*

	Intervention area (Duwakot)		Control area (Jhaukhel)		Impact	
	Baseline mean (SD)	Follow-up mean (SD)	Baseline mean (SD)	Follow-up mean (SD)	DiD	CI (95%)
Knowledge	54.6 (7.5)	61.2 (6.7)	56.2 (6.2)	56.9 (6.0)	5.82	(4.6; 7.0)
Attitude	139.8 (15.3)	148.2 (12.7)	141.7 (13.1)	143.3 (11.6)	6.87	(4.5; 9.3)
Practice	6.7 (1.4)	10.1 (1.8)	7.1 (1.3)	4.5 (2)	5.97	(5.6; 6.3)
Children's behavior	71.6 (4.9)	72.1(5.2)	71.9 (4.7)	67.1 (4.3)	5.22	(4.3; 6.1)

SD: Standard Deviation; DiD: Differences in differences

7 DISCUSSION

In this Thesis, I explored a community's perception of cardiovascular health through two lenses: cardiometabolic patients (Paper I) and mothers with young children (Paper II). Based on the outcome of the needs assessment, I developed and implemented a health promotion intervention package that focused on diet and physical activity and targeted mothers with young children. I also assessed the impact of the intervention on mothers' knowledge, attitude, and practice and on children's behavior as perceived by their mothers (Papers III–V).

Fast changing lifestyle and importance of assessing needs in the community

Rapid epidemiological transition and urbanization in Nepal have caused drastic changes in peoples' lifestyle, an important factor in the growing prevalence of CVD (26-28). Previous studies conducted in JD-HDSS show a high prevalence of CVD risk factors (e.g., unhealthy diet and low physical activity) as well as poor cardiovascular health literacy (46-48). Moreover, rapid urbanization, which both Duwakot and Jhaukhel have faced in recent years, could have a negative impact on the lifestyle of community members and further increase the prevalence of CVD. Indeed, an earlier study emphasized the importance of conducting an intervention in JD-HDSS (47).

Therefore, needs assessment was crucial for JD-HDSS to increase the effectiveness of future intervention programs. Thus, needs assessment identifies clear areas of focus for targeted educational activities to facilitate behavior change in an intervened community (92). Evidence suggests that application of the mixed methods approach for needs assessment by cardiologists in 52 countries provided information about existing gaps and provided insight on how to plan an intervention program more effectively (93). Similarly, the mixed methods approach helped identify gaps in the care of CVD and diabetic patient in South African communities and addressed existing problems (94). Moreover, advantages of mixed methods approach include its ability to simultaneously address both exploratory and confirmatory questions, thus balancing the disadvantages of a single research method (95).

Common misconceptions regarding diet and physical activity in the community

Most respondents in my qualitative studies (Papers I and II) mentioned unhealthy diet, smoking, and alcohol consumption as risk factors for CVD. Other studies describe similar findings (96, 97). However, respondents had misconceptions about what constituted a healthy diet. For example, most mothers thought that all “market food” (i.e., food available in the market, either as fast food or packaged food) is unhealthy and all homemade food is healthy, irrespective of cooking method (Paper II). Similar misconceptions were found among an Iranian population (96). Furthermore, many mothers at baseline (Paper III) emphasized that healthy food meant hygienic food, irrespective of content and preparation. These findings might result from Nepal’s prevalent problems regarding safe drinking water and sanitation, combined with fact that until recently many health programs (e.g., hand washing) in Nepal focused on preventing communicable disease (98, 99).

Evidence shows that mothers across the world have similar misconceptions regarding healthy diet. Although most mothers in my studies (Paper II and III) said that vegetables and fruits should be prevalent in a healthy diet, they underestimated their risk of getting CVD and believed that “healthy food” is only for sick people. Chilean women and a sub-Saharan African population share that perception, which is influenced by traditions, cultural beliefs regarding food, and lack of awareness (100, 101). Additionally, half of the respondents in my study viewed sugar-sweetened carbonated drinks and packaged fruit juice as good for quenching thirst during the summer, and some believed they are healthy for children. Brazilian mothers also think that it is acceptable to give sweetened beverages to children, and some offer sugar-sweetened carbonated drinks to their children before they reach the age of 6 months (102). One of the main reasons for such practice is the rapid expansion and cheap prices of junk food, including sugar-sweetened carbonated drinks, which make it more popular in Brazilian communities. On the other hand, Australian mothers try to avoid sugar-sweetened carbonated drinks and believe that water is the best beverage for their young children (103). However, mothers become more tolerant of giving sugar-sweetened carbonated drinks as children grow because it is very difficult for mothers to resist their child’s preference these drinks. On the other hand, Nepalese society views sugar-

sweetened carbonated drinks and other western food as a symbol of high status and modern lifestyle (104). Such perceptions are fueled by advertisements in the media, which encourage exposing young children to sugar-sweetened carbonated drinks. Moreover, lack of knowledge and understanding of the concept of healthy/unhealthy food makes mothers and their children more vulnerable to external factors such as the effect of media and social/cultural tendencies in the community.

Many respondents in Papers I and II were not clear about the impact of physical activity on cardiovascular health. For example, many mothers did not prioritize physical activity for their children and focused mostly on their children's homework (Paper II). Similarly, some respondents with cardiometabolic conditions did not emphasize physical activity because they did not consider it important (Paper I). Thus, underestimating the importance of physical activity is common, especially due to the belief that only overweight people should be more physically active. This belief is similar to that of parents in the United Kingdom (105). Moreover, other studies show people's belief that normal weight individuals already have enough physical activity (106). Such underestimation of the role of physical activity in health (Paper III) can result from lack of awareness, which is fueled by fact that health personnel and the media usually promote physical activity in the context of the global epidemic of rising obesity. That strategy may create the misunderstanding that others do not need to be physically active. Women from Ghana report similar misconceptions, mostly due to the absence of fitness culture in that country (107).

Role of external locus of control and low self-perceived control for behavior changes

This Thesis also determined that cardiometabolic patients change their behavior toward a healthy lifestyle only after being diagnosed with disease (Paper I). In spite of realizing that their health depended on their own behavior, a majority of respondents in Paper I and Paper II still relied on "powerful others" (e.g., medical professionals) for health-related information and disease management. This reliance suggests widespread prevalence of external LOC

(i.e., external factors beyond a person's own control, such as the environment or a higher power) in JD-HDSS (71).

Considering the fact that CVD is usually perceived as a disease of the adult and elderly population (7), most respondents were not concerned about healthy lifestyle when they were healthy (Paper I). Likewise, mothers did not put adequate effort into controlling their children's unhealthy lifestyle (Paper II). In fact, even those mothers who tried to control their children's diet and physical activity perceived that they had a low level of actual control. Similarly, patients had difficulty modifying their behavior toward a healthier lifestyle after getting advice from a doctor, even though they wanted to (Paper II). This is similar to Norwegian patients who reported being stuck in old habits. For many of them, the problem was that previous attempts to change their lifestyle became barriers to new attempts to change without supervision (108).

The combination of external LOC and low self-efficacy results in a low level of perceived control, which leads to low motivation to enact the behavior of interest (72). This explains low motivation among cardiometabolic patients to improve their health behavior (Paper I) and among mothers to modify their children's lifestyles (Paper II). On the other hand, patients who had a healthy lifestyle prior to diagnosis of disease could follow their doctor's advice about adopting a healthy lifestyle more easily than patients with unhealthy behavior pre-diagnosis. Similarly, mothers who did not consume fast food themselves and did not encourage their children to consume fast food did not report problems in controlling their children's behavior.

Self-efficacy affects behavior changes

One way to increase self-efficacy and motivate change is to improve knowledge (109, 110). During data collection, all respondents in Papers I and II mentioned the importance of health education to enhance cardiovascular health awareness in the community. Indeed, one of the main objectives of this Thesis was to develop a health promotion intervention that focused on improving mothers' knowledge and attitude regarding diet and physical activity. In turn, increased knowledge and improved attitude would influence

self-efficacy through various constructs of the theories described in this Thesis and adapted during the development of the intervention.

For example, according to the HBM applied in Papers I and II, self-efficacy is influenced by perceived susceptibility, severity, benefits, and barriers. Similarly, SCT proposes that personal factors (e.g. observational learning with a capacity to learn by observing others' behavior, rewards received, expectations, and environmental support) affect self-efficacy. Additionally, the prevalent type of LOC in a population affects behavior through perceived control. Thus, improved self-efficacy in a target population is expected to generate desirable behavior changes (110). This hypothesis is strongly supported by existing evidence, which demonstrates that effective early childhood interventions targeting parents and children influence healthy behavior among children (25, 79).

Impact of education on mothers' perception, knowledge, attitude, and practice and children's behavior regarding diet and physical activity

Similar to an earlier study among the adult population in JD-HDSS, my qualitative study (Paper II) found that level of education does not affect mothers' knowledge regarding diet and physical activity (47). I enrolled mothers into different groups according to education level, reasoning that less-educated women are usually from low castes and, considering the Nepalese culture, would not feel comfortable with more educated women from higher castes (19). The only difference was that less-educated mothers had difficulty expressing their opinions in the group because they were unaccustomed to group communications. On the other hand, other studies show an association between KAP scores and education level (111-113).

Similarly, my baseline paper (Paper III) showed that mothers with "good" knowledge had better practice regarding diet and physical activity, which was also reflected in higher KAP scores as education levels increase. Studies among Omani and Dutch mothers support this finding (114, 115). Moreover, I found that less-educated mothers who work as laborers or in agriculture scored lower on knowledge and attitude compared to mothers in other occupations. Such findings also support the effect of education on KAP and its relation to

diet and physical activity. Moreover, Hill Brahmins, Chhetri, and Newar mothers, who traditionally have greater access to education in Nepal (116), scored higher than other respondents.

Likewise, Paper III showed that a mother's level of education influences her children's dietary behavior and physical activity, which was supported by studies from Turkey, Egypt, and other settings (115, 117-119). However, I found that children's physical activity scores decreased as their mother's education level increased, possibly due to lower physical activity of better-educated mothers and their position as role models (120). Furthermore, better-educated mothers have better access to electronic devices that subsequently increase children's screen time and decrease physical activity. Therefore, the association of mothers' KAP and children's behavior scores with mothers' education can be a good point to consider for health education interventions to promote healthy lifestyle in the community.

Poor correlation between mothers' KAP and mothers' KAP with children's behavior due to existing barriers

The baseline paper (Paper III) shows that half of the mothers had "good" knowledge and attitude, but most (90%) had "poor" practice. Existing barriers might prevent mothers' from applying knowledge in practice; an explanation coincides with other studies (121, 122). Similarly, the same reasoning may explain the poor correlation between children's diet and physical activity-related behavior and their mothers' knowledge. Thus, at baseline I explored possible existing barriers that prevent mothers from changing their lifestyle toward healthy behavior, possibly affecting their children's behavior. While developing the HARDIC intervention package, I addressed the perceived barriers found during baseline (123). Moreover, during the training of peer mothers and the education classes of fellow mothers, I encouraged mothers to discuss whether they perceived barriers and if so, asked them to suggest solutions. Such discussions usually help people realize that their peers have similar problems and challenges and that it is possible to achieve a healthy lifestyle (124, 125). Thus, all mentioned activities, including health education regarding diet and physical activity, motivated the mothers to implement into practice the knowledge they received during the intervention.

HARDIC: a community-based health promotion program based on peer education

Based on previous research in JD-HDSS, which identified high prevalence of risk factors and CVD in the community (46-48), I started the HARDIC project with an in-depth understanding of the situation in the community, with particular focus on diet and physical activity. Thus, needs assessment through a qualitative study among mothers revealed the necessity for an intervention program to increase awareness regarding diet and physical activity (Paper II). Some mothers expressed that they prefer receiving health information from doctors and others felt they would be more comfortable communicating with a trained local person. Therefore, I concluded that the development of a health promotion program that included health education training and active involvement of trained local mothers would be able to address the needs of mothers with young children.

In fact, community participation is an effective strategy within health promotion because it empowers people by increasing their self-efficacy, an important component of SCT (69), and motivates them to work together because they feel united and recognize the benefit of their involvement (126, 127). Additionally, other studies show that women with improved self-efficacy are able to overcome perceived barriers more easily than those with low self-efficacy (128). Furthermore, considering the low decision-making power of women in Nepal (19), community participation in promoting empowerment of mothers would create a positive environment for behavioral changes within families (129). Hence, I decided to apply the peer education approach. In fact, peer education has successfully improved knowledge about nutrition and dietary behavior and promoted better maternal and neonatal care practices in rural Nepal and other parts of the world (64, 130, 131). Thus, I selected local peer mothers and trained them regarding CVD, healthy diet, and physical activity. The training I developed emphasized enhancement of educational and effective communication skills for peer mothers to ensure they would be able to educate other mothers in their neighborhood.

Evidence suggests that using behavior theories to develop health promotion programs improves the chance of success in achieving lifestyle changes (68). To achieve HARDIC's aim to address mothers' KAP regarding diet and

physical activity, I incorporated several health behavior theories that target individuals (HBM and SCT) and the community (Diffusion of Innovation Theory) (65). Thus, HBM addressed problem behaviors by evoking a health concern and motivated mothers to engage in behavioral changes through understanding an individual's perceived benefit and barriers as well as focusing on perceived susceptibility and perceived severity. SCT states that there is an interaction between personal factors of the individual, environmental factors, and human behavior wherein each factor influences the other (69). Moreover, I applied Diffusion of Innovation Theory to disseminate knowledge and skills to all mothers with young children in the intervention community through peer mothers (132). Other studies demonstrate successful dissemination of knowledge and skills among mothers based on this theory (64, 133).

While evaluating the immediate impact of the training and health education classes on mothers practice, I asked whether they intended to change own and their children's lifestyle. Theories such as Theory of Planned Behavior explain the intention component more explicitly (65). I did not measure the mothers' self-efficacy, motivation, and perceived control, which might have increased understanding of mothers' attitude and practice changes. Further, social marketing which is an effective strategy to influence voluntary practice of community members can also be applied to bring positive behavior changes in the community through commercial marketing technologies (65).

Positive impact of the HARDIC community-based trial

Overall, the HARDIC intervention was able to reach women in different ethnic groups and with different education levels. All peer mothers were from the three main castes—Brahmin, Chhetri, and Newar. Nonetheless, I was able to achieve a good representation of different ethnic groups among the fellow mothers, including minorities who are usually less educated. I had difficulty convincing low-income mothers to participate in the intervention, a phenomenon described earlier (134). Their participation was important because people with low socioeconomic status have a poorer diet and generally show worse cardiovascular health behavior (40, 135).

Most of the peer mothers were strongly motivated to participate in the training and had good completion rate (overall 65%), which is comparable to a similar trial from another setting (79). In comparison, fellow mothers were less motivated and had a lower completion rate, which also was observed by others (136). This phenomenon is one limitation of the peer approach because dissemination of information from peers to fellows depends on personal qualities of the trained peers, such as leadership and enthusiasm (136). Furthermore, a common reason for fellow mothers' unwillingness to attend and continue with the classes was that they expected incentives for attendance.

While evaluating the immediate impact of the intervention by applying the mothers' pre- and post-tests, I found significant improvement in knowledge for both peer and fellow mothers. Another study also shows intervention effectiveness when assessed soon after implementation (137).

In the follow-up, I found that the HARDIC trial effectively improved mothers' KAP regarding diet and physical activity in the intervention area. Median scores for knowledge and attitude increased from baseline to follow-up, and the number of mothers with "good" KAP scores had increased as well. In contrast to baseline, where no mothers in either village had "good" practice, 9% of mothers in the intervention area (Duwakot) showed "good" practice post-intervention compared to no changes regarding the practice category in the control area (Jhaukhel). Additionally, DiD analysis confirmed findings that KAP scores in Duwakot increased significantly post-intervention compared to Jhaukhel. A study in Iran, where a community-based intervention program improved the nutritional behavior of mothers, young children, and other populations, reported similar positive changes (61). Although a community-based intervention in China did not affect respondents' knowledge and attitude on diet and physical activity, it did report increased consumption of fruits and vegetables and improved physical activity (138). Importantly, I found that education level did not influence the impact of the intervention on mothers' KAP. Irrespective of education level, the intervention program affected all mothers equally well.

Regarding children's behavior, DiD analysis showed improvement post-intervention. However, median (IQR) scores for children's behavior did not

change between baseline and follow-up in intervention area, remaining at 72 (7), improvement was possibly shown by DiD due to lower median scores (IQR) in the control area at follow-up compared to baseline, 67 (6) and 72 (6), respectively. The non-significant changes in children's behavior regarding diet and physical activity could be due to the short gap between intervention and follow-up. On the other hand, my decision to not directly assess the children's behavior, but rather report the mothers' perceptions of such behavior, might have affected the results. Additionally, it is important to conduct an intervention on a regular basis to achieve desired changes and sustain them over time. Another study reported only short-term changes in the children's behavior (139).

8 CONCLUSION

The HARDIC project is unique because it is the first attempt in Nepal to address diet and physical activity among mothers with young children. This focus aimed to enable children to develop healthy lifestyles in early childhood and to simultaneously address the rising CVD burden at the community level. I started the project with needs assessment, conducted a baseline survey, tailored a health promotion intervention to the needs of mothers in the community, and assessed its impact. I decided that a mixed methods design would be the best way to achieve all objectives of my Thesis. I found that an unhealthy lifestyle remains prevalent among adults and children in JD-HDSS. Adult respondents had not perceived themselves at risk until disease developed. Moreover, children were not considered at risk for CVD at all due to their young age. The lack of preparedness for the intervention expressed by respondents and lack of awareness regarding cardiovascular health and warranted a health education program in JD-HDSS.

The HARDIC health promotion intervention, based on peer education and incorporating several behavioral theories, was effective and it improved KAP regarding diet and physical activity. It also demonstrated the potential for future application and scale up by community health workers, volunteers, and/or local women, thereby increasing awareness regarding CVD.

9 FUTURE PERSPECTIVES

As demonstrated in this Thesis, a community-based trial can successfully address misconceptions about CVD and risk factors, lack of skills, and low perceived control among mothers with young children regarding diet and physical activity. My short-term follow-up showed successful effects, and the expected long-term outcome of the HARDIC trial is a reduction in the prevalence of CVD in JD-HDSS. Because evidence suggests that the impact of a single intervention decreases over time, future interventions will be necessary to reinforce the results reported here. It is also important to consider the time and regular rounds of health promotion intervention required to sustain KAP regarding diet and physical activity. Such efforts could be expanded beyond mothers and applied to other community members (e.g., fathers and pupils in school settings). The HARDIC package has the potential for enlargement and adoption by a network of community health workers, volunteers, or local women.

Moreover, this program can contribute to the PEN Initiative in Nepal, which includes health promotion and behavioral changes regarding unhealthy diet and physical activity. However, PEN currently lacks a specific health promotional package. Further, involvement of the education sector, such as community schools, in the health promotion intervention would provide a synergistic way to improve children's behavior by addressing factors that influence the part of their lifestyle beyond family environment. Indeed, to facilitate healthy choices among community members, other components of health promotion (e.g. environment changes) should be considered, along with affordable and accessible health services.

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