Embracing a new beginning: understanding the teachable window for lifestyle change

Brust, M.

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General introduction

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CASE

A 58-year-old patient experienced his first myocardial infarction after years of fatigue, repeated high blood pressure readings, and significantly elevated lipid levels. Despite multiple warnings from his primary care physician to quit smoking for his health, he had never felt a real need to do so. The weeks following his heart attack had a profound emotional impact on him, and especially the distressing image of his scared partner, children, and grandchild by his hospital bed, had really affected him. The cardiologists and nurses reiterated the urgency of quitting smoking, and he now felt himself very receptive to the message. Determined to prevent another heart attack and spare his family from further sadness, he decided to quit smoking altogether. He enrolled in a smoking cessation program and successfully quit smoking, an accomplishment that his primary care physician had considered unlikely prior to his myocardial infarction. The patient experienced his myocardial infarction as a warning and a catalyst for a fresh start. This case serves as a typical example of what is called a "teachable moment" for lifestyle change: the main topic of this dissertation.

CHRONIC ILLNESS, PREVENTION, AND THE ROLE OF LIFESTYLE

Chronic diseases such as diabetes, cardiovascular diseases, and chronic obstructive pulmonary disease are recognized globally as the leading causes of mortality(1). In the Netherlands, for example, a considerable proportion of chronic diseases and the associated healthcare costs can be attributed to an unhealthy lifestyle(2). Behaviors such as an unhealthy diet, smoking, and a sedentary lifestyle may lead to the development of non-communicable diseases within individuals(3). Consequently, promoting healthy lifestyles among the population has become a focus of health care practices over the past decades. The urgency for this is underscored by the fact that individuals who do not smoke, maintain healthy diets, have a normal weight, engage in physical activity, and consume less alcohol, tend to have a life expectancy that is on average 12 to 14 years longer(4). Additionally, they tend to live longer in good health, free from diseases(5).

In the Netherlands, these insights have led amongst others to the establishment of the "Gezond en Actief Leven Akkoord" (GALA), i.e., an agreement between many different public parties aimed at enhancing overall population health through targeted local and regional prevention strategies (Rijksoverheid, 2023). The GALA encompasses a wide array

of population-level interventions to improve healthier lifestyle, including for example the creation of smoke-free zones. These interventions have been proven highly (cost) effective in improving overall population health(6). Furthermore, in the "Integraal Zorg Akkoord" (IZA), i.e., an agreement focusing on ensuring accessibility and affordability of future healthcare, prevention and healthy living play essential roles. Through the IZA, individual preventive measures that focus on lifestyle changes and health literacy are actively encouraged (IZA, 2023). Examples include the provision of lifestyle advice and offering opportunities to participate in lifestyle intervention. Interventions aimed at promoting healthy lifestyles, particularly combined programs that offer intensive patient support, have a high probability of being effective both in terms of health outcomes and health care cost savings(7, 8).

Complying with healthy lifestyle recommendations, however, remains a fair challenge for most people. The widespread poor (long-term) adherence to behavioral recommendations(9) is supported by the limited evidence for sustainability of behavior change in response to interventions(10-12). This is not surprising given the multitude of determinants known to affect health behaviors. In addition to individual factors such as attitude, knowledge, outcome expectancies, self-efficacy, and one's cultural and socioeconomic background (13-16), health behaviors are also greatly shaped by social and environmental factors such as social support, social norms, resource availability for (un)healthy options, such as the proximity of fast-food restaurants in a neighborhood (13, 15, 17-20). This variety of determinants, coupled with the habitual nature of most daily behaviors, presents a challenge for many individuals in initiating and maintaining healthier habits (21, 22). Evaluation of the effectiveness of lifestyle interventions yields inconsistent findings, particularly in view of the long-term adherence (12).

LIFE EVENTS AS TEACHABLE MOMENTS

Changing health behavior is not always the consequence of carefully considered planning. Instead, changes are often triggered by a specific event or experience(23). As a result of such unexpected incidents, people may experience the detrimental consequences of unhealthy behaviors and therefore the urgency of adopting healthier ones. This in turn increases the individuals' desire, willingness, and even the perceived ability to make positive changes to their lifestyle. The term "teachable moments" (24), has been forwarded to describe periods of time after specific events that suddenly increase receptiveness to lifestyle advice and motivation to change behavior (24-27). Teachable moments are mostly significant life - or health events after which individuals realize that the way they

have been living constitutes a serious threat to their health, and may even lead to an early death(25). Spontaneous behavior change triggered by teachable moments differs from the fundamental principles of the 'Stages of Change' theory, which advocates for gradual behavior change resulting from preparation and motivation building(23, 28), a perspective that has faced criticism in the past (29, 30). However, the Health Belief Model (HBM) emphasizes a significant role of cues to action in behavior change(31), which can alter individuals' appraisals of threat and outcome expectations, and in turn may cause an increased motivation to engage in behaviors that reduce the chances of becoming ill (again)(24, 25). Events that bring about teachable moments may work similarly as these cues to action. Examples of events that have been regarded as teachable moments include visits to a general practitioner(26, 32) or emergency department(33), screenings for cancer or cardiovascular disease(34-37), pregnancy, or gestational diabetes (71)(38, 39), a chronic disease diagnosis(40), a diagnosis of cancer(41-43), type 2 diabetes(44), or cardiovascular disease(45, 46), or even a chronic disease diagnosis of a partner(41, 44, 47-49).

INTERVENTIONS AROUND TEACHABLE MOMENTS

According to the so-called "Fresh Start Effect," people are better at achieving behavioral change goals and are more motivated at the beginning of something new(50). Indeed, studies on lifestyle interventions during or after potential teachable moments provide support for the promising role of such timed interventions. For instance, smoking cessation programs for pregnant women are well appreciated and effective, and lifestyle advice following cancer screening is also well-received, particularly when abnormal test results are involved(36). In addition, in a large survey study, adults with a recent chronic disease diagnosis were found to be over three times more likely to quit smoking compared to individuals without new diagnoses(51). Additional support for the concept of teachable moments is provided by West and Sohal(52), who concluded that individuals who quit smoking after an unplanned quit attempt, following an urgent health event, were more likely to remain abstinent from smoking compared to those who had planned to quit at a later date. Moreover, participation in health behavior interventions after a disease diagnosis appeared to be related to the extent to which the diagnosis was perceived as a teachable moment by the patients themselves(53). The examples provide evidence for the potential of teachable moments to help bring about lifestyle change, mostly in the case of quitting smoking.

PSYCHOSOCIAL MECHANISM OF TEACHABLE MOMENTS

As just mentioned, the meaning individuals give to critical situations, such as an acute cardiac event, determines their willingness to adopt healthier behaviors(24, 26, 32). To effectively capitalize on teachable moments in healthcare, it is useful to understand the conditions necessary for certain events to lead to increased motivation for behavior change. McBride et al.(24) developed a conceptual teachable moment framework (Figure 1) to elucidate the psychosocial mechanisms that determine whether an event becomes a teachable moments based on scientific evidence in the field of smoking cessation after a lung cancer diagnosis. The first factor of this framework that determines whether an event will be experienced as a teachable moment is an increased risk perception due to an event(24). This increased perception of risk, combined with outcome expectancies, can encourage individuals to engage in health behaviors, a proposition that is in line with many established health behavior models(31, 54, 55). The second element of the framework involves emotional or affective reactions to an event(24). When there is a strong emotional impact, which can be either negative or positive, it increases the personal focus on the event, making it seem more significant to the individual. As a result, this helps to trigger a teachable moment(24). Third, the framework suggests that a teachable moment can be elicited when an event causes a redefinition of the self-concept, i.e., beliefs about oneself, self-evaluations, and perceived role responsibilities(24, 56). Significant life events that cause changes in an individual's self-concept, identity, or social roles(56-59), e.g., someone may become more aware of their role responsibilities as a parent, grandparent, or partner, after becoming diagnosed with a chronic illness, can increase the motivation to change health behavior(60).

According to McBride's framework(24), whether an event is regarded as a teachable moment that increases someone's willingness to change lifestyle, is thus determined by the extent to which it triggers an increase in risk perception, an affective response, and a re-evaluation and change in self-concept(24). Additionally, the framework underscores the importance of sufficient motivation, lifestyle-related skills, and self-efficacy, to ensure that this willingness translates into actual behavioral change(24). This perspective aligns with existing literature on the intention-behavior gap, as illustrated by a review by Faries et al.(61), which identified factors such as intrinsic motivation and cognitive and behavioral capacity as key facilitators in turning an intention into an actual change in behavior.

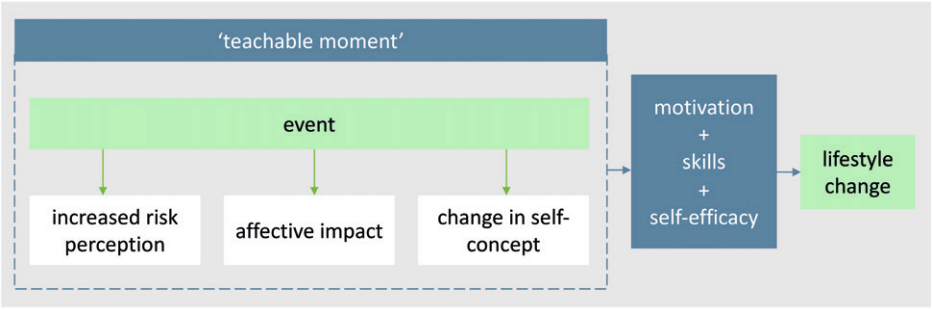

Figure 1. Conceptual teachable moment framework by McBride et al. 2003

About a dozen of studies have empirically tested the applicability of the framework in predicting lifestyle change after important life events. Empirical evidence supports the role of risk perception(38, 39, 44, 53), affect(38, 47, 62), and change in self-concept(38, 39, 44, 47, 62) in facilitating such behavioral changes. However, the majority of these studies have centered among a diagnosis of cancer(47, 53) or pregnancy(38, 39), thus it remains uncertain whether the framework may also be applicable to a broader range of events. Since there is a lack of research thoroughly examining the underlying mechanisms of life events as teachable moments, we do not know as yet how they may interplay, and/or whether other psychosocial factors might also facilitate lifestyle changes following potential teachable moments.

TOWARDS UTILIZATION OF TEACHABLE MOMENTS IN PRACTICE

Healthcare professionals have regular contact with patients around important life events that potentially evoke teachable moments, such as when patients are being newly diagnosed with a chronic disease. This offers a valuable opportunity for healthcare providers to discuss lifestyle at that moment in time when patients are potentially most receptive(25). The manner in which healthcare professionals respond to potential teachable moment situations may greatly contribute to the degree of patient motivation towards positive behavioral change(25, 26). Scholars suggest that teachable moments can be created through an optimal patient-physician interaction(26). Unfortunately, teachable moments situations in healthcare remain underutilized. For instance, a large study across 27 countries indicated –based on self-report data- that dietary advice was often not provided to cardiac patients post-hospitalization(63). Furthermore, in another study in

which the researchers analyzed patient-physician audio recordings in primary care, 30% of the consultations was categorized as missed opportunities for using the event as a teachable moment(26). Patients who had been in a successful consultation exhibited a better recall of health advice and an increased intention to modify their subsequent behavior(32). In another study that explored opportunities to offer spontaneous smoking cessation counseling in patients presented to an emergency department, even 70% of the patient-physician consultations was regarded as a missed opportunity to utilize the teachable moment(33).

Nonetheless, how lifestyle support around teachable moment situations should be offered remains unknown. For instance, it is still unsure what patients themselves require in terms of receiving lifestyle advice after important life events. To develop practices that align with the needs and preferences of patient groups, it is essential to assess their needs and preferences in this regard. Incorporating the patient perspective into the development of behavioral interventions typically leads to more individualized and cost-effective approaches(64, 65). Unfortunately, these patients' needs and preferences often receive insufficient attention; thus, to enhance the utilization of potential teachable moments in healthcare, this thesis includes research on this important aspect .

OBJECTIVE AND OUTLINE OF THIS THESIS

Several important questions on the concept of teachable moments have been understudied, including: Why some patients indeed embrace healthier behaviors after an important life event, but others do not? . When, and under which conditions do patients perceive an event as a teachable moment?(46). Therefore, the first research question of this dissertation is: Can life events serve as teachable moments that suddenly increase individuals' motivation and willingness to improve their health behaviors? Furthermore, exploring the underlying psychosocial mechanisms behind teachable moments could offer insights into why certain life events can turn into a "life changing event". Hence, the second question of this dissertation is: What is the underlying psychosocial mechanism of teachable moments? Are the prerequisites outlined by McBride et al(24) i.e., the impact that the event has on perceived risk, emotional responses, and changes in a person's self-concept, crucial factors, or do other psychosocial factors play a significant role in the mechanism of teachable moments? Lastly, considering prior research suggesting that the utilization of teachable moments in practice remain limited(26, 32), and given the absence of studies and guidelines on how to effectively provide lifestyle support around life events, the third question addressed in this dissertation is: How should potential

teachable moments be utilized, by the provision of lifestyle support around acute life events in a healthcare setting?

This dissertation focuses on cardiovascular disease events as a case study to address the research questions, as they are often suggested to be teachable moments but not yet investigated as such. Tofler et al.(45) and Coull and Pugh(46) have suggested that acute cardiac events can serve as potential teachable moments for smoking cessation and improving physical activity levels. Furthermore, studies have shown substantial lifestyle changes following acute cardiac events, such as the finding that around two third of former smokers remain smoke-free at least 8 months(66) and one year afterwards(45), an increased willingness to modify risk factors(67), a significant increase in physical activity(68), increased fruit and vegetable consumption(63, 69), and reductions in energy intake, salt, fat, and sugar after acute cardiac events(63). We consider acute cardiac events as an ideal case for this dissertation, because it has not been extensively investigated as teachable moments as yet, and because cardiovascular disease patients are the largest patient population in The Netherlands. This choice not only enables us to contribute to the broader understanding of teachable moments but also has the potential to generate practical implications for cardiovascular healthcare.

The studies conducted to answer the research questions are presented in the thesis as follows:

- In **Chapter 2**, we use a quantitative method to address research question 1 (the potential of life events as teachable moments) and research question 2 (the underlying psychosocial working mechanism of teachable moments). The chapter uses a cross-sectional design to explore whether the COVID-19 crisis induced a teachable moment that increased lifestyle change intentions among Dutch cardiovascular disease patients, and, drawing upon McBride's framework(24), investigates whether risk perception, affective impact, and self-concept are associated with increased lifestyle change intentions.
- In **Chapter 3**, we use a qualitative method to address the first two research questions. An Interpretative Phenomenological Analysis approach is adopted to explore how cardiac patients made sense of their myocardial infarction in terms of their lifestyle change (research question 1) and which processes of sensemaking are related to an intention to change lifestyle (research question 2). Hereby, Chapter 3 aims to shed light on the potential of acute life events as teachable moments and the potential psychosocial sensemaking processes that are involved during a teachable moment.

- The lack of validated scales hinders scientific research towards life events as teachable moments. **Chapter 4** therefore describes the qualitative and quantitative development and validation of scales specifically designed to learn more about the potential of life events to evoke lifestyle change intention (Cardiac Lifestyle Change Intention scale) (research question 1) and the characteristics of life events as teachable moments (Cardiac Teachable Moment scale) (research question 2).
- In addition to understanding the potential and underlying mechanisms of life events as teachable moments, it is essential to determine how they can be effectively utilized in healthcare settings to maximize the utilization of teachable moments. **Chapter 5** addresses research question 3 by investigating the perspectives of cardiac patients to explore the optimal timing and manner of delivering lifestyle advice following an acute cardiac event. The chapter employs a combination of qualitative and quantitative research methods.
- **Chapter 6** addresses the research objectives by summarizing and interpreting the findings of Chapter 2-5. The key insights of this dissertation are placed in the broader context of teachable moments in general, and it contains a reflection on how these findings have led to a better understanding of teachable moments for lifestyle. Moreover, the chapter discusses methodological considerations and provides recommendations for future research.

Combined, the chapters of this dissertation offer more insights in the potential of life events as teachable moments, the psychosocial mechanisms that underly the working mechanism of teachable moment, and the optimal utilization of these moments in healthcare. These insights can guide the development of targeted behavior change interventions or communication tools, enhancing the effectiveness of such interventions that capitalize on the potential of teachable moments(70). The findings from this research will provide recommendations for healthcare professionals regarding how to deliver tailored lifestyle advice at the appropriate moment within a healthcare setting. Whilst the chapters focus on acute cardiac events as a case, the overall aim is to obtain insights for life events as teachable moments in general.

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2

The COVID-19 crisis as a teachable moment for lifestyle change in Dutch cardiovascular disease patients

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ABSTRACT

Objective: When lifestyle changes are needed, life events or crises such as COVID-19 may function as 'teachable moments'. This study aimed to explore whether the pandemic can provoke a teachable moment regarding lifestyle change in cardiovascular disease patients.

Method: In this cross-sectional survey study, 830 cardiovascular disease patients reported their intentions to change lifestyle, instigated by the corona crisis, together with risk perception, affective impact, and changed self-concept, based on a 'teachable moments' framework.

Results: Between 8-28% of the sample reported increased intentions to optimize lifestyle behaviors, particularly related to general lifestyle (28%), physical activity (25%), and diet (21%). Multivariate regression analyses revealed that changed self-concept was associated with higher intentions to improve general lifestyle (B= 0.26; CI = 0.19 - 0.33), physical activity (B = 0.23; CI = 0.16 - 0.30), and smoking (B = 0.29; CI = 0.01 – 0.57). In addition, changed self-concept and affective impact were both significantly associated with higher intentions to improve diet (resp. B = 0.29; CI = 0.21 - 0.36 and B = 0.12; CI = 0.04 – 0.21) and to limit alcohol consumption (resp. B = 0.22; CI = 0.13 - 0.30 and B = 0.11; CI = 0.01 - 0.20). We did not find evidence for an important role of risk perception on behavior change intentions.

Conclusion: The COVID-19 crisis evoked a potential teachable moment for lifestyle change in cardiovascular disease patients, driven by a change in a patient's self-concept and to a lesser extent by an affective impact of the COVID-19 crisis. These results suggest an important window of opportunity for healthcare professionals to utilize the pandemic to promote a healthy lifestyle to their patients.

Keywords: COVID-19, lifestyle, behavior change, cardiovascular disease, prevention

INTRODUCTION

The novel coronavirus (COVID-19) outbreak has rapidly emerged as a global health threat in a very short time frame: the first reported case of this respiratory infectious disease was dated in November 2019 and a pandemic was officially declared by the World Health Organization (WHO) in March 2020(1). The number of individuals infected with SARS-CoV-2 has increased rapidly, leading to feelings of uncertainty, worry, and fear among large swaths of the population(2). Evidence is accumulating to support the notion that being a non-smoker, having a healthy nutrition pattern, and engaging in regular physical activity serve as protective factors for adverse health consequences of COVID-19(3-5). Conversely, obesity and smoking are associated with a greater risk of developing severe COVID-19 outcomes, hospitalization, and death(3, 6). These insights suggest the COVID-19 crisis has the potential to be a prompting situation that raises awareness on the importance of adopting a healthier lifestyle, especially for individuals with a history of cardiovascular diseases (CVD), as they are a particularly vulnerable subpopulation with a higher risk of mortality and morbidity during an infection(7, 8).

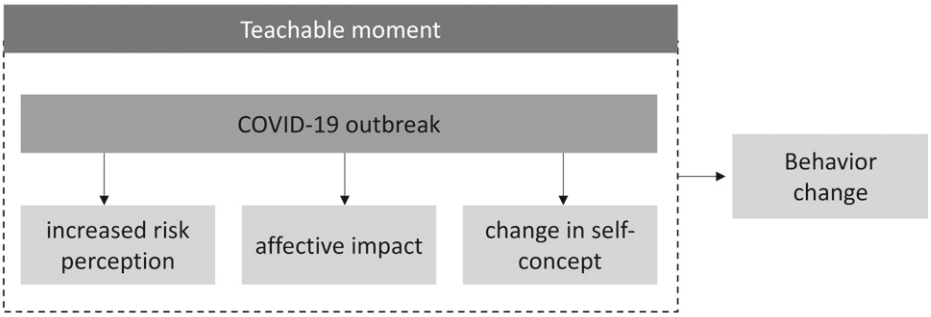
Situations that urge individuals to start living a healthier life are known as 'teachable moments' (TMs)(9, 10). TMs generally arise during or after significant life or health events such as hospitalization, pregnancy, or severe disease diagnosis, any of which may cause an individual to become more receptive to health behavior messages and encourage changes in health behaviors(9, 11-13). According to a conceptual framework proposed by McBride et al.(9), three facilitating characteristics allow life events to serve as effective TMs in terms of instigating health behavior change. First, an event should be characterized by an increase in risk perception. Second, an event must prompt a strong affective or emotional response for it to be perceived as significant and meaningful enough to prompt behavior change. And third, an event must lead to a change in a person's self-concept, in order to evoke the adoption of healthier behaviors. Tofler et al.(14) found evidence for a TM to stop smoking after patients were hospitalized with acute coronary syndrome. One year after hospitalization, the abstinence rate of their study participants remained as high as 61%. Further research is needed to establish whether TMs cause permanent behavior changes in CVD patients or whether new events are necessary to re-activate motivation. Given its novelty, little is known about whether the COVID-19 crisis can function as such a TM.

Although the pandemic may increase willingness towards healthier behaviors, home isolation and psychological strain may also induce unhealthy behaviors such as sedentary behavior, smoking, an unhealthy diet, and excessive alcohol consumption(15-17). This

lifestyle pattern is not only associated with increased mortality and morbidity risk following COVID-19, but may also lead to a worsening of cardiometabolic outcomes(4, 5). With 1.7 million Dutch CVD patients in 2019, cardiometabolic disorders are the most common type of chronic diseases in the Netherlands, and even the leading cause of death globally(18). Because of this high prevalence, it is very important and relevant to understand how the COVID-19 crisis influences motivation for a healthy lifestyle among CVD patients.

The aim of our study is to investigate whether the COVID-19 crisis has provoked a TM in Dutch CVD patients. We also explore whether a TM, if it occurs, is related to perceived risk perception, affective or emotional impact, and change in self-concept resulting from the COVID-19 crisis (Figure 1). These are key factors derived from the TM framework proposed by McBride et al.(9), but have never been empirically tested in relation to the COVID-19 crisis. Insights into these facilitating factors that turn the COVID-19 crisis into a TM could inform health promotion approaches during the development of tailored (online) lifestyle counselling interventions, and may as such further the optimization of lifestyle behaviors of CVD patients during or after the pandemic. We hypothesized that the COVID-19 crisis would lead to a TM, increasing both motivation to improve lifestyle behaviors and awareness of the importance of a healthy lifestyle.

Figure 1. Conceptual framework based on McBride et al.(9).



METHODS

Study design and participants

For this cross-sectional survey study, we used the online survey software program Qualtrics (www.Qualtrics.com). Recruitment and data collection took place during a 14-day window from May 5th, 2020 through May 19th, 2020. Individuals who were 18 years or older with a history of cardiometabolic diseases were eligible to participate in the study. Data collection

was completely anonymous. The majority of participants were recruited via Harteraad, the national Dutch patient association for individuals living with CVD. This patient association comprised at the time of data collection a total of 2606 CVD patients with diverse sociodemographic characteristics. All members of the patient association were invited to voluntarily participate in the study through an e-mail that was sent by the organization of Harteraad. In addition, participants were recruited via the first authors' personal social media (Facebook) channel. We confirmed whether participants were eligible to participate on the first page of the questionnaire, where they could specify their history of CVD. We chose these recruitment methods to approach as large a cohort as possible throughout the country, to obtain a broad insight into behavior change intentions during the COVID-19 crisis. By approaching members of the largest national patient association for individuals living with CVD, we aimed to recruit a representative sample of the general Dutch CVD population. All participants could access the online questionnaire by clicking on an anonymous link in the e-mail and social media post. After providing online informed consent on the first page of the questionnaire, participants could start the survey. The Medical Ethics Committee of Leiden University Medical Center approved and registered the study (METC-nr 18-112).

Measures

Intentions to optimize lifestyle as a result of the COVID-19 crisis were assessed using subscales from a larger survey, developed and validated using a different sample of CVD patients, aimed to construct a valid scale for assessing TMs related to lifestyle change. The survey statements were reframed to make them applicable for the current study (e.g. 'My heart attack has made me realize that a healthy lifestyle is important to me' was reframed as 'The corona crisis has made me realize that a healthy lifestyle is important to me'). Exploratory factor analyses and reliability analyses (results presented in Supplementary Material 1) on the current data led to the final scales presented in Supplementary Material 2. We separated intentions to change health behaviors, due to the COVID-19 crisis (i.e. TMs), by assessing four-item subscales related to TM for general lifestyle ($\alpha = 0.84$), dietary behavior ($\alpha = 0.89$), physical activity ($\alpha = 0.78$), and smoking ($\alpha = 0.79$), and a three-item subscale related to TM for alcohol consumption ($\alpha = .74$). A mean score was calculated per health behavior, with higher scores indicating a higher intention to optimize a health behavior as a result of the COVID-19 crisis. Indicating, a higher perceived TM. All survey statements were answered on a seven-point Likert scale ranging from 1 = 'strongly disagree' to 7 = 'strongly agree'. These response options were selected as they generally demonstrate the most equal conceptual distances between the anchor labels(19).

As predictor variables, three components of the TM framework were employed, 1) risk perception, 2) affective impact, and 3) altered self-concept(9). In the absence of validated questionnaires specifically targeting these components during the COVID-19 pandemic, we included self-generated items with answer categories ranging from 1 = 'not at all' to 7 = 'totally'. Risk perception was assessed using four items targeting perceived risk of adverse health outcomes when infected with the COVID-19 virus (e.g. 'Do you expect the coronavirus to have a worse effect on you than others of your age and gender?'). The four items were averaged to create a mean score (α = 0.83). Affective impact of the COVID-19 crisis was assessed using eight items targeting worry, stress, and negative emotions due to the outbreak (e.g. 'Does the threat of the coronavirus make you anxious?'). The Cronbach's alpha for the total scale showed a good internal consistency in the sample (α = 0.83). After the removal of three items, this alpha increased to 0.88. The mean score of the resulting seven items was largely correlated (r = 0.67; p = <.01) with the Negative Affect Scale of the Positive and Negative Affect short form (PANAS-SF)(20), which further validates the use of the self-generated items. Lastly, to assess self-concept, event-related measures are typically preferred due the changing nature of people's self that varies over the life course, particularly following significant life events(9, 21). Self-concept can be defined as a perception about oneself or one's position in the grand scheme of things(22). As such, changed self-concept as a result of the COVID-19 crisis was assessed by two self-generated items with a Spearman-Brown correlation of 0.69 (i.e. 'Has the corona crisis changed who you are as a person?' and 'Has the corona crisis changed your outlook on life?').

To assess the sample's sociodemographic characteristics, respondents were asked to report their age, gender, four-digit postal code, living situation (living alone or cohabitating), education, and employment status. Postal codes were linked to the Dutch Livability Index to score the livability of postal codes from 1 = 'very insufficient' to 9 = 'excellent'(23). Level of education was classified according to the International Standard Classification of Education (ISCED, 2011) into lower education (none, elementary or vocational education), middle education (higher general and secondary vocational education), or higher education (higher professional and scientific education).

Sample size

We aimed to obtain a broad insight into lifestyle change intentions of Dutch CVD patients. In previous studies that investigated the role of risk perception, affective impact and changed self-concept on behavior outcomes, a simple size of 218 and 59 was found to be underpowered to detect moderate or high effect sizes(12, 13). This current study therefore

aimed to recruit as many CVD patients as possible, and based the sample size on the expected availability and response rate of participants.

A total of 2606 members of the patient association received the e-mail with an invitation to participate the questionnaire. From a total of 964 unique subjects who opened the link to the survey, 854 participants managed to complete all items (89% completion rate). Data from 24 participants had to be removed as they were not diagnosed with CVD (based on their answers on a question about CVD history), bringing the final sample size of our analyzed cohort to 830 participants.

Statistical analysis

We calculated and presented descriptive statistics (medians and frequencies) for sociodemographic characteristics, predictor and outcome variables. In addition, the percentages of participants that reported increased intentions to change a specific health behavior, due to COVID-19 crisis, were calculated using the box-score method. This box-score is the sum of percentages of the three most positive answer options on a 7-point Likert scale. Hence, participants with an averaged mean score of > 5 (slightly agree) on the different outcome scales (Likert options 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neutral, 5 = slightly agree, 6 = agree, 7 = strongly agree) were denoted as participants with increased change intentions. An averaged mean score of ≥ 5 indicates that a participant demonstrates on average a slight intention to change a health behavior. This approach to determine favorable outcomes on Likert scales is in line with previous studies(24, 25). Prior to performing regression analyses, we tested whether the variables met the assumptions of regression methodologies, including normally distributed residuals, linearity, and multicollinearity (based on VIF and correlations between predictors of < 0.7(26)). Linear regression analyses were carried out to examine the association between our three predictors (risk perception, affective impact, and altered self-concept) and the five TM outcome variables (increased intentions to change general lifestyle, physical activity, dietary behavior, alcohol consumption, and smoking). We first assessed the univariate association between each of our predictors and outcome variables. Subsequently, we ran two linear regression models for each of the TM outcome variable, using an enter selection strategy imputing the predictors. The three predictors specified above were entered in the first multivariate model. In the second model, we additionally adjusted for age, gender, living situation (living alone or cohabited), education (lower, middle, high), and presence of COVID-19 related symptoms. A p-value of .05 was considered significant. Statistical analyses were carried out using SPSS (version 25; IBM; Armonk, NY).

We conducted post-hoc sensitivity analyses to explore the robustness of our findings(27). Firstly, we checked whether our findings differ when we change the outcome variables to single items that measure solely self-reported improved behavior (i.e. 'Due to the corona crisis, I live healthier'). To do so, we repeated our regression analyses with these single items as outcome variables, rather than the complete TM scales. Secondly, the Extended Parallel Process model (EPPM) states that while some level of fear could induce behavioral change in order to reduce a certain threat, the highest level of fear may also lead to maladaptive behavior aimed at coping with fear itself(28). We therefore checked whether individuals who are particularly worried or emotional similarly affect our results. Hence, we repeated the regression analyses with only subjects scoring below the 75th percentile on the affective response scale.

RESULTS

Sample characteristics

The sociodemographic and disease characteristics of our final sample comprising 830 cardiovascular disease patients are presented in Table 1. Participants had a median age of 59 years (interquartile range (IQR) 52-65), and the majority of the sample was male (60%), cohabited with a partner (73%), completed higher education (49%), was currently unemployed or retired (77%), lived in a neighborhood with a (more than) good (62%) or (more than) adequate (30%) livability score(23), and was diagnosed with coronary heart disease.

Influence of the COVID-19 crisis on healthy lifestyle intentions

The study initially explored the proportion of participants that expressed an increased intention to optimize lifestyle behaviors or noted increased importance of adopting a healthier lifestyle due to the COVID-19 crisis. Median scores and IQRs for predictor and outcome variables (range 1 – 7) are presented in Table 2. Figure 2 additionally provides sample percentages which indicate this increased interest in improving lifestyle or health behaviors due to the crisis (i.e. an averaged mean score of ≥ 5 indicating 'slightly agree' on a Likert scale ranging from 1 = lowest intention to 7 = highest intention to improve lifestyle due to COVID-19). As seen in this figure, around a quarter of participants had an interest in becoming more physically active (25%) and in healthier eating (21%). A lower percentage of participants expressed an interest in changing smoking (8%) and alcohol habits (13%).

Table 1. Sociodemographic and disease characteristics of the sample (N = 830)

Characteristic	**Median (IQR)**	
Age	59 (52 – 65)	
	Frequency (N)	**Percentage (%)**
Gender		
Female/male	329/499	40/60
Living situation		
Living alone/cohabiting	213/604	25/73
Education		
Low/middle/high	161/259/406	20/31/49
Employment		
Employed	188	23
Unemployed	635	77
Neighborhood livability		
2=more than insufficient	1	0.1
3=insufficient	5	0.6
4=weak	36	4
5=adequate	31	4
6=more than adequate	214	26
7=good	260	31
8=very good	154	19
9=excellent	103	12
Type of CVD		
Coronary heart disease	591	71
Valvular heart disease	149	18
Cardiac arrhythmia	284	34
Other	407	48
Presence of COVID-19 symptoms		
Yes/ no	187/831	23/77
Current smokers	64	8
Alcohol consumption	549	66

Note. Total percentages can deviate from 100% due to rounded numbers and/or multiple CVD problems.

Table 2. Median (IQR) and range of TM outcome variables and predictors

Characteristic	Median (IQR)	Range	N
Outcome variables			
TM			
Intention to change general lifestyle	4.1 (3.5 – 5.0)	1 – 7	822
Intention to change physical activity	4.0 (3.3 – 4.8)	1 – 7	819
Intention to change diet	4.0 (2.7 – 4.5)	1 – 7	814
Intention to reduce smoking	3.5 (2.0 – 4.0)	1 – 7	64
Intention to reduce alcohol	3.7 (2.7 – 4.3)	1 – 7	545
Predictor variables			
Risk perception	5.0 (4.3 – 6.0)	1 – 7	633
Affective response	3.3 (2.5 – 4.3)	1 – 7	723
Changed self-concept	3.5 (2.5 – 4.5)	1 – 7	827

Figure 2. Averaged mean score of ≥5 on TM outcome variables.

Predictors of TM for changing health behaviors

The assumptions for regression analyses were checked, including linearity, normally distributed residuals and multicollinearity. No violations of these assumptions were found, thus indicating normally distributed residuals and linearity between the predictors and outcome variables. In addition, Table 3 provides the Pearson's correlation between our predictors. As all correlations are lower than 0.7(26), there was no evidence of multicollinearity.

Table 4 shows the results of the univariate and multiple linear regression analyses. A higher affective response and a greater change in self-concept were significantly associated with increased TM for general lifestyle. A higher risk perception was not significantly associated with an increased intention to change general lifestyle. The multivariate analysis revealed that only changed self-concept emerged as a significant predictor of TM for general lifestyle change (B = 0.26; CI = 0.19 - 0.33) after controlling for age, gender, living situation, education, and COVID-19 related symptoms. Similar results were found for TM for increasing physical activity. Again, only affective response and changed self-concept were significantly positively associated with TM for increasing physical activity in the univariate analyses, whilst solely changed self-concept emerged as a significant predictor in the multivariate model (B = 0.23; CI = 0.16 - 0.30). Higher risk perception, higher affective response and greater changes to self-concept were all associated with increased TMs for optimizing dietary behavior and lowering alcohol consumption. When analyzed in the multivariate model, both affective response (B = 0.12; CI = 0.04 – 0.21) and changed self-concept (B = 0.29; CI = 0.21 - 0.36) significantly predicted a TM for dietary behavior, after adjustment for covariates. Risk perception no longer significantly predicted TM for dietary behavior in the multivariate model. Similar predictors were found for a TM for lowering alcohol consumption; affective response (B = 0.11; CI = 0.01 - 0.20) and changed self-concept (B = 0.22; CI = 0.13 - 0.30). Finally, only changed self-concept was positively associated with a TM for smoking cessation, which was retained in the multivariate model (B = 0.29; CI = 0.01 – 0.57).

Table 3. Pearson's correlation between predictors

Variables	Risk perception	Affective impact	Changed self-concept
Risk perception	1		
Affective impact	0.32*	1	
Changed self-concept	0.11*	0.49*	1

* $p = <.01$

Table 4. Univariate and multivariate regression analyses

	Univariate analysis B	95% CI	Multivariate model 1 B	95% CI	Multivariate model 2 B	95% CI
TM for general lifestyle (N=796)			$R^2 = 0.10$		$R^2 = 0.11$	
Risk perception	0.05	-0.03, 0.12	0.00	-0.08 - 0.07	-0.02	-0.10 - 0.05
Affective response	0.20***	0.13, 0.27	0.06	-0.02- 0.14	0.07*	-0.01 - 0.16
Changed self-concept	0.29***	0.23, 0.35	0.26***	0.19 - 0.33	0.26***	0.19 - 0.33
TM for physical activity (N=796)			$R^2 = 0.08$		$R^2 = 0.09$	
Risk perception	0.06*	-0.01, 0.14	0.02	-0.05 - 0.10	0.01	-0.06 - 0.08
Affective response	0.17***	0.11, 0.24	0.04	-0.04 - 0.12	0.06	-0.03 - 0.14
Changed self-concept	0.26***	0.20, 0.32	0.24***	0.17 - 0.31	0.23***	0.16 - 0.30
TM for dietary behavior (N=794)			$R^2 = 0.13$		$R^2 = 0.14$	
Risk perception	0.09**	0.01, 0.17	0.01	-0.06 - 0.09	0.00	-0.08 - 0.08
Affective response	0.29***	0.21, 0.36	0.13***	0.04 - 0.21	0.12***	0.04 – 0.21
Changed self-concept	0.35***	0.29, 0.42	0.29***	0.22 - 0.37	0.29***	0.21 - 0.36
TM for alcohol consumption (N=534)			$R^2 = 0.10$		$R^2 = 0.15$	
Risk perception	0.13***	0.04, 0.22	0.08*	-0.01 - 0.16	0.04	-0.05 - 0.13
Affective response	0.24***	0.15, 0.32	0.08	-0.02 - 0.17	0.11**	0.01 - 0.20
Changed self-concept	0.28***	0.21, 0.36	0.23***	0.15 - 0.32	0.22***	0.13 - 0.30
TM for smoking (N=61)			$R^2 = 0.14$		$R^2 = 0.21$	
Risk perception	0.21*	-0.04, 0.47	0.18	-0.11 - 0.47	0.20	-0.09 - 0.50
Affective response	0.23*	-0.01, 0.46	0.05	-0.27 - 0.36	0.03	-0.29 - 0.36
Changed self-concept	0.29***	0.08, 0.50	0.29**	0.01 – 0.56	0.29**	0.01 – 0.57

Note. Model 1, multivariate analysis with three predictors; model 2, multivariate analysis with three predictors, additionally adjusted for age, gender, living situation, education and presence of COVID-19 symptoms. * $p < .10$ ** $p < .05$, *** $p < .01$

Sensitivity analyses

The regression analyses were repeated using single-item measures assessing a self-reported change in lifestyle, physical activity, dietary behavior, alcohol consumption, and smoking, due to COVID-19, as outcome variables rather than the multi-item TM scales. Our results were largely similar in terms of coefficients compared to the original analyses (data not shown). At the second sensitivity analysis where participants with responses above the

75th percentile on the affective response scale were excluded, comparable coefficients were found in the regression analyses (data not shown), suggesting patients most mentally affected by the COVID-19 crisis did not exude bias in the overall results.

DISCUSSION

We investigated the extent to which the COVID-19 crisis served as a teachable moment (TM) for changing health behavior among Dutch individuals living with cardiovascular disease (CVD), a disease responsible for 25% of the mortality in the Netherlands. Between 8-28% of the sample reported that they had optimized health behaviors or became more motivated to do so, due to COVID-19. Changes particularly related to general lifestyle (28%), physical activity (25%) and dietary behavior (21%), and to a lesser extent to limiting alcohol consumption (13%) and smoking (8%). These findings support our hypothesis that the COVID-19 pandemic may represent a TM regarding lifestyle change for a part of our sample; the outbreak seems to prompt some CVD patients to adopt risk-reducing health behaviors or makes them aware of the importance of doing so. We further explored the underlying motivation for behavior change intentions by investigating whether higher risk perception, affective impact, and changed self-concept were associated to the occurrence of a TM. These factors were derived from a theoretical framework(9), yet empirical evidence regarding its application to life events was still limited. We did not find evidence for the applicability of the whole TM framework. The extent to which the COVID-19 crisis was experienced as a TM was predominantly explained by an altered self-concept, resulting from the pandemic. This factor appeared to be the strongest predictor of intentions to change all health behaviors. An affective response towards the crisis did also have a facilitating role in the extent to which the crisis evoked a TM. CVD patients that were more affectively impacted by the COVID-19 crisis demonstrated increased intentions to adopt a healthier diet and to limit their alcohol consumption. Evidence for an important role of risk perception on evoking a TM was not found. CVD patients who perceived themselves to be more at risk for adverse health outcomes during a COVID-19 infection did not demonstrate higher intentions to adopt a healthier lifestyle.

Comparison with other studies

Other studies that have investigated lifestyle during the COVID-19 pandemic have shown varying outcomes. Mainly reporting improved dietary behaviors but also decreased physical activity levels, largely due to an increase in sedentary behavior(29-31). Consistent with previous studies, approximately one fifth of our sample reported increased motivation

to improve their diet due to the pandemic. These findings add to the evidence base suggesting significant life events such as a disease diagnosis or becoming a parent are associated with improved eating behaviors(32). In contrast to previous studies(29-31), the best-represented TM in our study related to improving physical activity, with a quarter expressing greater motivation to increase their activity. In our sample, 8% of the smokers were more motivated to quit smoking due to the pandemic, a figure slightly below other health behaviors. Although these results are similar to another study on the influence of the corona crisis on smoking habits(33), we expected this figure to be higher, in light of increasing evidence emphasizing the hazards of smoking for the respiratory COVID-19 disease(6). Caution when interpreting our results is warranted, as our sample only included 8% smokers compared to 21% in the general adult Dutch population(34), probably due to recommendations that CVD patients should avoid smoking. Smokers who continued to smoke following a diagnosis of CVD may not adequately perceive quitting smoking as important or may experience extreme difficulty with smoking cessation. Moreover, it is possible that patients have more opportunity to smoke, because of home-isolation, or experience stress, which in turn may increase tobacco use(16).

Explanation of the findings

The role of the three factors of the TM framework(9) on behavior change intentions can be explained by existing psychological theories reported in previous studies on health behavior. First, our results confirm an association between a TM and a change in self-concept; the perception of oneself or one's position in life(22). The more individuals indicated that the corona crisis changed their sense of self, who they are as a person or their outlook on life, the more they perceived the outbreak as a turning point towards improving lifestyle. An explanation for this phenomenon can be found in identity theories(35). Significant life events can cause an identity shift, prompting people to become more self-aware and thereby to re-evaluate current health behaviors and their conflicting effect on future health goals(35). A transition in self-concept or identity thus facilitates behavior change(36). Events that endanger positive expectations about their future self are usually experienced as most relevant to individuals, which in turn evoke greater behavioral responses(9, 37). In an extensive qualitative study, it was explained that major life events impacted an individual's outlook on life and thereby made them increasingly thoughtful regarding the effects of their current diet(32). Our finding that a higher level of altered self-concept was associated with increased intentions towards behavioral change provides evidence that the COVID-19 crisis induces a comparable effect.

Second, our results confirm that an affective response towards the COVID-19 crisis was associated with the occurrence of a TM for improving nutrition and reducing alcohol consumption. This association is in line with existing research on affect and health behaviors, that emphasizes the relation between emotions and beneficial behavior-related decision making(38). Emotionally laden contexts or events could have a cueing effect on deciding to adopt protective health behaviors(39, 40). According to the framework described by McBride et al.(9), an emotional response is essential for an event to become a TM. This affective response causes events to be perceived as more meaningful and significant. Negative emotions such as worry and fear raise concern about health problems and increase motivation to eliminate health risks by adopting risk-reducing behaviors(41). In a study conducted by Knell et al.(31), health concerns were also reported as the main reason for avoiding negative health behaviors during the pandemic, in particular related to a reduction in alcohol consumption and smoking.

Third, although perceived risk of severe health outcomes when infected with the COVID-19 virus was associated with a TM for lifestyle change, this association was no longer significant in the complete regression models. While our sample, on average, perceived themselves to be highly susceptible, this perception was not associated with healthier lifestyle intentions. This is in line with a study by Vörös et al.(42), who neither found a link between patient's estimations of their own cardiovascular risk and their willingness to change their lifestyle. According to the Health Belief Model (HBM) theory, the likelihood of engaging in health-protective behaviors is explained by both the perceived threat of a disease as well as perceptions regarding the effectiveness of behaviors adopted to counteract that threat(43). It is thus crucial that individuals believe that adopting risk-reducing health behaviors will actually reduce the health threat of COVID-19. Although we did not take behavior expectations into account in our study, it is possible that the relevance of lifestyle in relation to COVID-19 was unfamiliar to participants at the time of data collection. Future research should thus continue to explore the role of risk perception following significant life events, but specifically include perceived risk linked to unhealthy lifestyle. Moreover, the protective effects of engaging in a healthy lifestyle during the current pandemic should be clearly and empathically emphasized to CVD patients.

Implications

The potential TM for CVD patients presents some considerable implications concerning how to capitalize on the corona crisis as a TM. During potential TMs, individuals have a heightened receptivity for health behavior messages(9-11). Health authorities, (mental) healthcare professionals, patient organizations, and governments should therefore actively

provide health behavior education during and after the current pandemic. In doing so, they might encourage CVD or other chronic patients to utilize the pandemic as a turning point towards a healthier lifestyle. Targeting risk perception is already a frequently used behavior change approach in health promotion interventions(44). Although this could be an effective strategy in some situations, our results imply that it may be valuable to additionally draw attention to an altered self-concept and affective responses in relation to an event. Specifically, by emphasizing the extent to which the pandemic has altered patients' self-image or their world image, patients may be redirected towards new health behaviors and habits that fit these new identity perceptions(35, 45). Further, motivation for lifestyle change may increase by acknowledging and targeting the affective impact of the COVID-19 crisis, and subsequently linking these to risk-reducing health behaviors(41).

Strengths and limitations

Our study had several noticeable strengths. First, we mention the large sample size and the diverse demographic characteristics of the population we approached. Second, to our knowledge this is the first study to investigate the influence of the COVID-19 crisis on the lifestyle attitudes of CVD patients. Our results provide important guidelines that inform behavioral guidance programs during current and future public health threats. The third strength we experienced, was the use of measures to assess the TM outcome variables based on high construct validity, and the use of specific event-related measures to assess risk perception, affective response and changed self-concept, as advocated by McBride et al.(9). Lastly, individuals with cardiometabolic disorders are part of the largest chronic disease patient group worldwide(18). Our findings could therefore substantially benefit a large number of individuals globally.

However, future research studies should also take certain limitations into account. First, although investigating a single patient population typically enhances internal validity of findings, our focus on CVD patients alone is likely to reduce the generalizability of our findings to other patient population or to the general population(46). Less vulnerable groups could experience a lesser sense of urgency to adopt risk-reducing health behaviors, and are thus possibly less likely to perceive the COVID-19 crisis as a TM. However, we expect that the extent of changed self-concept and affective impact of the crisis could explain and predict behavior change intentions of other patient groups as well. Further research is necessary to confirm this assumption. Second, since the majority of our participants was member of a CVD patient association, our sample might have a higher-than-average interest in employing a healthy lifestyle, which could affect the generalizability of our results. Also, although we aimed to approach CVD patients with diverse sociodemographic

characteristics, nearly half of our participants completed higher education. This overrepresentation of higher educated people is a common phenomenon in science, presumably because this group has a greater interest in health and science(47). Yet, as our sample also consisted of a reasonable percentage of lower-educated participants and those with unhealthier lifestyle behaviors (e.g. smokers), bias on the observed associations may be likely towards the null. Third, the use of self-generated scales may impact the reproducibility of our results, thus further longitudinal data collection is needed. Fourth, given the self-report design of the study, lifestyle behaviors could not be validated on the basis of objective measures such as pedometers and a risk of recall bias cannot therefore be entirely discounted. Moreover, the use of a cross-sectional design prevented us from exploring lifestyle changes during COVID-19 over longer time periods. Lastly, although the study was actually based on a valid conceptual model, determinants of other behavior change theories may have also been worth exploring. Future studies should expand the study design with additional behavior change determinants, including perceived risk linked to unhealthy lifestyle.

Conclusion

In summary, the COVID-19 crisis may present a teachable moment for CVD patients, making them increasingly motivated to change health behaviors and increasingly receptive for behavioral messages. A change in a person's self-concept, due to the COVID-19 crisis, and experiencing an affective response towards the crisis, were both associated with increased intentions to change lifestyle behaviors. These results highlight a window of opportunity for healthcare professionals to utilize the pandemic to promote a healthy lifestyle among their patients. Employing targeted lifestyle advice during or shortly after the current COVID-19 crisis may encourage CVD patients to bring about desired behavioral changes, with a relatively modest effort.

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SUPPLEMENTARY MATERIAL 1

Exploratory factor analyses and reliability analyses on outcome variables

Table 1. Rotated Factor Matrix and reliability analysis TM for general lifestyle

Item	2-factor structure [a, b]		1-factor structure	Corrected item-total correlation	Cronbach's alpha if item deleted
	1	2	1		
1. Due to the corona crisis, I more strongly feel the necessity of adopting a healthy lifestyle.	0.73	0.07	0.73	0.63	0.64
2. Due to the corona crisis, I allow myself more time to pursue a healthy lifestyle.	0.78	-0.19	0.75	0.60	0.65
3. The corona crisis has made me realize that a healthy lifestyle is important to me.	0.76	0.12	0.77	0.65	0.63
4. For me, my lifestyle is fine the way it is (reversed).	0.02	0.34	0.03	0.30	**0.84** [c]
5. Due to the corona crisis, I live healthier.	0.76	0.12	0.76	0.66	0.63
R^2 factors	45.74%	3.65%			
R^2 total	49.39%		45.36%		

Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.
b. The second factor accounted only for an additional 3.65%, therefore 1-factor structure more appropriate.
c. Item 4 will be deleted.

Table 2. Factor Matrix and reliability analysis TM for physical activity

Item	1-factor structure [a]	Corrected item-total correlation	Cronbach's alpha if item deleted
1. Due to the corona crisis, I more strongly feel the necessity of sufficient physical activity.	0.62	0.63	0.41
2. Due to the corona crisis, I allow myself more time to exercise.	0.80	0.45	0.51
3. The corona crisis has made me realize that sufficient physical activity is important to me.	0.59	0.62	0.41
4. For me, my amount of physical activity is fine the way it is (reversed).	0.17	0.11	**0.78** [b]
5. Due to the corona crisis, I exercise more.	0.72	0.39	0.54
R^2 total	38.59%		

Extraction Method: Principal Axis Factoring.
a. 10 iterations required.
b. Item 4 will be deleted.

Table 3. Factor Matrix and reliability analysis TM for dietary behavior

Item	1-factor structure [a]	Corrected item-total correlation	Cronbach's alpha if item deleted
1. Due to the corona crisis, I more strongly feel the necessity of adopting a healthy diet.	0.83	0.76	0.72
2. Due to the corona crisis, I allow myself more time to prepare and consume healthy meals.	0.78	0.67	0.75
3. The corona crisis has made me realize that a healthy/ healthier diet is important to me.	0.86	0.77	0.72
4. For me, my diet is fine the way it is (reversed).	0.11	0.11	**0.89** [b]
5. Due to the corona crisis, I eat healthier.	0.81	0.72	0.72
R^2 total	54.16%		

Extraction Method: Principal Axis Factoring.
a. 6 iterations required.
b. Item 4 will be deleted.

Table 4. Rotated Factor Matrix and reliability analysis TM for lowering alcohol consumption

Item	2-factor structure [a, b]		1-factor structure [c]	Corrected item-total correlation	Cronbach's alpha if item deleted
	1	2	1		
1. Due to the corona crisis, I more strongly feel the necessity of sticking to this advice of the Dutch Heart Foundation.	0.83	0.04	0.85	0.57	0.28
2. The corona crisis has made me realize that sticking to this advice of the Dutch Heart Foundation is important to me.	0.81	0.10	0.80	0.57	0.29
3. For me, my alcohol consumption is fine the way it is (reversed).	0.00	0.25	0.01	0.01	**0.74** [d]
4. Due to the corona crisis, I consume less alcohol.	0.48	-0.22	0.46	0.34	0.50
R^2 factors	39.41%	3.06%			
R^2 total	42.47%		39.20%		

Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 2 iterations.
b. The second factor accounted only for an additional 3.06%, therefore 1-factor structure more appropriate.
c. 15 iterations required
d. Item 4 will be deleted.

Table 5. Factor Matrix and reliability analysis TM for smoking cessation

Item	1-factor structure [a]	Corrected item-total correlation	Cronbach's alpha if item deleted
1. Due to the corona crisis, I more strongly feel the necessity of quitting smoking.	0.87	0.73	0.66
2. The corona crisis has made me quit smoking.	0.56	0.50	0.75
3. The corona crisis has made me realize that quitting smoking is important to me.	0.87	0.74	0.66
4. For me, my smoking behavior is fine the way it is (reversed).	0.44	0.39	**0.79** [b]
5. The corona crisis has made me smoke less.	0.50	0.43	0.77
R^2 total	45.52%		

Extraction Method: Principal Axis Factoring.
a. 7 iterations required.
b. Item 4 will be deleted.

SUPPLEMENTARY MATERIAL 2: FINAL SURVEY

TM for general lifestyle

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
1. Due to the corona crisis, I more strongly feel the necessity of adopting a healthy lifestyle.							
2. Due to the corona crisis, I allow myself more time to pursue a healthy lifestyle.							
3. The corona crisis has made me realize that a healthy lifestyle is important to me.							
4. Due to the corona crisis, I live healthier.							

TM for physical activity

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
1. Due to the corona crisis, I more strongly feel the necessity of sufficient physical activity.							
2. Due to the corona crisis, I allow myself more time to exercise.							
3. The corona crisis has made me realize that sufficient physical activity is important to me.							
4. Due to the corona crisis, I exercise more.							

TM for dietary behavior

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
1. Due to the corona crisis, I more strongly feel the necessity of adopting a healthy diet.							
2. Due to the corona crisis, I allow myself more time to prepare and consume healthy meals.							
3. The corona crisis has made me realize that a healthy/ healthier diet is important to me.							
4. Due to the corona crisis, I eat healthier.							

TM for lowering alcohol consumption

The general advice of the Dutch Heart Foundation concerning alcohol consumption is: do not drink alcohol or drink a maximum of 1 glass of alcohol per day.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
1. Due to the corona crisis, I more strongly feel the necessity of sticking to this advice of the Dutch Heart Foundation.							
2. The corona crisis has made me realize that sticking to this advice of the Dutch Heart Foundation is important to me.							
3. Due to the corona crisis, I consume less alcohol.							

TM for smoking cessation

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
1. Due to the corona crisis, I more strongly feel the necessity of quitting smoking							
2. Due to the corona crisis, I smoke less.							
3. The corona crisis has made me realize that quitting smoking is important to me.							
4. The corona crisis has made me quit smoking.							

Risk perception

	Not at all	No	Not really	Neutral	A little	Yes	Absolutely
1. Do you belong to a risk group for adverse complications of the coronavirus?							
2.Do you expect serious complications when you become infected with the coronavirus?							
3. Do you expect the coronavirus to have a worse effect on you than others of your age and gender?							
4. Do you expect to survive a coronavirus infection?							

Affective response

	Not at all	No	Not really	Neutral	A little	Yes	Absolutely
1. Are you concerned about the threat of the coronavirus?							
2. Does the threat of the coronavirus make you anxious?							
3. Does the threat of the coronavirus make you gloomy?							
4. Are you experiencing stress due to the corona crisis?							
5. Are you sleeping worse due to the corona crisis?							
6. Do you suffer from nightmares about the corona crisis?							

Changed self-concept

	Not at all	No	Not really	Neutral	A little	Yes	Absolutely
1. Has the corona crisis changed who you are as a person?							
2. Has the corona crisis changed your outlook on life?							

3

Making sense of a myocardial infarction in relation to changing lifestyle in the five months following the event: an Interpretative Phenomenological Analysis

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ABSTRACT

Objective: Previous research has shown that experiencing an acute cardiac event, such as a myocardial infarction (MI), can lead to lifestyle changes. This study aimed to explore the potential of a MI as a 'teachable moment' (TM) for positive lifestyle changes and to identify psychosocial sensemaking processes that facilitate or hinder the presence of a TM. Method: We conducted semi-structured interviews with 14 patients who suffered their first MI and were hospitalized in a larger Dutch city. Participants were interviewed twice, respectively one and five months after their hospitalization. They were encouraged to explain how they experienced their MI and how this had affected their lifestyle. We used an Interpretative Phenomenological Analysis approach to the data collection and analysis. Findings: The participants varied in their willingness to adopt a healthy lifestyle due to their MI. Most participants experienced their event as a TM for changing specific health behaviors, for example facilitated by reflecting on self-concept or social roles and by constructing and comprehending a personal narrative of their MI. Some participants struggled to follow through on their intentions to change their behavior, for example because of a negative attitude towards a healthy behavior or because they perceived it as incongruent to their identity. Only three participants maintained most former health behaviors, for example because they failed to acknowledge their MI as severe or because of earlier life events that elicited more blunted cognitive responses. Conclusion: Cardiac patients may experience a TM, which is the consequence of interrelated processes of psychosocial sensemaking. As this does not occur at a singular time point, we suggest using the term 'teachable window' rather than 'moment'. Given these findings, there is a window of opportunity to provide continuous psychosocial and lifestyle support during and after hospitalization for acute cardiac events.

Keywords: Teachable moments, Lifestyle, Prevention, Life events, Cardiovascular diseases, Sensemaking, Health communication

INTRODUCTION

The prevalence of cardiometabolic diseases worldwide is increasing, contributing to considerable health-care costs, mortality, and physical and mental burden(1-3). Modification of unhealthy risk behaviors among cardiovascular disease (CVD) patients not only lowers their risk of developing other comorbidities such as type two diabetes mellitus, obesity, and mortality, but also prevents recurrent cardiac events(3, 4). Moreover, favorable lifestyle changes may improve health-related quality of life among patients(5). In accordance, cardiac patients are strongly advised to adhere to healthy behavioral recommendations(3).

Hospitalization for acute cardiac events may temporally increase patients' motivation to make favorable changes in their lifestyle(6, 7). Consequently, cardiac events may trigger a potential teachable moment (TM)(7, 8), a period when individuals are more receptive to receiving lifestyle advice and motivated to adopt risk-reducing health behaviors(9). That a cardiac event can serve as a TM is indeed observed in a study by Jokar et al.(10) which revealed that cardiac patients demonstrated greater willingness to modify risk factors after their event, and by Coull and Pugh(11), who observed that the event served as a TM for physical activity (PA) among their participants. Furthermore, evidence for this phenomenon is demonstrated by higher smoking cessation rates(7, 8) and increased vegetable intake after a CVD diagnosis compared to the general population(12).

Significant life events may initiate and sustain positive lifestyle changes by generating a sudden shift in individuals' judgments of their health and circumstances(13, 14). By doing so, these events help to overcome common barriers to lifestyle change. For instance, risk events can influence perceptions of perceived risk, such as unrealistic optimism characterized by an underestimation of one's likelihood to be affected by future health events which can be a barrier to engage in protective health behaviors(15, 16). Moreover, acute life events help break habitual behaviors which normally are difficult to modify, allowing room for new, healthier, habits to be formed(17-19). The Health Belief Model (HBM), which emphasizes an important role of cues to action(20), theoretically underlies the concept of TMs. A cardiac event serve as a cueing life event that influences patients' perceived threat of illness (recurrence) and the perceived benefits of lifestyle change, in turn leading to strong motivation for healthier lifestyle choices(9, 21). Therefore, TMs represent an important window of opportunity for healthcare providers to offer lifestyle advice.

The potential of a life event to trigger a TM for lifestyle change depends on an individual's sensemaking process(9). Through a literature search focusing on smoking cessation after a lung cancer diagnosis, McBride et al(9) identified three psychosocial factors that play a

role in this phenomenon: 1) an increased perception of personal risk for adverse health outcomes, 2) a strong emotional or affective response to the event, and 3) a redefinition of one's self-concept or social role. Previous quantitative studies have provided empirical evidence supporting the role of risk perception(22, 23), affect(24, 25), and change in self-concept(24, 25) in facilitating TMs. Additionally, previous qualitative research has suggested that all factors appear instrumental in the context of pregnancy as a TM(26), while risk perception and self-concept were associated with experiencing a type 2 diabetes diagnosis as a TM(27). Nonetheless, it remains unclear if these exact same psychosocial factors also apply to acute cardiac events becoming TMs.

A better understanding of the psychosocial sensemaking processes that influence the onset of a TM after acute cardiac events is essential for effectively utilizing such events as opportunities for lifestyle counseling(28). Solely providing lifestyle information often proves inadequate(29), e.g. because a large part of behavior is based on routines and automatic processes(17). Even when patients initially demonstrate a willingness to optimize a health behavior, a gap exists between intention and actual action(30, 31), as health behaviors are influenced by a complex interplay of individual, social, and environmental factors(32). Numerous studies have identified psychosocial factors that can enhance patients' adherence to behavioral recommendations following a CVD diagnosis, such as an individual's knowledge, self-efficacy, and attitude and beliefs about lifestyle (change), as well as illness perception and anticipated consequences of engaging in healthy behavior(11, 18, 33, 34). Additionally, social factors such as social or professional support facilitate cardiac patients' ability to adopt healthier behaviors(18, 34).

It remains unclear how patients make sense of their cardiac event and how this process of sensemaking relates to their motivation to change behaviors, and therefore, how this may instigate a potential TM. The aim of this study was therefore to examine the potential of a myocardial infarction (MI) to serve as a TM, and to in-depth explore processes of sensemaking that may explain differences in lifestyle change intentions among cardiac patients. In this, we sought to identify underlying psychosocial factors that facilitate or hinder the presence of an effective TM. To the best of our knowledge, this is the first study that attempts to examine the underlying mechanisms of acute cardiac events as potential TMs.

METHODS

Study design

An Interpretative Phenomenological Analysis (IPA) approach was applied for data collection and analysis. This qualitative research method, often used for building theories or narratives, is ideal to uncover how individuals makes sense of a certain experience(35). It is characterized by a deep examination of - relatively few(36) - individual cases rather than producing general statements about the group as a whole(35). The interpretative aspect of IPA allows participants to interpret their experience and explain what meaning it had for them(35, 37).

Sample and procedure

Inclusion criteria included hospitalization for a first MI at one of two general hospitals in a larger Dutch city, living in or near the city, being 18 years or older, being able to speak Dutch, having no other chronic or neurodegenerative disorders, and planning to participate a cardiac rehabilitation (CR) program. Participants were recruited by cardiologists or nurse practitioners who informed patients about the study during hospital discharge. Interested patients received a patient information letter and an informed consent form. Afterwards, the first researcher further contacted them and scheduled the first interview. Participants received a voucher of 25 euros for participation. The Medical Ethical Committee of Zuidwest Holland considered this study not to be subject to the Medical Research Involving Human Subjects Act (WMO) on November 2nd 2018 (18-112).

Semi-structured interviews were conducted in person by the first author (MB), who is a health psychologist with expertise in qualitative research and who followed courses about IPA and qualitative interviewing prior to the study's initiation. Participants were interviewed twice: approximately one month (T1) and five months (T2) after their MI. This approach facilitated investigation of lifestyle trajectories within individuals over time. T2 was strategically chosen, occurring about one month after participants' completion of CR. As lifestyle support has stopped at this point-in-time and participants had then resumed back to their regular daily life, it marks a clinically significant moment. The interview guide was self-developed by 3 researchers (MB, WAG, JCK). Following IPA guidelines(35), it contained primary open questions asking participants to tell something about their MI and its impact on life and lifestyle, and several prompts to encourage patients to speak in-depth about the topic. Inspiration for the interview guide was drawn from previous studies employing IPA or focusing on lifestyle changes following acute cardiac events(18, 26). The interview guide (Supplementary Material 1) was tested in a pilot interview with an individual diagnosed

with CVD. In accordance with the aim of facilitating a natural conversational flow(35), the sequence of interview questions was not rigidly bound by the guide. While participants remained in control of the parameters of the topic, the interviewer gently redirected the conversation back to the subject matter when participants deviated from themes related to the MI and its impact on life and lifestyle. Interviews lasted on average 67 minutes (range 43 – 93 minutes) at T1 and 53 minutes (range 29 – 71 minutes) at T2.

Analysis

Interviews were audio-recorded and transcribed verbatim. An IPA approach was administered to the data analysis(35), which was primarily conducted by the first author (MB, health psychologist). First, an audio-recording was listened to and a transcript was read multiple times. Second, initial reflective notes were made based on content (what was said), language use (how it was said), and interpretation (what meaning it has for a participant). A double hermeneutics process was followed in which a participant's interpretation of their experience was in turn interpreted by the researcher(35, 37). The third step was to transform these notes into emergent themes. In line with IPA recommendations(35), the analysis was completely inductive without predetermined theories. At the start of the analysis process, the first (MB) and third (SvB, psychologist) author independently performed the first three steps of the analysis on two randomly selected interviews, discussed their similarities and disagreements, and ultimately together explored and developed themes and reached 100% agreement about the emergent themes. Afterwards, the remainder of the analysis was performed by the first author in a similar manner. To recognize her subjective interpretating role and to ensure that interpretations were grounded in the transcripts, emergent themes were further discussed during meetings with the second (WAG, health psychologist) and last author (JCK, dietician and epidemiologist). The fourth step was to find clusters of emergent themes. The final overview of clusters of emergent themes was the result of regular meetings among the first, second, and last author, during which they discussed and produced the overview together. After repeating all steps for the interviews from T2, transitional themes over time were explored to identify changes in the participant's perspective on lifestyle from T1 to T2. Finally, we explored which clusters of psychosocial sensemaking processes were related to differences in lifestyle change intentions considered at T2. We have selected this as our primary focus, as we regarded lifestyle changes at T2 are clinically most relevant.

RESULTS

Fourteen cardiac patients were included in the study. Their demographic and pre-event lifestyle characteristics are provided in Table 1. While most participants modified certain health behaviors due to their MI, substantial variations in behavioral decisions were evident among participants and across behaviors. An overview of all themes is provided in Supplementary Material 2. Stories of lifestyle change as a result of the cardiac event at T1 and T2 are summarized in Supplementary Material 3, hereby indicated per distinct behavior (i.e. diet, PA, smoking, alcohol, stress) whether participants were intended to improve or had already improved the behavior.

Table 1. Demographic and lifestyle characteristics

Name	Sex	Age	Level of education	Relation status
1. James	Male	60	Middle	Married
2. Martin	Male	81	Lower	Married
3. Amanda	Female	66	Middle	Cohabitation
4. Thomas	Male	-	Lower	Married
5. John	Male	68	Higher	Married
6. Hester	Female	53	Middle	Single
7. Eric	Male	61	Higher	Married
8. Ian	Male	66	Middle	Single
9. Peter	Male	58	Higher	Married
10. Shivani	Female	-	Middle	Married
11. David	Male	65	Higher	Married
12. Emma	Female	59	Middle	Married
13. Harry	Male	57	Lower	Relation
14. Steven	Male	64	Lower	Married

Note. All cardiac patients experienced an MI. Names are replaced with pseudonyms. Level of education was classified according to the International Standard Classification of Education (ISCED, 2011) into lower education (none, elementary or vocational education), middle education (higher general and secondary vocational education), or higher education (higher professional and academic education).

Lifestyle change at T1 and T2

Considering at T1, our analysis revealed three themes related to differences in lifestyle and lifestyle change intentions among participants: 1) *initial influence on lifestyle behaviors*, where participants mentioned to directly have adapted health behaviors due to their heart

attack, 2) *influence on lifestyle intentions*, where willingness to change health behaviors was expressed but not yet acted upon, and 3) *no initial influence on intentions and behaviors*, where no such effects were noted. Participants varied in their intentions and behaviors across distinct behaviors; someone may be inclined to alter one behavior and not be as willing to change another. For instance, Amanda improved her diet by reducing snacking (theme 1), was additionally motivated to reduce her stress (theme 2), but did not feel compelled to enhance PA (theme 3). Moreover, most former smokers (James -occasional smoker-, Martin, David, and Emma) abruptly quit smoking yet did not consider improving dietary habits.

Considering at T2, the analysis also revealed three themes related to differences in lifestyle change intentions among patients. The first theme was 1) *teachable moment for lifestyle intention and change*. With the exception of John, all participants were motivated to change or adopt certain healthier behaviors in the months following their event. Within them, a TM was thus experienced for one or more particular health behaviors. For some, the MI acted as a wake-up call regarding the urgent need to adopt risk-reducing health behaviors. Consequently, Thomas, Eric, Peter, and Steven stated that they took a positive view on their MI. Perceiving the event as a warning, they felt that they had received a second chance in life and were therefore motivated to take action regarding their health behaviors, as illustrated by Steven's comment:

> Steven, T2: Maybe it was all for the good, otherwise things might have ended badly. If you've reached a certain age and maybe have much poorer general health. It's like I am probably still in the prime of life and then you can cope, isn't it great that you get a second chance?

The second theme was *discrepancy between contemplating change and actively pursuing change*, indicating that an initial willingness to adopt a healthier behavior at T1 was no longer pursued at T2. James, Amanda, John, Hester, Ian, Shivani, Emma, and Steven were initially thinking about changing certain health behaviors, however, these intentions did not translate into active engagement with these behaviors at T2.

The third theme was *maintaining former (unhealthy) behavioral habits*, in which no impact of the MI on behaviors and behavioral intentions was noted. Most participants had such behaviors which they continued following their diagnosis. This is not necessarily negative, as it could reflect pre-existing healthy habits such as Amanda's active lifestyle prior to her MI. Only a minority of participants implemented only minor or no behavioral changes after being hospitalized at T1; John demonstrated a slightly increased awareness of the importance of exercise, James quit smoking the occasional cigar and contemplated

becoming more physically active, and Ian professed an increased awareness of the importance of healthy eating. Nonetheless, they all retained former behavioral routines in all other lifestyle aspects.

Change trajectories in lifestyle change

Certain favorable lifestyle changes were adopted immediately following hospital discharge, such as Thomas's decision to immediately improve his diet:

> Thomas, T1: Food, yes, I did adapt that immediately because I have a sweet tooth.

In contrast, James, Ian, Eric, Ian, and Steven only began to adopt healthier behaviors later in their trajectory. Participants could change in their intention and change of a health behavior along their trajectory from T1 to T2. For instance, despite Ian's disinterest in healthier eating at T1, he had reduced snacking behavior at T2:

> Ian, T2: Initially, I admit that I thought, "why", but I do believe that, partially, umm... that bowl of peanuts isn't there anymore in the evening, you know, next to the TV.

This example demonstrates how cardiac patients undergo a change trajectory in lifestyle changes between the two interview moments. Similar trajectories of change were evident across different behaviors. For instance, Amanda initially altered her diet at T1, but by T2, she felt that changing her behavior was not worth the effort as healthier eating made her feel "less like herself". Conversely, Eric and Ian, who had not considered their diet at T1, incorporated dietary changes at T2. Similar regarding stress, the influence of the MI on stress reduction was immediately visible in Eric, Shivani, and Steven. However, Amanda, Hester, and Peter needed longer to implement changes in their stress management. Progress in PA behavior seemed more gradual, with minimal adaptions noted at T1, but most participants had increased their PA at T2. Notably, those uninterested at T1 in improving PA maintained their inaction at T2. In terms of alcohol consumption, apart from John and David, no other participants consumed alcohol around T1. However, at T2, some resumed their alcohol intake albeit in moderation compared to before their MI. Smoking cessation predominantly occurred immediately after hospitalization, as shown by Martin's comment below. Moreover, it remained relatively stable, as most former smokers (James, Martin, David, and Emma) maintained their abstinence from tobacco at T2.

> Martin, T1: After that I completely stopped with roll-ups, haven't had a single one. Completely stopped.

Psychosocial sensemaking processes

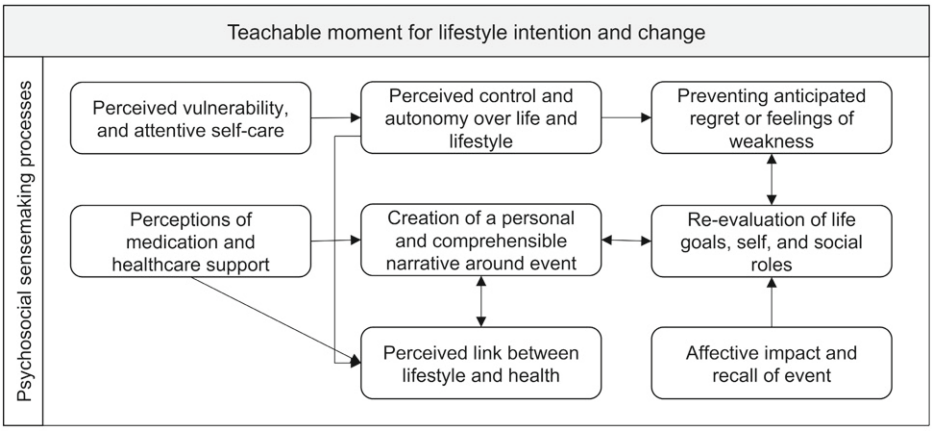
In this section, we elaborate on the psychosocial sensemaking processes associated with variations in lifestyle change and lifestyle change intention at T2. As psychosocial themes did not differ substantially at T1 and T2, the processes were prominent on both time points unless otherwise stated.

Teachable moment for lifestyle intention and change

Figure 1 shows all processes of sensemaking related to experiencing a TM for lifestyle intention and change. In the figure, we depict inter-theme pathways as themes have an interrelated impact on instigating lifestyle change intentions, with evident relationships between themes. An example of a pathway is illustrated by Peter's narrative (below); triggered by looking at his physical appearance, his emotions (affective impact) had initiated a cognitive process in which he no longer considered his current body a reflection of his true identity (re-evaluation of self), a reconsideration that was reinforced by his brother's emotional comments (affective impact).

> Peter, T1: Yes, it really was a shock, but are you surprised that this is happening to you. And then you see your own body and I think okay, this is not how I want to appear anymore.[. . .] And he [Peter's brother] had said oh, I hope I don't lose my dear brother who has always been an example to me. Yes, I don't see it that way at all, but he is younger than me and well, then I do have to cry. [. . .] his words have always stuck with me.

Figure 1. Themes and inter-theme pathways within a teachable moment for lifestyle intention and change following a myocardial infarction.



Note. This figure presents a schematic overview of the emergent psychosocial sensemaking processes related to the theme 'teachable moments for lifestyle intention and change', as well as how these processes are interrelated. It is important to note that this figure does not indicate the relative importance or sequence of the processes, as the current study does not provide evidence on these aspects.

Perceived vulnerability and attentive self-care

The figure firstly shows perceived vulnerability and attentive self-care as a process related to experiencing a TM. Martin, Amanda, Thomas, Eric, David, Emma, and Steven experienced feelings of intense vulnerability and an acute perception of themselves as (mortal) human beings, accompanied by feelings of susceptibility to other lifestyle-related illnesses. This realization prompted a heightened sense of urgency for health protective health behavior, as Emma conveyed:

> Emma, T2: You don't really expect it. Of course you some inkling but then.. you just fail to take it into account. And I know now I really have to think about it more, because it could happen to me anytime, that's been proven

Thus, perceptions towards the notion that "illnesses could happen to me" shifted amongst most participants, and Martin, Amanda, Hester, Shivani, and Emma were particularly worried about their cardiovascular and general health. For Hester, these worries resulted in an avoidant coping mechanism, in which she tried to avoid thinking about her heart attack and its possible consequences for her life. In others, however, these concerns motivated participants to take better care of their health and fitness, as explained by Shivani:

> Interviewer, T2: What are you most worried about then? Shivani: About my body, about myself, and yes, I still have so much to enjoy and so much to do, then I think, yes, you to want to keep doing those things at least for a while, etc., so now I do try to be a bit more careful with myself.

Martin, Amanda, Eric, Peter, Shivani, and Harry additionally described a sudden realization of the finiteness of life. Consequently, this awareness made them willing to take the necessary measures to increase their chances of living a longer, healthier life:

> Martin, T1: You think, okay just a little bit further really. Interviewer: And how does that relate to smoking? Martin: Well, I hope that this [quitted smoking] will let things carry on a bit longer, of course.

Post-diagnosis, some participants experienced physical consequences such as fatigue (e.g. James, Amanda, Shivani, David, and Steven). These consequences acted as a constant reminder of their status as cardiac patients and increased awareness of certain necessary precautions. Shivani, Eric, David, and Steven specifically mentioned that they responded to perceived bodily needs by taking better care of themselves when physical symptoms were noticeable. This form of attentive self-care is illustrated by Shivani:

> Shivani, T1: Well, my body, I've always been used to doing anything and keeping at it, and I can't do that now. I can't manage it, I can do everything but at a certain point I really have to stop because I feel that I can't carry on.

Perceived control and autonomy over life and lifestyle

Realizing their vulnerability, certain patients feared losing autonomy over their health and lives in the future. James, Martin, Ian, and David expressed such concerns about losing control over their lives, body, or selves. Their diagnosis raised worries about a declining physical condition, which were closely connected to concerns about reduced autonomy. Consequently, they were compelled to live healthier to preserve future autonomy, associating good physical condition as crucial:

> David, T2: Well, to get a good level of fitness, I already said it there [CR], because they asked. At least to get my fitness back so that I can, if I have to, walk to the center of town or whatever.

David, Harry, and Steven regarded their behavioral changes as relatively effortless, demonstrating a higher self-efficacy:

> David, T2: The only change I've made and that's to quit smoking and [to take up] exercise; really, I don't think that's such a change.

This high level of confidence reinforced their perceived ability to adhere to behavioral recommendations. The integration of healthier behaviors into participants' lives during the first months after the hospitalization facilitated a sense of mastery in the case of Eric, Ian, Peter, and Steven. As a result of the experience of being able to live a healthy life, at T2 they felt increasingly confident regarding their ability to continue healthier behaviors:

> Peter, T2: and I've also now realized that if you just change a few things, you can lose a couple of kilos really fast. That if I can just get above a certain limit, just be super strict for a few weeks, then it'll all be fine again.

Preventing anticipated regret or feelings of weakness

As depictured in the figure, feelings of personal control on behaviors and future autonomy influence the concept of anticipated regret, because such perceptions of control shape how someone may feel after performing an unhealthy behavior. Certain participants were driven to avoid feelings of anticipated regret or weakness due to the continuation of unhealthy behaviors. For example, a wish to avoid personal blame for future health

problems motivated John to continue PA, Martin to quit smoking, Peter, Harry, and Ian to follow a healthier diet, and Ian to consume less alcohol and participate in CR so as to become more active, as illustrated below:

> Ian, T2; I also started drinking my wine a little less. So that they can't tell me later like, you see, I told you so.

Both Thomas and Harry explicitly regarded failure to adhere to lifestyle recommendations as a character trait of the weak. Accordingly, they were strongly motivated to avoid engaging in unhealthy behaviors:

> Thomas, T1: I would see that as very weak. That people give up, by smoking or whatever, no, just stop with things like that. I'm not some wimp.

Re-evaluation of life goals, self, and social roles

Experiencing an MI triggered patients to reflect on what they deemed important in life, where their priorities lay and what they essentially valued in life. Consequently, the investment of time or resources underwent substantial adaptation. Eric, Peter, and Steven, for example, became more vigilant concerning their work-life balance when they realized that they had become detached from life and family due to responsibilities at work. A shift in priorities occurred, moving the focus from career to family, as illustrated by Peter:

> Peter, T2: Well, I think that's what a heart attack is about, that it makes you see the world in a different way, it also forces you to think about what is really precious to you, what is important. And then of course your family and relatives come first more[…]. And work, that becomes something, just a social responsibility, just a way to earn money.

Peter especially felt that his heart attack had led him to critically reflect on his self-concept prior to the MI, leading to a perceived incongruence between his former self and his real, desired self. This resulted in a strong sense of dissatisfaction regarding his self and appearance prior to the MI, motivating him to optimize his health behaviors in order to make live in more congruence with his real, desired self:

> Peter, T1: I remember at a certain point I was allowed to take a shower for the first time and I saw myself in the mirror and I thought, no, this isn't you, with a bit of belly and looking very tired. This isn't you, this is not who you want to be. And I just decided then and there that I was going to immediately lose weight.

Experiencing an MI also changed identities and social roles. For example, Martin, Thomas, and Peter adopted a heart patient identity and accepted the lifestyle restrictions that accompany that role. In addition, the importance of specific social roles was re-evaluated primarily by Thomas, Eric, Peter, and Steven. Eric, Peter, and Steven began to consider their social role as an employee much less important as their social role as a loved one (i.e. partner, parent, or friend), as illustrated below by Eric.

> Eric, T1: this event makes you make choices as to what really matters. And as much as I like work, in the end life is about that [social] circle, that's where your real foundation is.

This process of reflection on social roles was an important driver of lifestyle change, as it provided motivation to ensure that certain social roles were fulfilled for as long as possible. Furthermore, it impacted anticipated regret, as continued unhealthy behaviors evoked anticipated remorse toward the social environment for burden them with preventable health issues and not ensuring maximum time together.

Creation of a personal and comprehensible narrative around the event

All participants reflected on the period of time before and after their MI, linking the event to behavioral causes and consequences, in an effort to create a more personal and comprehensible narrative. Martin, Amanda, Thomas, Eric, Peter, David, and Steven created a comprehensible narrative for themselves that helped them to accept the necessity of behavioral adaptations. For example, Peter described below how he felt that it was actually "logical" that he stopped consuming alcohol. When social roles were re-evaluated and new priorities in life are accompanied by behavioral changes required to achieve them, patients seemed more motivated to adhere to these changes.

> Peter, T1: I don't know if it is an achievement [stopped drinking alcohol], I don't think so, it's perfectly rational and obvious to me actually. And I think that that of course makes you start to think about your past

Perceived link between lifestyle and health

Comprehending the narrative could instigate a TM when a direct link to lifestyle was recognized. Martin, Amanda, Ian, Peter, Shivani, David, and Steven all believed that their cardiac problems were influenced by lifestyle behaviors. The causal attribution of their cardiovascular problems to unhealthy behaviors shaped an informed desire to change the behaviors. For instance, Martin stated that he only maintained smoking abstinence because he directly attributed his MI to tobacco use:

> Martin, T2: If they say tomorrow that smoking has nothing at all to do with it, I'll start smoking again tomorrow, yes. But of course, I have smoked for 60 years, so there must be something wrong somewhere, with the veins.

Martin, Amanda, Thomas, Peter, and Harry were generally confident in their internal locus of control concerning regulation of their cardiovascular health. A high level of personal control reinforced participants' motivation to making a link to desired lifestyle behaviors, as illustrated by Thomas:

> Thomas, T1: Yes, it's up to you. You're the one who has to do it. Try to be smart. And I suppose that most people who get this [CVD] are adults. You can still have it and grow old. Fine. That's how we're going to handle it.

Interestingly, participants tended to focus on wanting to change the health behavior to which they attributed their cardiovascular problems. This was almost solely tobacco use in the case of former smokers. Hester, the only smoker to attribute her MI to stress rather than smoking, continued to smoke after her diagnosis:

> Hester, T1: But I'm also convinced that the stress I've had in my life has been worse than all those cigarettes. Because I'm always stressed. Always. My entire life.

Amanda, Hester, Peter, Shivani, Emma, and Steven attributed their cardiac problems to stress. Consequently, they perceived their cardiac event as a TM to prioritize relaxation and stress reduction. The extent to which participants considered stress management as their responsibility, rather than a result of external factors, influenced their intentions. For example, initially, Amanda attributed her stress to be the outcome of a demanding working situation. However, by T2, after participation in coaching sessions, she had learned that she could take individual action to address her maladaptive response to stressors:

> Amanda, T2: So just like work, that's the cause of the stress these last 3 years. But no, I know I could have reacted differently myself, I recognize that now, but I didn't. […] So, and that's the lesson I've learned

While Ian also attributed his cardiac event to stress, he did not believe that reducing his stress levels was feasible, considering it as an unchangeable aspect that he had experienced his entire life. Consequently, he took no action in this direction and did not feel any guilt, as he was not aware of the role he could play in making changes.

> Ian, T2: okay, but how are you supposed to do that [reduce stress]? Look, if I solve that problem today, tomorrow I'll have found something else, it's just how I am.

Perceptions of medication and healthcare support

Beyond healthcare professionals' roles in emphasizing the importance of behavioral changes by supporting patients to create a personal narrative and by linking health to lifestyle, patient perspectives on medication and healthcare support also shape the occurrence of TMs. Amanda, Thomas, and Harry saw medication use as symptom control rather than using it to battle potential causes of cardiovascular problems. Together with an overall negative attitude towards medication, this belief fostered an urge to adopt dietary changes beneficial in controlling cardiovascular risk factors. For example, Amanda explains below her ambivalence regarding the consumption of unhealthy foods that could increase her cholesterol level while simultaneously using medication to decrease it:

> Amanda, T1: because I think it's weird to just, you know, high cholesterol? Okay then, I'm going to take those pills, no problem, and meanwhile eat crisps that raise my cholesterol. That's obviously really stupid.

Most participants were generally positive concerning support received from healthcare professionals. Below, Martin specifically mentions that he maintained his abstinence from smoking because of he felt obligated to do so towards the healthcare professionals who treated him. However, this seemed mostly to be of influence sooner after hospitalization, as no such feelings were expressed at T2.

> Martin, T1: well, I think I would come across as a bit ungrateful, when you've just had a heart operation and then you just keep puffing away. And then they all try to keep you in line and help you get healthy again[…] Well, then you're definitely obliged to quit, of course. You can't just keep on puffing away regardless. Not me in any case.

John, on the other hand, repeatedly demonstrated his dissatisfaction with healthcare in general. Recent and earlier occurrences during hospitalization had fostered suspicion towards the advice of healthcare professionals, causing him to become less receptive.

Additional important healthcare-related themes that impacted participant's lifestyle change intentions include a facilitating role of received lifestyle information, a reluctance and selectivity concerning lifestyle advice, and a need for specific anchors related to the impact of behavioral change on health indicators, as illustrated by Amanda below.

Amanda, T1: Those pills will definitely lower your cholesterol. As for all that exercise, as I already said, how often have I got to jump around to lower that cholesterol? 100 times? 10 times?

Affective impact and recall of event

Martin, Hester, Shivani, and Emma vividly recalled their event and expressed negative emotions such as sadness and fear in the narrative of their event. Experiencing the event as affectively impactful reminded them to take good care of their cardiovascular health to prevent the occurrence of another event.

Emma, T2: also when I feel it [chest pressure] I still find it pretty scary. Yeah, you don't want to end up lying there again, do you? No, so then you know what it's all for, don't you?

Thomas, Eric, Peter, and Steven felt positively affected by the aftermath of their event and generally described feelings of gratitude concerning the support received from their social network or concerning the opportunity for a second chance in life. These positive emotions motivated health behavior change, as explained by Peter:

Peter, T1: in my case gratitude is now the main feeling, that I'm still here and that I'm still there for my family, for my friends [. . .] I also understand, of course, that's also the reason we're sitting here, that I have to take steps to start changing things in my life.

Martin, Thomas, Eric, Peter, and Shivani were very affected by the notion of worry and fear amongst their loved ones, mostly their spouses. Martin and Thomas even described the experience of their partners' emotions as the most salient image relating to their cardiac event. They were consequently determined to live healthier lives in order to prevent their partner witnessing another cardiac event, as illustrated by Thomas:

Thomas, T1: I think I was most affected by my wife's emotions. Because she was, though now a bit less, really terrified. To lose me [. . .]. Then you're standing at a counter selling all kinds of delicious things, and then I tell myself, get a grip, don't give in! [. . .] Why would you take the risk, you just don't want to do that to your partner.

Nonetheless, an event did not necessarily have to be experienced as emotionally impactful in order to trigger a TM. David and Ian regarded their event as neither emotional nor impactful, yet both made substantial changes to their health behaviors. This is additional evidence that multiple processes of sensemaking can instigate a TM. For example, below

Ian explains his intention to nevertheless pursue a healthier diet in order to prevent a subsequent MI that might be more serious:

> Ian, T2: But I actually look back positively on that heart attack. Didn't cause any real problems at all, yes except for those 2 hours then. You know, then you think okay, it most likely had nothing to do with food, but [knock on wood], the second time it's over.

Discrepancy between contemplating change and actively pursuing change

This section will elaborate on the processes important in shifting from contemplating change at T1 to no longer actively pursuing change at T2.

Belief: full recovery of health after surgery

By T2, Thomas, John, Ian and Harry all believed that they had fully recovered their cardiovascular health. While John refused all lifestyle changes, and Thomas maintained his adherence to self-imposed behavioral changes at T2, Ian and Harry struggled to remain motivated to live a healthy life at T2 compared to T1. Their belief in personal recovery seemed to lower their perceived need to continue living a healthy life. Below Ian describes how this belief was further strengthened by physical assessments at the hospital:

> Interviewer, T2: And then what happened? And now? Ian, T2: 100% in physical shape. I did that bike test and I was on it and they are like "Sir, that's really great".

Positive attitude towards unhealthy behavior or negative attitude towards healthy behavior

Differences in attitudes towards certain unhealthy and healthy behaviors seemed to affect the participants' perceived ability and willingness to perform or omit them. Eric and Peter, for example, found pleasure in PA during CR, which fostered their decision to continue exercising afterwards. Conversely, Martin, Amanda, and John expressed an aversion to healthy eating, as evident in Martin's referral to it as "nonsense". Although they all seemed motivated at T1 concerning healthier eating, they were not able to keep this motivation and had almost completely returned to their usual dietary habits at T2.

> Martin, T2: I've never liked eating a lot of vegetables. I: Because you don't like the taste, or? P: I really don't need it actually, all that nonsense. I'll eat it, but isn't that I [like it].

A similar phenomenon was evident among participants with positive attitudes towards unhealthy, undesirable behavior, often involving alcohol and unhealthy foods. Ian, David, Harry, and Steven enjoyed alcohol intake, considering it as valuable in their social life. In

addition, Amanda, Ian, Emma, and David realized that they preferred unhealthy foods, such as sweets and snacks, to the extent that omitting these behaviors was not worth the benefit. This is illustrated by Amanda:

> Amanda, T2: yes, now I am a bit different when I see all those sweets. In the beginning you are really strict and then comes that moment again of "I don't want to be 100" and that also makes sense, you know. Rather 85 and a nice life.

Identity mismatch in relation to healthy behaviors

Beyond merely holding a negative attitude towards healthier behaviors, Amanda, Hester, Ian, Shivani, and David even experienced a mismatch between those healthier behaviors and their personal identities and values in life. They realized at T2 that they considered certain unhealthier behaviors (i.e. most often smoking, eating snacks or drinking alcohol) particularly valuable for their identity and social life. This process of sensemaking contributed to discrepancies in lifestyle intentions between T1 and T2, as changing behaviors closely tied to one's identity seemed to be challenging to adhere to. For instance, David's motivation to lose weight was evident at T1, yet by T2, he realized that freely drinking alcohol and eating was fundamental to his social activities:

> David, T1: No, I just feel that, it's [the weight] all wrong, it's not supposed to be here, I just notice that it bothers me and it just needs to come off now.

> David, T2: Yes, we can spend evenings, hours at the table, but eating normally, not eating mountains of food. […] Then I just do as everybody else does, yet, but do I have to change my life that much then that I'm not allowed to drink a single beer?

Similarly, Amanda initially expressed a wish to control her snacking behavior. However, by T2, she stated that her personal and social identity depended on "social eating" and she strongly associated the consumption of snacks and sweet foods with socializing.

> Amanda, T2: sweet has something cozy and delicious. So yes that fits me, I am [a] cozy [person].

Consequently, she eased her self-imposed restrictions, gravitating towards behaviors more congruent with her identity. However, she was still trying to find a new balance by implementing minor changes to her dietary behavior concordant with her identity, for instance illustrated below:

> Amanda, T2: Yesterday you're playing a board game and then there is all this cheese and fig bread placed in front of you. And as happened for example yesterday, it was a conscious decision to eat most of the strawberries.

Cognitive dissonance

John, Amanda, and Peter faced conflicting thoughts about balancing a return to normal life and protecting their health. At T1, they believed in the role of a specific risk behavior in their cardiovascular condition and were motivated to change it. However, by T2, they had often resumed former activities that interfered with their behavioral goals, leading for them to change the perceptions of the risks of the specific behaviors. A process of cognitive dissonance aimed at reducing tension between health goals and life activities seemed to have occurred in these participants, as illustrated by Peter:

> Interviewer, T2: The last time you already mentioned stress in your life as the most important cause, wasn't it? Peter, T2: Well, maybe I did mention that last time. Could be. I've changed my mind a bit since, because although I do think that the stress is really important, but I was very focused on it at the time, [...] I mean, when I'm working now everyone says "Take it easy", and then I say okay, but hard work really isn't a problem for me.

Maintaining former (unhealthy) behavioral habits

The following section elaborates on processes of sensemaking related to the immediate continuation of former healthy or unhealthy behavioral habits.

Perceiving lifestyle or behaviors as fine as is; no necessity to change

Some participants were convinced that they already lived a healthy lifestyle prior to their hospitalization. James, John, and Ian considered their overall lifestyles to be relatively healthy, Hester and Shivani regarded their eating behavior as already healthy, and Amanda, Ian, and Harry perceived their exercise behavior sufficient. Consequently, these participants did not perceive a need or feel any urgency to optimize behaviors that they already considered healthy, as illustrated by Ian:

> Ian, T1: because I cycle a lot and I walk for hours, I'll walk for 2 hours, I'll go to [town] and then go via [town] to [town] and then I'll come all the way back again. Almost every morning when the weather is a bit like today and there's no wind, then I'll go on my racing bike. Okay, I do have a bit of a belly, but I actually have very good physical fitness, perfect in fact.

There were some indications of misconceptions in this matter. For example, when Hester described her diet, she included some evidently unhealthy food habits. In addition, the quote below shows that John was unaware of the unhealthiness of take-away meals:

> John, T1: if you just eat normally, it's healthy, right? You know, a nice Chinese or Greek? But hey, that's not really unhealthy. It's a grilled chicken or it's that grilled stuff. No, I don't think that's bad for you.

Compensatory health beliefs

A tendency to form compensatory health beliefs, indicating self-justification of certain unhealthy behavioral habits by emphasizing healthier ones, was evident in some participants who maintained unhealthy behaviors. Smoking cessation offered a striking example of this phenomenon. Martin, John, and Emma successfully quit smoking, and they used this achievement to justify not adopting healthier alcohol or dietary behaviors for themselves. Additionally, John, Ian, Harry, and Emma did not experience feelings of guilt during unhealthy behaviors, presumably due to simultaneous engagement in healthier actions, as illustrated by Ian:

> Ian, T1: Look, I eat unhealthily you know, but I also eat very healthy food. Look, sometimes I don't feel like cooking, then I'll get some fries at that Turk's [place]. But then I'll also get a bowl of salad, and then eat that too.

Downplaying the life event

John, Ian, David, and Harry failed to acknowledge the severity of their MI and experienced little affective impact in the aftermath of hospitalization. Although they were aware that an MI had occurred, they felt that the event itself lay in the past and would not affect their future. This downplaying of the impact of a cardiac event, as exemplified below, seemed to hinder the process of sensemaking, which is important in inducing a TM.

> Ian,T1: well you, your daughters are crying and I'm saying there's nothing wrong, because I'm already laughing in that bed. Yes, I'm saying nothing at all is wrong here, it's done

Previous significant life events

Some participants regarded other early life events as more salient than their cardiac event. Specifically, James, John, Hester, and Ian previously experienced multiple important life events, such as earlier diagnoses of illness (all), illnesses of family members (John, Hester, and Ian), or a history of abuse (Hester). Experiencing multiple earlier life events seemed to

elicit more blunted emotional and cognitive responses towards the cardiac event itself. The experience of multiple significant life events therefore seemed to hinder the process of sensemaking and lowered the TM effect of the cardiac event, as illustrated by John:

> John, T1: I can imagine that someone who has never had any problems will have a hard time dealing with it, or when it's the first time you've had anything like this. But I've had back surgery, and twice for my neck hernia, so those are also things that cause some panic of course

Reduced interoceptive awareness

Comments by John and Ian appeared to signal reduced interoceptive awareness, suggesting that they responded poorly to otherwise alarming physical signals, as illustrated by Ian's quote below. This in turn affected their cognitive-affective sensemaking, because a poorer perception of physical signals seemed to relate to a lower perceived severity of their illness.

> Ian, T2: And then a nurse comes rushing in who says "Haven't you noticed, your heart is racing"; then I say "I don't feel a thing".

DISCUSSION

A significant life event such as an MI may have a major impact on a person's life and lifestyle, although each patient generally experiences an event in a unique way(38, 39). The aim of this study was to explore whether an MI could act as a TM, and to in-depth explore which sensemaking processes played a role on lifestyle change. We conducted the study using IPA, which is characterized by an interpretative exploration of a case-by-case process of sensemaking of an experience(35). We found that experiencing an MI often elicited a need within patients to make sense of what had happened. As a consequence, most participants developed more positive attitudes towards a healthy lifestyle and even implemented positive lifestyle changes. The impact of the MI on lifestyle seemed to be an ongoing process, consisting of multiple situations causing processes of reflection and sensemaking within patients. Therefore, we consider 'teachable window' (TW) as a more appropriate term than 'teachable moment'. While patients varied in how they made sense of their MI, several common processes of sensemaking that seemed important for experiencing a TW were observed in multiple patients. These included perceiving a connection between lifestyle and health, consciousness of one's own vulnerability should unhealthy behaviors continue, a wish to regain autonomy and control over one's own

life, one's own or loved one's emotional experiences, and reflecting on one's identity in relation to health behaviors.

Comparison with previous studies and explanation of findings

Understanding potential TWs is important as previous studies have shown that life events can motivate people to change ingrained lifestyle habits(13, 40). Moreover, lifestyle modifications that are triggered by life events are known to induce particularly sustainable behavioral changes(13). Individuals that experience important life events are more likely to engage in self-reflection, which may in turn trigger a desire to further develop oneself in a positive way(18, 41). Our findings complement a growing body of literature that considers a cardiac event as a turning point towards healthier lifestyle behaviors(11, 18, 42, 43). We found that lifestyle changes may be not directly instigated by the MI, but are rather the consequence of a continuous process of sensemaking over a longer period of time after hospital discharge. This has also been established in previous studies and reflects a more universal view of a turning point as a gradual process rather than a single moment(18, 44).

For some patients, the experience of an MI induced a clear TW towards adopting healthier behaviors, whilst others showed more avoidant coping behaviors. That psychosocial sensemaking plays an important role in this divergence was also evident in other studies of cardiac events, where relatable psychosocial themes were identified. These themes may therefore be important in TW mechanisms. For example, previous studies emphasized the importance of causal beliefs linking lifestyle and cardiac health, as well as outcome expectations(18, 45, 46). In addition, Bremer et al.(38) reported that feelings of security changed after experiencing a cardiac arrest, often accompanied by emotional distress. Similar themes also emerged in our study regarding an increased perception of vulnerability, health worries, and the perceived finiteness of life. A confrontation with the finiteness of life can cause people to change their approach on life and adopt different attitudes and motivation related to certain life activities(43). Also, in line with previous research(11, 18), our findings underscored that experiencing physiological benefits of lifestyle changes seemed to enhance patient commitment to maintain to the changes. This is likely tied to interoception mechanism or the ability to process afferent bodily signals(47). A higher interoceptive sensitivity has been linked to engaging in beneficial health behaviors such as PA(48), whereas lower interoceptive sensitivity has been associated with unfavorable behaviors, like smoking(49). Our finding that attitude towards medication was important was also similar to the findings of previous research, for instance demonstrated by a clear preference for lifestyle change over medication use(50). Moreover, Lönnberg et al.(51) found that a wish to avoid medication encouraged taking the health behavior necessary

to control cardiovascular health. Earlier studies also emphasized the influential roles of family, friends, and healthcare professionals in cardiac patients' lifestyle changes, offering direct support, enabling behavior change, or providing motivation(18, 46, 52), a theme recurrent in the present study.

Reflecting on one's self-concept, identity, and social roles was found to be an important sensemaking process within experiencing a TW. These concepts have previously considered as important mechanisms of behavioral change. As they cause individuals to reflect on their priorities, significant life events such as acute cardiac events may often be accompanied by a re-evaluation of social roles(53). In our sample, this was driven by a confrontation with the emotions of patients' loved ones after their MI, which increased their awareness of the social roles they wished to fulfill. Life events can additionally trigger a reappraisal of aspects of identity and self-concept(13, 40, 54), the latter referring to the belief that someone has about oneself or one's position in a wider social context(55). We found that an MI can cause patients to look at themselves differently and reconsider their sense of vulnerability. This transition often entailed a shift towards greater perceived accountability for personal health. This transformation was closely tied with gratitude and anticipated regret, as patients did not want to take their "second chance" for granted. Another important factor is identity, as we found that health behaviors that did not correspond with a patient's self-identity seemed to be more difficult to pursuit. A higher likelihood of pursue of behavior that is consistent with one's identity was also emphasized by Jin et al(56) and Rhodes et al.(31).

Next to perceiving an inconsistency between a health behavior and someone's identity, we also encountered other adverse processes that seemed to hinder the experience of a TW after a cardiac event. Our findings align with those of Nicolai et al.(18), who also found that a perceived lack of necessity for behavioral change hindered cardiac patients' adherence to recommendations. In our study, some participants believed that they have completely recovered in health, which further reduced their perceived necessity of a healthy lifestyle. Nonetheless, it is also possible that these participants only claimed full recovery as a coping mechanism to avoid anticipated regret over not changing behaviors or to mask fear of losing control over their illness. Falun et al.(19) encountered satisfaction with former behavioral habits as a barrier to lifestyle change after an MI. A similar theme emerged in our study. Other adverse processes that we encountered, such as cognitive dissonance regarding the discrepancy between lifestyle beliefs and current behaviors, highlight the importance of providing structural lifestyle support in cardiac healthcare, as health promotion interventions that attempt to lower cognitive dissonance are known to be effective in establishing sustainable behavior change(57).

Theoretical interpretations

Several themes encountered in our study align with the heuristic framework proposed by McBride et al.(9). McBride's changed self-concept is similar to our theme "reflections about priorities, self, and social roles". We both recognize "affective impact" as a key determinant of a TM, and our themes "perceived link between lifestyle and health" and "perceived susceptibility, vulnerability, and health-related worry" are equivalent to McBride's concept of risk perception. However, these themes were far from exclusive and did not operate independently. For instance, our findings suggest that perceiving an affective impact of the MI may interrelate with reflections on one's priorities, self, and social roles, which is also previously established in literature(58, 59). The self-determination theory (SDT), often been applied to explain intrinsic motivation(60)(61), is also also consistent with some important themes we encountered. For example, the need for competence part of the SDT aligns with our theme "self-efficacy and perceived behavioral control", while the need for relatedness show similarities to our finding that a changed outlook on social roles was important for behavior change. Moreover, similar to the SDT, we found that feelings of autonomy in regaining control over one's life and health played an important role in making beneficial changes. We therefore believe that an extension of McBride's TM framework(16) would bring it a step closer to reality. Consequently, we have proposed a heuristic framework with themes and inter-theme pathways that may explain an MI-related TW. This framework will need to be further validated in future studies.

When we consider the time after a health event as a TW rather than a TM, McBride's heuristic framework(9) can also be integrated with principles of the Salutogenic model and, in particular, factors involved in Sense of Coherence (SOC)(62). According to this model, having a strong SOC is a coping mechanism that supports maintenance of good health, aided by perceiving stressors in life as comprehensible, manageable, and meaningful(62, 63). Certain themes encountered in our study, such as "comprehending the narrative concerning the MI" and "re-evaluating one's priorities or self", show similarities to SOC. When patients are able to attribute a positive meaning to their MI, they can potentially achieve a SOC and have healthier coping mechanisms. Achieving a SOC may therefore be an important underlying explanation of how acute life events become TWs(43). Our finding that earlier significant life events may impede a TW may be related to the findings of Wolff et al.(64), who reported that recent traumatic life events negatively impact SOC.

Practical implications

Cardiac healthcare professionals can play an important role in supporting cardiac patients' lifestyle changes(18), especially during a TW. To make the most of this opportunity, it is

important for healthcare professionals to be attuned to the processes of sensemaking described in this study, while also taking patient differences into account. One way to capitalize on a TW, based on our themes, is to encourage patients to reflect on their identity and goals in life, while supporting them in making connections to healthy behaviors that align with their values. Motivational interviewing techniques, with its principles closely related to the factors of the SDT(65), can be particularly useful in encouraging patient autonomy regarding their personal goals(66). Moreover, it is essential to allow room for psychosocial consultation, where healthcare providers can discuss the impact of the MI on the patient's life and encourage the patient to construct a narrative around their MI, as the latter has been shown to support a process of greater self-awareness(41). Physical training sessions can also provide an opportunity to form new cognitions about one's self and their one's identity as an exerciser or physically active person.

Importantly, as we observed that patients may experience a change trajectory regarding their motivation to live a healthy life, lifestyle counseling should not be confined to the hospital but should also continue and be targeted towards helping patients integrate healthy habits to their daily lives. As the transfer from hospital to home is frequently perceived as insecure by cardiac patients(38, 42), there is a need to provide continuity of lifestyle support during the TW(67). Personalized eHealth application seem promising for this(68). Finally, involving partners or family members throughout the rehabilitation phase may be a promising approach for promoting long-term success.

Methodological considerations and future perspectives

To the best of our knowledge, this is the first study using an IPA approach to explore a cardiac event as a potential TW. Our sample of 13 participants exceeded recommendations for IPA research(69). The ideographic focus of IPA(35) allowed us to obtain in-depth insights into the processes of sensemaking that were important for experiencing a TW in our sample. It should be noted that the interpretative nature of IPA(37) means that the analysis of patients' interpretations may be shaped by the authors' prior knowledge of TMs. To reduce this influence we used inductive analysis as much as possible, as well as a second coder without such prior knowledge. The utilization of a convenience sample of interested patients and the lack of information of patients who declined to participate limit the generalizability of our findings. While generalizability is not a primary objective in IPA studies, we encourage scholars to explore the applicability of our findings to a broader range of cardiac patients, including those from diverse cultural backgrounds. Moreover, we encourage scholars to further explore cardiac events as TMs using IPA and longitudinal survey studies to empirically evaluate the predictive properties of our proposed heuristic

framework on objective behavioral outcomes. Additionally, while our use of two interview points provided insights concerning lifestyle trajectories after hospital discharge, it is still not known whether patients achieved sustainable lifestyle changes that will persist for the remainder of their lives. Future research is needed to determine whether an MI-related TW can actually induce sustained behavioral habit formation and automatic behaviors in cardiac patients. Finally, we encourage other scholars to conduct fundamental and applied research on utilizing TWs, including the timing, context and practical implementation of personalized lifestyle support, taking into account the perspectives of the cardiac patient as well as the healthcare professional.

Conclusion

The findings of this study demonstrate that experiencing a TW after an important life event such as an MI is influenced by psychosocial contexts, thoughts, and cognitions, that interact and influence a person's intention to change their health behaviors. We encountered certain processes of sensemaking that may be important in explaining behavioral change after important life events. Given these findings, one may conclude that there is an important window of opportunity for providing lifestyle counseling after acute cardiac events or comparable chronic disease diagnoses. To maximize impact on behavioral change, it is important for cardiac healthcare providers to incorporate lifestyle consultations that connect to a patient's psychosocial sensemaking, over a longer period of time following an event.

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SUPPLEMENTARY MATERIAL 1

Interview schedule T1

Demographics (quantitative):

- Sex, age, country of birth mother and father, relationship status, education.

Smoking and alcohol consumption (quantitative):

1. **Do you smoke?**
   - ☐ Yes, on average … cigarettes per day.
   - ☐ No
   - ☐ No, I quit smoking since … .
2. **Do you ever drink alcohol?**
   - ☐ Yes, on average … glasses per day
   - ☐ No
   - ☐ No, I quit drinking alcohol since … .

Discussing the myocardial infarction

1. **Can you tell me about your heart attack?**

   Prompts:
   - Can you tell me about the period before your heart attack?
   - Can you tell me about the time in the hospital?
   - Can you tell me about the weeks after you came back home?
2. **Can you tell me about the emotional impact of your heart attack?**

   Prompts:
   - How did it affect you?
   - How did your social environment/partner experience this period, and how was that for you?

Impact of myocardial infarction on life and lifestyle

1. **Can you tell me about the impact of your heart attack on your life?**

   Prompts:
   - Can you tell me something about your life?
   - Have there been any changes in your life due to your heart attack?
     i. How does this affect you? What do you think about it? How did this happen?
   - Are there things you were able to pick up again since your heart attack?
     i. How does this affect you? What do you think about it? How did this happen?

- Can you describe if your heart attack has had any other impact on areas of your life, such as work, relationships, or sexuality?
    - i How does this affect you? What do you think about it? How did this happen?

2. **Can you tell me about your lifestyle before your heart attack?**

   Prompts:
   - Can you tell me about your [diet, exercise, smoking, alcohol consumption, stress, and sleep]?
   - To what extent were you concerned about your lifestyle?
       i. Did you ever think about living healthier? What thoughts went through your mind?
3. **Can you tell me about your lifestyle since your heart attack?**

   Prompts:
   - Can you tell me about your current [diet, exercise, smoking, alcohol consumption, stress, and sleep]?
4. **Can you describe if and how your heart attack has influenced your lifestyle? By lifestyle, we mean diet, exercise, smoking, alcohol, stress, sleep, and other aspects related to your health.**

   Prompts:
   - Have there been any changes in your diet and lifestyle since your heart attack?
       i. Can you give an example?
   - In what ways has it influenced specific choices you make?
   - In what ways has it influenced your thoughts about lifestyle?
5. **Do you ever think about wanting to live a healthier life? What thoughts go through your mind?**

Changes in (intention to change) lifestyle since myocardial infarction: yes

1. **Can you tell me how this went?**

   Prompts:
   - What made it difficult/easy?
2. **Can you describe what led to the change in [behavior]/why you wanted to change [behavior]?**

   Prompts:
   - In what way did your heart attack play a role?
   - Can you describe your [thoughts about] lifestyle from the period before your heart attack until now?
   - What other things played a role?

     Prompt: personal factors, social factors, environmental factors

3. **Why is it that you want to change/have changed [behavior] now, and for instance not before your heart attack?**
4. **Almost everyone does something unhealthy at times. Can you describe what goes through your mind when you make an unhealthy choice now?**
   Prompts:
   - How was this before your heart attack? How is it different now?
5. **Do you expect to maintain these changes?**
   Prompts:
   - What makes you expect this or not?
6. **Do you ever think about changing (or not changing) something else in your diet and lifestyle?**
   Prompts:
   - What makes you want it?
   - What makes it difficult/easy?
7. **How do you see your lifestyle in the future?**

Changes in (intention to change) lifestyle since myocardial infarction: no

1. **What makes you find your lifestyle good as it is? What led you to not wanting to change [behavior]?**
   Prompts: personal factors, social factors, environmental factors
2. **Can you describe your [thoughts about] lifestyle from the period before your heart attack until now?**
3. **Are there things that you find difficult to change in your diet and lifestyle?**
   Prompts: personal factors, social factors, environmental factors
4. **How do you see your lifestyle in the future?**

Final questions:

1. **Can summarize how your heart attack has impacted your lifestyle and why you think this happened?**
2. **Have you been able to share everything? Is there anything else you would like to discuss/add?**
3. **Are there other things that have been important to you regarding your heart attack and lifestyle?**
4. **Are there any other things you would like to discuss?**

Interview schedule T2

Smoking and alcohol consumption (quantitative):

1. **Do you smoke?**
   Yes, on average … cigarettes per day.
   No
   No, I quit smoking since … .
2. **Do you ever drink alcohol?**
   Yes, on average … glasses per day
   No
   No, I quit drinking alcohol since … .

Discussing the myocardial infarction

1. **Can you tell me about the last couple of months since your heart attack?**
   Prompts:
   - Can you tell me about your feelings?
   - Can you tell me where you are now in the process?
   - Which aspect of the past months do you remember the most and why?
2. **Can you tell me about the emotional impact of your heart attack?**
   Prompts:
   - How did it affect you?
   - How did your social environment/partner experience this period, and how was that for you?

Impact of myocardial infarction on life and lifestyle

1. **Can you tell me about the impact of your heart attack on your life?**
   Prompts:
   - Can you tell me something about your life?
   - Have there been any changes in your life due to your heart attack?
     i. How does this affect you? What do you think about it? How did this happen?
   - Are there things you were able to pick up again since your heart attack?
     i. How does this affect you? What do you think about it? How did this happen?
   - Can you describe if your heart attack has had any other impact on areas of your life, such as work, relationships, or sexuality?
     i. How does this affect you? What do you think about it? How did this happen?
   - Has the way you see yourself changed?
   - Have there been any changes that you feel good about?

2. **Can you tell me about your lifestyle since your heart attack?**
   Prompts:
   - Can you tell me about your current [diet, exercise, smoking, alcohol consumption, stress, and sleep]?
3. **Can you describe if and how your heart attack has influenced your lifestyle? By lifestyle, we mean diet, exercise, smoking, alcohol, stress, sleep, and other aspects related to your health.**
   Prompts:
   - Have there been any changes in your diet and lifestyle since your heart attack?
     i. Can you give an example?
   - In what ways has it influenced specific choices you make?
   - In what ways has it influenced your thoughts about lifestyle?
4. **Do you ever think about wanting to live a healthier life? What thoughts go through your mind?**

Changes in (intention to change) lifestyle since myocardial infarction: yes

1. **Can you tell me how this went?**
   Prompts:
   - What made it difficult/easy?
2. **Can you describe what led to the change in [behavior]/why you wanted to change [behavior]?**
   Prompts:
   - In what way did your heart attack play a role?
   - Can you describe your [thoughts about] lifestyle from the period before your heart attack until now?
   - What other things played a role?
   - Prompts: personal factors, social factors, environmental factors
3. **Why is it that you want to change/have changed [behavior] now, and for instance not before your heart attack?**
4. **Almost everyone does something unhealthy at times. Can you describe what goes through your mind when you make an unhealthy choice now?**
   Prompts:
   - How was this before your heart attack? How is it different now?
5. **Do you expect to maintain these changes?**
   Prompts:
   - What makes you expect this or not?

6. **Do you ever think about changing (or not changing) something else in your diet and lifestyle?**
   Prompts:
   - What makes you want it?
   - What makes it difficult/easy?
7. **How do you see your lifestyle in the future?**

Changes in (intention to change) lifestyle since myocardial infarction: relapse

1. **Can you tell me about your [thoughts about] lifestyle from the period before your heart attack until now?**

Prompts:

- Can you describe how it happened that you started thinking differently about lifestyle since the last interview?

2. **Can you explain how it happened that you restarted [behavior] again?**
   Prompts:
   - In what ways does your heart attack still play a role?
   - What other things played a role?
   - Prompts: personal factors, social factors, environmental factors

Changes in (intention to change) lifestyle since myocardial infarction: no

1. **What makes you find your lifestyle good as it is? What led you to not wanting to change [behavior]?**
   Prompts: personal factors, social factors, environmental factors
2. **Can you describe your [thoughts about] lifestyle from the period before your heart attack until now?**
3. **Are there things that you find difficult to change in your diet and lifestyle?**
   Prompts: personal factors, social factors, environmental factors
4. **How do you see your lifestyle in the future?**

Cardiac rehabilitation:

1. **Could you describe how you experienced your participation in the cardiac rehabilitation program?**
2. **To what extent/how has participation in cardiac rehabilitation influenced your lifestyle?**

Final questions:

1. **Can summarize how your heart attack has impacted your lifestyle and why you think this happened?**
2. **Have you been able to share everything? Is there anything else you would like to add/discuss?**
3. **Are there other things that have been important to you regarding your heart attack and lifestyle?**
4. **Are there any other things you would like to discuss?**

SUPPLEMENTARY MATERIALS 2: OVERVIEW THEMES

Differences in lifestyle and lifestyle intentions – T1

Initial influence on lifestyle behaviors:

a. Quitted smoking the occasional cigar (1)
b. Emphasis: little and simple adjustments in diet (2)
c. Quitted smoking immediately after event (2, 11, 12)
d. MI as turning point for smoking cessation (2, 11, 12)
e. Actively suppress smoking habit (2, 12)
f. Wanting to avoid stress (3, 6, 9, 10)
g. Drastic dietary change (4, 9, 13, 14)
h. Dietary changes: fewer sweets (4)
i. Lowering/quitting alcohol consumption (4, 9, 14)
j. Smoking less after MI (6)
k. Elaboration of plans to reduce stress (9, 14)
l. Elaboration of plans to improve diet (9)
m. Immediate weight loss after MI (9)
n. Healthier dietary habit formation (9, 8, 13)
o. Initially quit alcohol to prevent losing control (9, 14)
p. Impact of MI on stress reduction: taking care of self, relaxation, and avoiding stress (10, 14)
q. In progress: learning to relax (10)
r. Incorporating simple increases in PA: taking the stairs instead of the elevator (11)
s. Small reduction in alcohol consumption (12)
t. Dietary changes: reduction rather than banning (13)
u. Dietary changes: immediately cut off food that are bad for health (13)
v. Consuming less alcohol due to medication (13)
w. Dietary changes: smaller portions (14)
x. New rule: no longer allowing to eating until full (14)
y. Impact on life: becoming a calmer person (14)

Influence on lifestyle intentions:

a. Motive to drink less alcohol: to lose weight (1)
b. Struggle: smoking cessation (2)
c. Intention to follow dietary advices of healthcare (2)
d. Doubts about permanent smoking cessation (2, 11)

e. Wanting to be more physically active after event (2, 6, 7, 9, 11)
f. Wanting to lose weight (2, 7)
g. Not sure about motivation to change diet (3)
h. Postponing behavior change: intention to search information about healthy lifestyle (3)
i. Health-related information seeking (3)
j. Searching for behaviors to improve: diet (4)
k. Increased feelings of guilt when smoking (6)
l. Ambivalence regarding smoking cessation: wanting to quit and not wanting to quit (6)
m. Plan: to discuss diet with dietician (6)
n. Wanting to reduce stress but not feeling able to (6)
o. Postponing dietary change: intention but not started yet (7)
p. Belief: relaxation important for recovery (7, 10)
q. Becoming more aware of importance to live healthy (7)
r. Increased notion of importance of exercise (7)
s. Increased notion of importance of relaxation (7, 9, 10, 14)
t. Taking more time for relaxation (7, 9, 10, 14)
u. Goal: regular PA (9)
v. Consequence MI: taking better care of self/health (9, 10, 13, 14)
w. Major impact on life: not wanting to relax but need to (10)
x. Goal: continuing taking time for relaxation after recovery (10)
y. Wanting to lose excessive weight gain (11)
z. Motive for changing diet only related to weight gain (11)
aa. Goal: adhere to dietary changes until reaching target weight (11)
ab. Motive for being more active: to lose excessive weight gain (11)
ac. Wanting to increase PA for weight control and to improve physical condition (12)
ad. Has made no concrete plans for PA (12)
ae. Consuming less alcohol due to potential negative effects in combination with medication (13)
af. Doubts about motivation to drink less alcohol (14)
ag. Increased notion of the dangers of overeating (14)

No initial influence on intentions and behaviors:

a. Little impact of MI on diet (1, 7, 10, 12)
b. Little adjustments in diet after MI (2)
c. No impact of MI on lifestyle (5, 8)
d. No impact of MI on diet (5, 8)
e. No intention to change alcohol consumption (5)

f. Continue to smoke with increased guilt (6)
g. No intention to change alcohol and diet (8)
h. Acceptance of high stress in life (8)
i. Continuing former exercise behavior (3, 8, 13)
j. Continue drinking alcohol (8, 11, 14)
k. Negative impact of MI on PA due to deteriorated physical condition (10, 14)
l. Restarted drinking alcohol after doctors' approval (14)

Differences in lifestyle and lifestyle intentions – T2

Teachable moment for lifestyle intentions and change

a. Started PA on a low level (1)
b. Increase in exercise (2, 7, 9, 14)
c. Regularly exercising as part of new life (2, 7, 9, 14)
d. Staying absent from smoking remains difficult (2)
e. Start with changing simple behaviors, rest will follow (3)
f. Dealing more optimally with stress implemented in life (3)
g. New dietary behaviors became habit (4, 7)
h. More physically active: biking and walking (4)
i. MI as positive experience (4, 7, 9, 14)
j. Reduced alcohol consumption (4, 9)
k. Reduced number of daily cigarettes (6)
l. Taking more time for relaxation (6, 7, 9, 10)
m. Major impact of MI on diet (4, 7, 9, 13)
n. Habit formation: reaching daily exercise goals (7)
o. Habit formation: scheduling moments for rest and relaxation (7)
p. Change: eating smaller portions as an acceptable alternative (8, 14)
q. Unconscious changes in diet: becoming more aware of importance of healthy lifestyle, not thinking about MI (8)
r. Follow dietary advices to be sure (8)
s. Reason to exercise: to feel physically and mentally better (9)
t. In progress: searching for a healthier way to deal with work and stress (9)
u. In progress: preventing relapse to former snacking habits (9)
v. Habit formation: exercise (9, 11)
w. Slight increase in exercise (10)
x. Impact of MI on stress reduction: taking care of self, relaxation, and avoiding stress (10)
y. Staying absent from smoking with minor effort (11)

z. Staying absent from smoking while experiencing reduced cravings (12)
aa. Habit formation: has cut off food that are bad for health (13)
ab. Consuming less alcohol due to potential negative effects in combination with medication (13)
ac. Impact of MI on stress reduction: being a calmer person and taking more time for relaxation

Discrepancy between contemplating change and actively pursuing change

a. Continue drinking alcohol, with minor reduction in alcohol consumption (1)
b. Positive test results as starting point for unhealthy behaviors again (3, 8, 11, 14)
c. Drifting back to old unhealthy behaviors (3)
d. Difficulty with sustained behavior change (3) – finding time for exercise (4)
e. Faded motivation to adhere to healthy diet (3)
f. Less motivated to adhere to dietary changes due to contradictory lifestyle advices (3)
g. Drifting back to behaviors that fit with identity, yet with minor adaptations: reduction rather than avoidance (3)
h. Interested in increasing PA, no concrete plans (6)
i. Health problems prevent capability to exercise (6)
j. Wanting to reduce stress but not feeling able to (6)
k. Struggle: adhering to healthy lifestyle during transition to work (9)
l. Relapse facilitates falling into old habits (9)
m. Occasionally using alcohol as reward (9)
n. No longer an impact of MI on diet (11)
o. No longer intended to optimize PA (12)

Maintaining former (unhealthy) behavioral habits:

a. No impact of MI on diet (1, 5, 6, 12)
b. Not following dietary advices from healthcare (2)
c. Negative impact of MI on diet: snacking as substitute for cigarette cravings (2)
d. Already followed an active lifestyle (3, 8)
e. Continuing former exercise behavior (3, 8)
f. Little impact of MI on diet (7, 10)
g. No impact of MI on lifestyle (5, 8)
h. No intention to change alcohol consumption (5, 8)
i. Health problems prevent capability to exercise (5)
j. Continue drinking alcohol (5, 8, 11, 13, 14)
k. Acceptance of high stress in life (8)

l. Continuing former PA (8)
m. Restarted drinking alcohol after doctors' approval (14)

Psychosocial sensemaking processes

Perceived susceptibility:

a. Period of uncertainty increased worries about heart (2)
b. Worries about health (2, 4, 6, 10, 12, 14)
c. Worries about heart (2, 3, 6, 10, 12)
d. Uncertainty about physical limits (2, 6, 10, 13, 14)
e. Stress evokes heart-related worries (3)
f. Health-related information seeking: own cardiovascular risk (3)
g. Worries about potential recurrent event (3, 6, 10, 12)
h. Shift in perception towards illnesses could happen to me (2, 4, 6, 10, 12)
i. When asked directly: low worry (5)
j. Avoidant coping: Suppressing health-related worries (6)
k. Previously aware of own cardiovascular risk (6, 7)
l. First moment of fear: notion of limited physical fitness (7)
m. Belief: thin line between health and illness (7)
n. Worries about colorectal cancer – unrelated to cardiovascular health (8)
o. Affected by notion of limited physical condition (10)
p. No health-related worries (13)
q. No worries about recurrent MI (13, 14)
r. Perceived susceptibility for acquiring health problems/lifestyle-related disorders (14)
s. Higher perceived need for healthy living (10, 11)

Becoming aware of own vulnerability and finiteness of life

a. Impaired confidence in health (2, 10)
b. Expectation: physical deterioration due to MI (2)
c. Worries about physical or mental decline (2)
d. Motive for smoking cessation: to slower physical and mental decline (2)
e. Becoming aware of finiteness of time (2, 3, 7, 9, 10, 13)
f. Expectation: physical decline or becoming more vulnerable (2, 7)
g. Perception of being close to death (3, 9, 10, 12)
h. Confronted with finiteness of life (3, 10, 11, 12)
i. Already aware of own cardiovascular risk (7)
j. Belief: life is vulnerable (7, 12)

k. Being careful with health because enjoys life (13)
l. Increased notion of importance to take better care of self (11, 12, 13, 14)

Physical symptoms and attentive self-care:

a. Feeling fatigued after MI (1, 3, 10, 11, 14)
b. Physical symptoms increase health worries (1, 9)
c. Becoming aware of lower physical condition (2)
d. Physical symptoms cause smoking cessation intention (2)
e. Feeling better after surgery (2, 6, 9)
f. Stress evokes heart-related worries (3)
g. Alert on symptoms (3, 10)
h. Lack of motivation to eat healthy due to absence of complaints (5)
i. Physical symptoms prior to MI (6, 9, 10)
j. First moment of fear: notion of limited physical fitness (7)
k. Responsiveness to body needs: Consideration of healthy habits depending on body needs (7)
l. Insensitive to bodily symptoms (8)
m. Lack of symptoms prior to MI cause fear (9)
n. Worries due to notion of being fatigued (10, 14)
o. Responsiveness to body needs: taking more time for relaxation because body needs this(10, 14)
p. Notion of limited physical fitness (10)
q. Notion of limited physical fitness increase motivation for healthy living (11)

Autonomy and taking back control over life and body:

a. Motive for losing weight: wanting to improve condition and mobility (1, 2, 9, 11)
b. Motive for exercise: to improve physical condition (1, 10, 11)
c. Fear of losing control over life (1, 2, 8, 11)
d. Worries about declining physical condition (1, 2, 8, 11)
e. Motive for exercise: to regain previous energy (1)
f. High importance to autonomy (2, 11)
g. Little effort: improving diet to extent life expectancy (2)
h. Wanting to increase mobility and independence (2, 11)
i. Goal: increase the chance of healthy remaining life (4, 6, 9)
j. Not wanting to extent life expectancy with lifestyle restrictions (5)
k. Acceptation of becoming dependent of others (7)
l. Lower need for autonomy (7)

m. Goal: get the most out of remaining life (9)
n. Need for autonomy: having a hard time with accepting help (10)
o. Goal: back to old level of mobility (10, 14)
p. Need for control: own influence on health outcomes (13)

Self-efficacy and perceived control over behaviors and health

a. Low control over dietary behavior: determined by partner (1, 2)
b. Perceived control over own behaviors (8, 13, 14)
c. Wanting to avoid stress but not able to (6, 8)
d. Previous successes facilitate motivation (7, 8, 9, 11)
e. Previous successes facilitate sense of mastery (7, 8, 9)
f. High self-efficacy: lifestyle changes perceived as easy (11, 13, 14)
g. Behavior changes perceived as simple (11, 13, 14)
h. Quitted smoking with minor effort (11)
i. High confidence in ability to stay absent from smoking (11)
j. Emphasis on own initiative in lifestyle change(13)
k. Dietary changes perceived as easy (13)
l. Being able to drink less alcohol increased self-efficacy (14)

Prevention of anticipated regret or feeling weak:

a. At least want to do everything possible to prevent anticipated regret (1, 2, 8, 9, 13)
b. Start PA to prevent anticipated regret (1)
c. Start PA to deal with anticipated negative reactions from colleagues (1)
d. No longer able to justify smoking after MI (2)
e. No longer able to justify smoking towards self and family (2)
f. Belief: continuing to smoke is weak (2, 13)
g. Anticipated shame when continuing unhealthy behavior (2, 4)
h. Insecure about level physical condition (11)
i. Wanting to improve physical condition to prepare for cardiac rehabilitation (11)
j. Belief: not changing behaviors is weak (4)
k. Increased feelings of guilt when smoking (6)

Re-evaluation of priorities and life goals:

a. Doubts about working again (1)
b. Redefinition of priorities in life (4, 6, 7, 9, 14)
c. Re-evaluation of life priorities: loved ones more important (4, 7, 9, 14)
d. Becoming more connected to loved ones (4, 9)

e. Being grateful about second chance in life (4, 6, 7, 9, 11, 13, 14)
f. Resumed to normal life activities very quickly (5, 11, 13)
g. Event has little impact on life (5, 11)
h. Reflection on past life and values (7, 9, 14)
i. Event as cue to redefine life priorities (7)
j. Re-evaluation of life priorities: work less important (7, 9, 14)
k. Contrast with previous habits: work (7)
l. Longer after event: start to think of work again (7)
m. Consideration of future mainly on work area (7)
n. MI facilitated plan to work less (7, 14)
o. Re-evaluation of life priorities: wanting to become more social (9)
p. Anticipation: work being a barrier for living healthy (9)
q. In decision phase: can I continue to work? (10)
r. Ambivalence: wanting to continue to work but unsure about ability to do so (10)
s. Worries about going back to work (10)
t. Not wanting to work again (14)

Reflection about self-concept prior and after event:

a. Feeling ashamed about deteriorating condition (2, 10, 14)
b. Old unhealthy behaviors incongruent with self (4, 8, 9, 11, 14)
c. Becoming a better and more likeable version of self (4, 7, 9)
d. Reflection on past life and values (7, 9, 14)
e. New healthy behaviors congruent with self (7, 8, 9)
f. Feeling closer to self: prouder and more confident (7, 9)
g. Dissatisfaction with self and appearance prior to MI (9)
h. Critical reappraisal of appearance and self (9)
i. Towards congruence with desired self (9)
j. Redefining unhealthy behaviors as incongruent with self and appearance (9, 11)
k. Linking alcohol consumption to previous disliked self (9)
l. Impaired identity as an independent person (10)

Identity as a heart patient:

a. Feeling like a heart patient (2, 4, 7, 9, 11, 14)
b. Believing that being a heart patient implies restrictions (2, 4, 9)
c. Accept being a heart patient (2, 4, 9)
d. Safe anchor of being a healthy person was gone (3)
e. Shift between feeling ill and not feeling ill (3, 10)

f. Patient role does not fit identity (3, 10)
g. Affected by notion to be a heart patient (4)
h. Not feeling like a real heart patient (8, 11, 14)

Shift in social role

a. Re-evaluation of social role (4, 7, 9, 14)
b. Changed importance: family before work (7, 9, 14)
c. Re-evaluation of life priorities: loved ones more important (4, 7, 9, 14)
d. Wanting to become more social (9)
e. Becoming more connected to loved ones (4, 9)

Creation of a personal and comprehensive narrative around the event:

a. Narrative around event: searching for cause MI (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14)
b. Reflection: impact of event on behavior (2, 3, 4, 7, 9, 14)
c. Reflection: MI was preventable (2, 3, 9)
d. Accept that MI has consequences for life and lifestyle (2, 3, 4, 7, 9, 14)
e. Reflection: what does the event mean for me? (3, 4, 7, 9, 14)
f. Health-related information seeking: Verification of own theory of cause MI (3)
g. MI was unexpected (3, 4, 5, 9, 10, 13, 14)
h. MI was unexpected due to medication to control cardiovascular health (5)
i. Belief: not meeting risk factors (7)
j. Reflection on past life and values (7, 9, 14)
k. Considering behavior change as positive progress in life (9, 11)
l. Considering behavior change as logical consequence of MI (9)

Causal attribution to lifestyle as cause of MI

a. Own theory: smoking as perceived cause MI (2, 11, 12)
b. Direct link between behavior and cardiovascular health (2, 3, 6, 7, 8, 9, 10, 11, 12, 14)
c. Self-blaming (2, 3, 9, 12)
d. Reflection: MI was preventable (2, 3, 9)
e. Stress evokes heart-related worries (3)
f. Attribution MI: stress (3, 6, 8, 9, 10, 12, 14)
g. Direct link between stress and cardiovascular health (3, 9, 10)
h. Attribution MI: work-related stress (3, 4, 9, 14)
i. Confronted with consequences of unhealthy behaviors (9)
j. Fear of potential consequences of unhealthy behaviors (9)
k. Attribution MI: genetics, lifestyle and stress (9)

l. Attribution MI: past unhealthier behaviors (11)

Causal attribution of MI unrelated to lifestyle:

a. Cause of MI unrelated to lifestyle (1, 3, 5, 13)
b. Fully convinced: cause of MI unrelated to lifestyle (5)
c. Cause of MI unrelated to smoking (6)
d. MI was unexpected due to active lifestyle (8, 13)
e. MI was unexpected due to healthy lifestyle (10)
f. Cause of MI unrelated to diet (1, 5, 8, 10, 12)
g. Cause of MI: genetics and bad luck (13)
h. MI was unexpected due to no family history (14)

Response efficacy and risks of unhealthy behaviors:

a. Belief: smoking cessation reduces chance of worsening of CVD (2, 6, 12)
b. Regulation cholesterol: internal locus of control (3)
c. Internal locus of control: perceived influence on own health (2, 3, 4, 9, 13)
d. Direct link between stress and cardiovascular health (3)
e. Perception about people living unhealthy: illness is own fault (4, 13)
f. Becoming more aware of urgency to live healthy (because of illness diagnosis) (2, 3, 4, 9, 7, 11, 13, 14)
g. Motive for changing diet: lower another risk factor (7)
h. Perceiving alcohol consumption as constructive behavior (9, 13, 14)

Low perceived link between lifestyle and health:

a. Belief: healthy living does not implies good health (1)
b. External locus of control (1)
c. Not fully convinced of link between smoking and illness (1)
d. Not fully convinced of link between diet and illness (5, 8)
e. Belief: no clear link between smoking and mortality (6)
f. Belief: little influence on own health (5)
g. No perceived link between alcohol and health (8, 13)
h. Lack of insight in dangers of alcohol (11, 13)
i. Not convinced about alcohol-health link (14)

Support and information from healthcare

Attitude towards medication:

a. Complete trust and surrender to medication to control cardiovascular health (1, 7, 8)
b. Struggle: medication use (2, 4, 10, 11)
c. Doubts about use or efficacy of medication (2)
d. Negative side effects of medication (3, 4, 10, 13)
e. Worries about negative side effects of medication (3, 4)
f. Negative side effects of medication worse than event itself (4)
g. Negative attitude towards medication (3, 4, 13)
h. Ambivalence: medication use and unhealthy diet (3, 13)
i. Wanting to fix cause by lifestyle instead of symptoms by medication (3, 4, 13)
j. Favoring changing diet rather than using medication (4, 13)
k. Expectation: better lifestyle equals less medication (4, 13)
l. Medication as a counteract for unhealthier habits (8)
m. Belief: alcohol increases potential negative effects of medication (9)
n. Medication as most significant consequence of MI (4, 11, 13)
o. Ambivalence: feeling good but having to take medications (13)
p. Ambivalence: good physical condition but having to take medication (13)
q. Distrust towards medication industry (13)
r. Temporally compliance: stop taking medications after a while to avoid being target of medication industry (13)
s. Motivation for reducing alcohol consumption: alcohol worsens negative effects of medication (13)

Attitude and trust towards healthcare:

a. Positive care experience: impressed with healthcare (2)
b. Feeling obligated to quit smoking towards healthcare (2)
c. Feeling obligated to live healthy towards healthcare (4)
d. Belief: rejection when continuing to smoke (2)
e. Appreciation of care (2, 4, 7, 8, 9, 10, 13)
f. Positive healthcare experience (4, 8, 9, 10, 13)
g. Negative healthcare experience (5)
h. Pain during surgery (5)
i. Low trust in healthcare (5)
j. Able to surrender to care of healthcare professionals (4, 7)
k. Trust towards healthcare (7, 13)

Received information and increased knowledge of health and health behaviors:

a. Follows dietary advices from healthcare (2, 13, 14)
b. Limited knowledge of healthy diet before MI (2,13)
c. Need for clear anchors (3)
d. Increased knowledge of aspects on health
e. Intention to follow dietary advices from healthcare (2)
f. Compliance with dietary adherence under certain conditions (2)
g. Need to see efficacy of behavior changes (3)
h. Increased knowledge about healthy lifestyle due to received information (4)
i. Expectation: receiving dietary advices (7)
j. Open/Need for tailored dietary advices (7)
k. Open for alternatives for bad dietary choices (13)
l. Restarted drinking alcohol after doctors' approval (14)
m. Wanting to lose weight after receiving lifestyle advices (14)
n. Dietary changes: cut off food that are bad for health (13)
o. Conspiracy: mistrust towards intentions of society (13)
p. Reason to cut off unhealthy behaviors: to not fall into the trap of society (13)
q. Wanting to lose weight after receiving lifestyle advices (14)
r. Restarted drinking alcohol after doctors' approval (14)

Reluctant and selective towards lifestyle advices and lifestyle change intention:

a. Disagree with alcohol restrictions (1)
b. Selectivity towards received lifestyle advices: only remembering lifestyle advices that fit own perspective (1)
c. Perceiving lifestyle advices as restrictions (2)
d. Justifying smoking behaviors because other behaviors are fine (6)
e. Contradictory lifestyle information lowers motivation to adhere to healthy lifestyle (8)
f. Less motivated to adhere to dietary changes due to contradictory lifestyle advices (3)

Need for anchors:

a. Need for closure: Low tolerance of ambiguity (3)
b. Need for clear anchors: efficacy of behavior changes (3, 4, 5, 8, 13)

Affect and emotions towards event:

a. Difficulties talking about MI (1, 2, 6)
b. Difficulties talking about emotions (1, 2, 5)
c. Description of event unrelated to emotions (1, 5, 11)

d. Description event focuses on medical aspects of MI (1, 5, 11, 13)
e. Emotional distancing (1, 2, 8)
f. Emotional when discussing MI (2, 6, 10, 12)
g. Vivid recall of MI (2, 6, 10, 12)
h. Aware of severity of event (2, 9, 10)
i. Perception of being close to death during event (3, 9, 10)
j. Realization: something serious has happened (4, 6)
k. Emphasizes: no fear during event (4, 5, 7, 8, 11, 13)
l. Gratitude as most salient emotion (4, 7, 9, 14)
m. Being grateful about second chance in life (4, 6, 7, 9, 11, 13, 14)
n. Feeling emotional after event (6, 10)
o. Few emotions around event (8, 11)

Affect of partner and loved ones

a. Responding indifferently about emotions of partner (1, 3, 5, 11)
b. Emotions of social environment as most saliant image (2, 4)
c. Emotions of social environment (2, 3, 4, 5, 7, 9, 10)
d. Contrast emotions patient and partner/social environment (2, 4, 7, 10, 11)
e. Worries of partner or loved ones (2, 5, 10, 11)
f. Feeling obligated to change behavior towards others (2)
g. Feeling obligated to change behavior towards loved ones (2, 4, 9)
h. Affected by emotions and social support of environment (2, 3, 4, 9, 10)
i. Affected by emotions of partner (2, 4, 9, 10)
j. Period of uncertainty for loved ones (2, 9)
k. Received support facilitated positive emotional coping (3)
l. Image of emotions of partner during unhealthy temptations (4)
m. Image of emotions of partner prevent unhealthy behaviors (4)
n. Conversations between patient and partner about event (4, 7, 9)
o. No conversations between patient and partner about event (5, 11, 13)
p. Fear of children (6)
q. Talking about event facilitated coping (9)
r. Low affective impact of event on couple (5, 11, 13)

Belief: full recovery of health at T2

a. Does not expect permanent damage to heart (4)
b. Belief: fully recovered in health (4, 5, 8, 13)
c. Feeling physically good facilitated confidence in health (8)

d. Belief: prognosis of CVD diagnosis more positive than prognosis of other health problems (8)
e. Belief: healthy compared to others (8, 11, 13)
f. Positive indication: lack of damage (8, 11, 13, 14)
g. Confirmation: good physical condition (8, 13, 14)

Attitude towards behavior

Negative attitude towards desired behavior

a. Belief: healthy eating/living healthy is not fun (2, 5, 8)
b. Aversion to healthy eating (2, 3, 5)
c. Belief: people that live healthy are dull (8)
d. Belief: people that eat healthy are dull (3)
e. Allergic to people that live very healthy (5)
f. Not wanting to exaggerate healthy living (5, 8)

Positive attitude towards unhealthy behavior

a. Sudden conflict: mixed feelings towards smoking (2)
b. Belief: smokers are fun (2)
c. Food as social activity (3, 8, 11, 12)
d. Enjoyment of unhealthy foods (3, 8, 11, 12)
e. Alcohol consumption as pleasure (8, 11, 13, 14)
f. Alcohol implies fun (8, 11, 13, 14)
g. Alcohol as social activity (8, 11, 13, 14)

Identity in relation to behavior (mismatch):

a. Snacking fits with identity (3)
b. Fear to become a boring old person (3)
c. Fear of identity change: becoming a dull person (3, 8)
d. Being a more dull person did not fit with desired self (3)
e. Unwanted identity change towards being a more dull person (3, 8)
f. Finding a balance between healthy lifestyle and social life (3)
g. Identity as a social person, unhealthier choices are part of this identity (3, 8, 11)
h. Going back to behaviors that fit with identity, yet with minor adaptations (3)
i. Old unhealthy behaviors incongruent with self (4, 8, 9, 11, 14)
j. Perceiving smoking as thing of self (6)
k. Drifting away from identity as smoker (6, 12)

l. Identity as a healthy person (7, 10, 13)
m. Exercise must match preferences (7)
n. Shift towards becoming a sporty person (7, 9)
o. Enjoyment of exercise facilitates compliance (7, 9)
p. Identity: social person that drinks alcohol– alcohol implies fun (8, 11, 13, 14)
q. Social events most important to self (8)
r. Feeling ashamed about becoming more conscious about health (8)
s. Being a stressful person as static character trait (8)
t. Avoiding stress incongruent with cultural identity (10)
u. Not working incongruent with identity (10)
v. Identity: not a real smoker (11)

Cognitive dissonance:

a. Reviewing narrative around MI: shifted from stress as cause towards lifestyle as cause (9)
b. Cognitive dissonance: changing life goals during unhealthy temptations (3)
c. Cognitive dissonance (1)

Perceiving lifestyle or behaviors as fine as is; no necessity to change:

a. Consideration of a behavior as relatively healthy (1, 3, 5, 6, 7, 8)
b. Consideration of overall lifestyle as relatively healthy (1, 5, 8)
c. Everything is fine, not necessary to change a behavior (1, 5, 6, 8, 10, 11, 14)
d. Overall standard during life: high importance to healthy lifestyle (10)
e. Not perceived as necessary to stop occasional snacking (5)
f. Consideration of diet as relatively healthy (10, 11, 14)
g. Aware of unhealthy dietary habits: no urgency to change (3, 5, 11)
h. Not wanting to exaggerate healthy living (5)
i. No perceived need of lowering alcohol consumption (11)
j. Incorrect perception patient: consideration of behavior as relatively healthy (6)
k. Sufficient active lifestyle (3, 8, 13)
l. Rarely drinking alcohol (10)

Compensatory health beliefs:

a. Justifying of unhealthier behaviors by emphasizing smoking cessation (2, 5, 12)
b. Justifying of unhealthier behaviors by emphasizing healthier behaviors (2, 4, 8, 12)
c. Justifying smoking behaviors because other behaviors are fine (6)
d. Emphasizes not being addicted to alcohol (8, 13, 14)
e. Justifying alcohol consumption (12, 13, 14)

Downsizing of perceived severity and impact of event:

a. Wording: using smaller words for event (1, 5, 8)
b. Not having the feeling that something severe has happened/low perceived seriousness of event (5, 8, 11, 13)
c. Description of event based on stories of others (3, 9)
d. Physical consequences more saliant than mental consequences (3)
e. Downplaying impact of event: not felt like MI (5, 11, 13, 14)
f. Not felt like MI due to lack of symptoms (11, 14)
g. Downscaling of impact event: Low sense of urgency (13)
h. When asked directly: Low sense of severity (13)

Previous significant life events:

a. Other life event as most saliant experience (1, 5, 8)
b. Period of stress as most saliant experience (3)
c. Other health problems outweighed impact of MI (5, 8)
d. Previous illness diagnoses (1, 5, 6, 11)
e. Health problems before MI (5, 6, 8, 11)
f. Previous life events diminish the perceived impact (5, 6, 8)
g. Positive aftermath MI compared to previous illnesses (8, 11)
h. Financial stressors (5, 6, 12)
i. Illness of partner (5)
j. Bad childhood (6)
k. Death of parent (6)
l. Death of ex-partner (8)
m. History of abuse (6)
n. Previous life event as a teachable moment for dietary change (10)
o. Previous life event as a teachable moment for smoking cessation (9)

SUPPLEMENTARY MATERIAL 3: STORIES OF LIFESTYLE CHANGE AND LIFESTYLE CHANGE INTENTIONS

Table 2. Stories of lifestyle change and lifestyle change intentions due to the myocardial infarction

Name	T1		T2	
James	Diet:	No impact of MI on diet.	Diet:	No impact of MI on diet.
	PA:	Thinking about increasing PA, but back pain prevents capability to exercise.	PA	Goal: becoming physically more active. Has started some PA at a low level.
	Alcohol:	Has reduced alcohol consumption due to medication intake.	Alcohol	Has continued former alcohol behaviors, with a minor reduction in alcohol consumption, yet being uncertain about whether to continue this.
	Smoking:	Has quitted smoking the occasional cigar	Smoking	Has quitted smoking the occasional cigar.
	Stress:	-	Stress:	-
Martin	Diet:	Low consideration of healthy diet, but minor adjustments in diet since MI: partner has reduced use of salt.	Diet:	Negative impact of MI on diet: snacking as substitute for cigarette cravings.
	PA:	Goal: to optimize his physical condition by exercising	PA	Has increased PA: regular cycling.
	Alcohol:	-	Alcohol	-
	Smoking:	Has quitted smoking immediately after MI but uncertain about whether to continue this because of cravings.	Smoking	Has stayed absent from cigarettes, which remained difficult.
	Stress:	-	Stress:	-
Amanda	Diet:	Is motivated to change diet to benefit cardiovascular health. Has reduced snacking: salty and sweet foods.	Diet:	Went back to former unhealthier dietary habits: salty and sweet foods, but with minor adaptations: reduction rather than avoidance.
	PA:	Continuing former exercise behaviors: already followed an active lifestyle	PA	Continuing former exercise behaviors: already followed an active lifestyle
	Alcohol:	Non-alcohol consumer	Alcohol	Non-alcohol consumer
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	Wanting to reduce stress.	Stress:	Has implemented actions to respond more healthily to stressors in life and taking more time for relaxation.

Table 2. *(continued)*

Name	T1		T2	
Thomas	Diet:	Major impact of MI on diet: e.g. cutting down snacks, stopped using sugar in tea and coffee, reading food labels.	Diet:	Habit formation regarding healthier diet.
	PA:	Wanting to (re)gain a good physical condition to prevent heart problems during intensity.	PA	Has started to become more physically active: biking and walking, yet difficulties in finding time.
	Alcohol:	Has decreased alcohol consumption.	Alcohol	Has decreased alcohol consumption: alcohol-free wine or one glass of alcohol per day instead of two.
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	-	Stress:	-
John	Diet:	No impact of MI on diet. Misconception: considering diet as relatively healthy, therefore regarding changing diet as unnecessary.	Diet:	No impact of MI on diet
	PA:	Slightly interested in increasing PA, but health problems prevent capability to exercise.	PA	Health problems prevent capability to exercise
	Alcohol:	No impact of MI on alcohol: no intention to decrease alcohol consumption.	Alcohol	No impact of MI on alcohol: no intention to decrease alcohol consumption.
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	-	Stress:	-
Hester	Diet:	Misconception: considering diet as relatively healthy, therefore regarding changing diet as unnecessary. Plan: to discuss diet with dietician	Diet:	No impact of MI on diet
	PA:	Wanting to increase PA to lose weight and optimize physical condition, but has made no concrete plans. Health problems prevent capability to exercise.	PA	Is interested in increasing PA to lose weight and optimize physical condition, but has made no concrete plans. Health problems prevent capability to exercise.
	Alcohol:	Non-alcohol consumer	Alcohol	Non-alcohol consumer
	Smoking:	Mentioned to smoke less cigarettes per day since MI, however contradictions in her interview answers make this statement less reliable.	Smoking	Has reduced number of cigarettes slightly since MI.
	Stress:	Experiencing much stress generally. Wanting to reduce stress but not feeling able to.	Stress:	Experiencing much stress generally. Wanted to reduce stress but not feeling able to. Has become more aware of her mental health and is taking more time for relaxation accordingly.

Table 2. *(continued)*

Name	T1		T2	
Eric	Diet:	Little impact of MI on diet, but has become more aware of necessity of healthy eating. Postponing dietary change, but open for dietary advices.	Diet:	Habit formation: adhering to received advices during cardiac care: consciously eating fruits, fish, and other healthy foods.
	PA:	Becoming more conscious of importance of PA and is consequently willing to spend more time to exercise.	PA	Major increase in PA: e.g. home trainer, walking with dog, buying an activity tracker. Habit formation: reaching his daily activity goals.
	Alcohol:	Non-alcohol consumer	Alcohol	Non-alcohol consumer
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	Taking more time for rest and relaxation.	Stress:	Habit formation: scheduling moments for rest and relaxation during each day.
Ian	Diet:	No impact of MI on diet.	Diet:	Has implemented changes in diet: became more aware of importance of healthy eating.
	PA:	Continuing former exercise behaviors: already followed an active lifestyle.	PA	Continuing former exercise behaviors: already followed an active lifestyle.
	Alcohol:	Continuing former alcohol consumption.	Alcohol	Continuing former alcohol consumption.
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	Experiencing much stress generally, but not feeling able to reduce stress	Stress:	Experiencing much stress generally, but not feeling able to reduce stress

Table 2. *(continued)*

Name	T1		T2	
Peter	Diet:	Major impact of MI on diet: elaboration of and adhering to plans to improve diet	Diet:	Major impact of MI on diet: adhering to plans to improve diet. In progress: preventing relapse to former snacking habits
	PA:	Goal: becoming more active	PA	Habit formation: exercise with personal trainer
	Alcohol:	Completely stopped consuming alcohol	Alcohol	Much reduced alcohol consumption compared to prior to MI, but occasionally uses alcohol as a reward.
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	Goal: wanting to reduce stress. Started elaboration of plans for stress reduction.	Stress:	In progress: searching for a healthier way to deal with work-related stress. However, taking good care of health has become much more important than work.
Shivani	Diet:	Little impact of MI on diet: considering it as relatively healthy.	Diet:	Little impact of MI on diet: considering it as relatively healthy.
	PA:	Negative impact of MI on PA due to deteriorated physical condition. Goal: continue previous level of PA.	PA	Slightly more engaged in exercise compared to prior to MI.
	Alcohol:	Non-alcohol consumer	Alcohol	Non-alcohol consumer
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	Impact of MI on stress reduction: taking care of self, relaxation, and avoiding stress	Stress:	Impact of MI on stress reduction: taking care of self, relaxation, and avoiding stress
David	Diet:	Compensation behavior for smoking cessation: eating more. As a consequence, becoming somewhat more absent from snacking to lose excessive weight gain.	Diet:	No longer an impact of MI on diet.
	PA:	Incorporating simple increases in PA: taking the stairs instead of the elevator.	PA	Habit formation: has incorporated new routine after cardiac rehabilitation: exercise twice a week.
	Alcohol:	Continuing former alcohol consumption.	Alcohol	Continuing former alcohol consumption.
	Smoking:	Has quitted smoking immediately after MI with minor effort.	Smoking	Has stayed absent from cigarettes without difficulties.
	Stress:	Does not experience stress.	Stress:	Does not experience stress.

Table 2. *(continued)*

Name	T1		T2	
Emma	Diet:	No impact of MI on diet.	Diet:	No impact of MI on diet.
	PA:	Wanting to increase PA for weight control and to improve physical condition, but has made no concrete plans.	PA	Continuing former PA.
	Alcohol:	Small reduction in alcohol consumption.	Alcohol	No impact of MI on alcohol: continuing former alcohol behavior.
	Smoking:	Has quitted smoking immediately after MI while still experiencing cravings.	Smoking	Staying absent from smoking while experiencing reduced cravings.
	Stress:	-	Stress:	-
Harry	Diet:	Habit formation: has cut off food that are bad for cardiovascular health.	Diet:	Habit formation: has cut off food that are bad for cardiovascular health.
	PA:	Continuing former exercise behaviors: already followed an active lifestyle.	PA	Continuing former exercise behaviors: already followed an active lifestyle.
	Alcohol:	Consuming less alcohol due to potential negative effects in combination with medication.	Alcohol	Consumed less alcohol due to potential negative effects in combination with medication.
	Smoking:	Non-smoker	Smoking	Non-smoker
	Stress:	-	Stress:	-
Steven	Diet:	Considering diet as relatively healthy, but trying to eat smaller portions.	Diet:	Habit formation: eating smaller portions and decreasing snacking.
	PA:	Negative impact of MI on PA due to deteriorated physical condition. Goal: continue previous level of PA.	PA	Has become more physically active and incorporated regular exercise in daily life
	Alcohol:	No impact of MI on alcohol: continuing drinking alcohol	Alcohol	No impact of MI on alcohol: continuing drinking alcohol
	Smoking:	Non-smoker	Smoking:	Non-smoker
	Stress:	Impact of MI on stress reduction: taking more time for relaxation	Stress:	Impact of MI on stress reduction: being a calmer person and taking more time for relaxation

Note. It should be noted that this table reports only lifestyle changes that participants directly associated with their myocardial infarction.
Abbreviations: MI = myocardial infarction; PA = PA

4

The development and validation of scales to measure the presence of a teachable moment following a cardiovascular disease event

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ABSTRACT:

Better conceptually-driven research is necessary to learn more about 1) the characteristics of life events as teachable moments (TMs) and 2) the potential of life events to evoke lifestyle change intention (LCI). This study aimed to develop and validate two scales for the purposes of TM research in the context of cardiovascular disease (CVD): the *CardiacTM* and *CardiacLCI*-scales. After the initial development of items based on a theoretical framework and literature search, six experts rated the content validity of both scales as sufficient. The item list was further adjusted after think-aloud sessions with two CVD patients. The resulting scales were presented online in a cross-sectional survey, which yielded 625 responses of Dutch CVD patients (June, 2020). To test construct validity, we conducted Exploratory Factor Analysis (EFA) with Varimax rotation on a random split-half of the sample (n=300) and evaluated the factor structure with Confirmatory Factor Analysis (CFA) on the holdout sample (n=325). EFA and CFA on the CardiacTM-scale (α=0.88) revealed a 28-item six-factor structure explaining 61.0% of the variance, with adequate goodness-of-fit statistics (CFI=0.87; TLI=0.85; SRMR=0.07) and internally reliable factors (Affective impact, Risk CVD, Changed self-concept, CVD group identity, Risk non-communicable disease, Anticipated regret). The CardiacLCI-scale (α=0.81) revealed an 11-item two-factor structure explaining 51.5% of the variance, with adequate model fit (CFI=0.92; TLI=0.90; SRMR=0.08) and internally reliable factors (Event-related lifestyle change and General healthy lifestyle). The scales may be used to expand knowledge around life events as TMs and to support conversation regarding lifestyle after cardiac and other life events.

Keywords: Teachable moments, lifestyle, prevention, questionnaire development, validation, health communication

INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of mortality both in the Netherlands and worldwide(1). The course of cardiometabolic health is heavily influenced by the ability of an individual to change unhealthy behaviors such as smoking, unhealthy dietary uptake, and insufficient physical exercise(2). Nonetheless, the prevalence of unhealthy behaviors is increasing, and even amongst those wishing to live a healthier life, the adoption and maintenance of risk-reducing health behaviors is often a major challenge(3). Within the field of health behavior change, research has identified life situations that may help instigate risk-reducing changes in behavior. These situations, referred to as 'teachable moments' (TMs), often occur in the time window following an important life or health event, and individuals may be more willing to optimize their lifestyle following a TM(4-7). Because CVD events have been linked to lifestyle changes such as quitting smoking(8), scholars suggest that a potential TM following a cardiac event may induce the adoption of healthier lifestyle behaviors among affected patients(8, 9).

Based on existing reports, investigating cardiac events as potential TMs appears promising. It is logical to suppose that individuals might be more receptive to health behavioral messages during certain life events, a supposition confirmed in a study of cancer screening(10). Health-promoting interventions during or close to TMs might therefore be better received and thus more effective in achieving improved health behavior outcomes(6, 11-13). Potential TMs around cardiac events consequently represent an important and promising opportunity to convey lifestyle advice at the optimal moment in a healthcare trajectory. The TM concept is, however, still insufficiently developed(4, 5). A better appreciation of the factors mediating TMs could increase our understanding of the nature of motivation to change(14), as well as help guide health communication tailored to related underlying cognitions.

The experienced significance of a life event for an individual is likely to be determined by the way an event is cognitively interpreted(4, 15). This interpretation in turn determines its impact on intentions towards behavioral change and actual changes in behavior(4, 16, 17). According to a conceptual framework proposed by McBride et al.(4), an effective TM is characterized by three key cognitive characteristics: 1) an increased perception of a person's personal risk, 2) an affective or emotional impact of an event, and 3) a redefinition of a person's self-concept. This framework is employed as the basis of a substantial part of TM research, and efforts have been made to empirically test the applicability of the framework(18, 19). There is, however, major inconsistency in the way scholars measure

increased risk perception, affective impact, and changed self-concept(5). An example of this inconsistency can be found in two studies by McBride et al.(18, 19) in which being diagnosis of cancer was explored as a TM. The former study assessed affective impact by asking patients to rate their concern regarding colon cancer development(19), while the latter study assessed the Positive and Negative Affect Scale (PANAS)(20) as a measure of affective impact(18). Naturally, inconsistency in methodologies impacts the comparability of studies that explore potential TM events.

Differences in research methodology within TM research highlight a need for better designed and conceptually-driven studies when exploring life events as potential TMs(4, 5, 21). However, validated measures specifically designed for this purpose are still lacking. The main aim of the present study was therefore to develop and validate two scales: 1) the *Cardiac Teachable Moment Framework* scale (CardiacTM), which aims to assess whether a cardiac event fullfills the TM criteria of risk perception, affective impact, and changed self-concept, and 2) the *Cardiac-induced Lifestyle Change Intention* scale (CardiacLCI), which aims to assess whether a cardiac event actually induced a subsequent lifestyle change intention (LCI) in affected patients. This study applied the principles of scale development and validity testing as recommended by Boateng et al.(22), and consisted of: 1) item development, 2) construct development, and 3) construct evaluation.

METHODS

Step 1: Item development

Identification of Domains and Item Generation

Applying the guidelines formulated by Boateng et al.(22), the development of our questionnaires began with a thorough exploration of the constructs of interest. Hence, we first searched literature to explore subdomains that comprised our constructs CardiacTM (including risk perception, affective impact and changed self-concept(4)) and CardiacLCI. The search was performed in PubMed and Web of Science, using keywords described in Supplementary Material 1. Once the subdomains were defined, we generated items pertaining to these subdomains(22, 23). Whenever possible, items of existing validated measures were used as the basis for our new scales. For those constructs that lacked comparable measures, items were generated during brainstorm sessions involving the researchers (NAEV, MEK, MB). To maintain consistency, all items had to be unipolar and formulated as statements that could be assessed using a 7-point Likert scale (ranging

from strongly disagree to strongly agree, as these anchors demonstrate the most equal conceptual distance(24)).

Modification of items by an expert panel and a target group

The second step in item development was to administer the scales to an expert panel in order to assess content validity(22). Six experts working in cardiac care were asked to provide qualitative feedback on the items and to rate the clarity and relevance of the items using the Content Validity Index (I-CVI) (from 1=an irrelevant item to 4=an extremely relevant item)(25). A I-CVI of ≥0.80 is recommended for sufficient content validity of an item(25).

After assessing content validity, the final step in item development was to pre-test the adjusted scales using the think-aloud method(26). In this method, members of the target population were instructed to think out loud when filling in the scales. Two patients who experienced a stroke 6 months or 2 years prior to the think-aloud session, respectively, participated the think-aloud session in the (online) presence of a researcher (NAEV). The thoughts and comments of the patients on the items was subsequently used to remove or adapt items that were unclear or difficult(26).

Step 2 and 3: Construct development and construct evaluation

Procedure, participants and measures

After the initial items were developed and revised, the next step was to determine psychometric properties of the scales by asking a larger number of CVD patients to fill out the questionnaire. The questionnaire in this cross-sectional survey study was distributed online (www.Qualtrics.com) and comprised the items of our newly developed scales plus additional measures to assess convergent validity(27). To explore convergent validity of the 'risk perception' items, we included the Perceived risk of a heart attack/stroke subscale from the ABCD questionnaire(28), which consists of 8 items (e.g. I feel I will suffer from a heart attack or stroke sometime during my life) with response options ranging from 1=strongly agree to 4=strongly disagree. Regarding the 'affective impact' items, we first included the 3-item ultra-brief form of the Penn State Worry Questionnaire (PSWQ)(29) (e.g. Once I start worrying, I cannot stop), with response options ranging from 1=not at all typical to 5=very typical. This shorter PSWQ version showed comparable internal consistency to the normal PSWQ, which is regarded as the gold standard when assessing worry(29). We also included the Negative Affect subscale from the PANAS short-form, a frequently used scale for assessing emotions, in which participants could indicate the extent to whether they experienced five negative emotions (e.g. Upset)(20). For the 'self-concept' items, we included the Acceptance subscale of the Illness Identity Questionnaire

(IIQ)(30) due to its relatedness to the construct. We did not explore convergent validity of the CardiacLCI-scale, because measures to capture event-induced LCI are currently lacking. All measures were initially translated to Dutch using a back-translation process with three bilingual researchers, in which original English items were first translated to Dutch by the first researcher, then back-translated to English by the second researcher, after which a third researcher compared meaningful differences between the original and back-translated items and decided on approval of the translation(31).

The anonymous link to the questionnaire was distributed through the Dutch Heart Foundation website and via an e-mail invitation to members of Harteraad, the largest Dutch CVD patient organization. Individuals were eligible to participate if they were 18 years or older, were able to read Dutch, and had suffered from any form of heart problem(s) for which they had been hospitalized. After providing online informed consent, participants were requested to keep their most recent cardiac event in mind when filling out the remaining questionnaire. The study was approved by the Medical Ethics Committee of Leiden University Medical Center in April 2020 (METC-nr 18-112).

Statistical analysis

For both scales, analyses were conducted in several steps, comprising factor validity, convergent validity (only CardiacTM-scale) and reliability(27). We initially explored the normality of all items and removed items that visually demonstrated outliers in QQ-plots or had skewness values of >2 or kurtosis values of >7(32). To deal with overfitting when using the same dataset for both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), we randomly divided our dataset in two mutually independent halves(22). Using the first half of the dataset, we assessed the suitability of the data for EFA based on the Kaiser-Meyer-Olkin Measure of Sampling adequacy (KMO) and Bartlett's test of sphericity(33, 34). We then conducted EFA and extracted factors using an orthogonal (Varimax) rotation approach(35). We inspected the scree plot to decide on the number of factors to be extracted and carried out iterations in EFA to identify core constituent items in each factor. Cross-loading items, items with loading ≤0.30, and/or items with loadings with a less than 0.20 difference between factors were deleted at each iteration(36). Using the second half of the dataset, we evaluated the factor solution with CFA with maximum likelihood estimation. Standardized factor loadings were deemed as unacceptable below 0.10(37). The Chi-square (χ^2)-index is often used to evaluate model fit, but is highly sensitive to large sample size(38). Therefore, we additionally explored two incremental fit indices (the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI)) as well as one residuals-based fit index (the Standardized Root Mean Square Residual (SRMR))(38). The CFI and TLI should exceed 0.90(39) and the SRMR should

be lower than 0.08 to indicate good model fit(38). The resulting factors were additionally tested for convergent validity with the Pearson product-moment correlation, with <0.30 demonstrating low, 0.30-0.50 medium, and >0.50 high convergent validity(40). Lastly, the internal reliability of all factors was assessed using Cronbach's α coefficients with α≥0.70 as the threshold indicating sufficient reliability and α≥0.80 demonstrating good reliability(41).

RESULTS

Step 1: Item development

Identification of Domains and Item Generation

The subdomains identified are presented in Table 1 and the complete results of the literature search are elaborated in Supplementary Material 1. We selected and drafted 74 initial items to fully measure the broad construct CardiacTM and 16 items to measure the construct CardiacLCI. All items, including references to the source questionnaires, are provided in Supplementary Material 2.

Table 1. Identification of subdomains

CardiacTM-scale	CardiacLCI-scale
Risk perception	Lifestyle change intention
Perceived susceptibility and severity of CVD	Impact of event on lifestyle
Perceived susceptibility and severity of NCD	
Perceived relative risk	
Increase in risk perception after cardiac event	
Affective impact	
Level of worry	
Negative affect	
Self-concept	
Social role	
Perceived stigmatization	
Identity and lifestyle	
Future/possible self	
Feeling of self-worth	
Body image	

Note: CVD = cardiovascular diseases; NCD = non-communicable diseases

Modification of items by expert panel and target group

Cardiac Teachable Moment Framework scale

The I-CVI for the clarity and relevance of items ranged from 0.50 to 1 (Supplementary Material 3). Items 4, 14, 15, 40-42, 55-58, 68, and 73 were deleted based on I-CVI values <0.80. Qualitative feedback from experts resulted in the revision of items 6, 8, 16, 17, 19-21, 45, 48, 64, 69 and 71 to improve readability, and the addition of two items to better capture the constructs (e.g. Since my cardiac event, I feel more often down).

The qualitative feedback from the patients during the think-aloud sessions resulted in the additional deletion of item 3, 22, 23, 42 and 67 because they were difficult to understand or overlapped with similar items. Furthermore, it resulted in changes to the phrasing of items 9, 13, 18, 25, 28 and 67 in order to increase readability, such as the removal of double negatives. For example, item 'I think my chances that I will experience lifestyle-related diseases in the next ten years are low' was rephrased into 'I think my chances (…) are high'. Additionally, all items that contained the phrase 'since my heart incident' were rephrased into 'due to my heart incident', in order to optimally capture whether a change could be annotated to the cardiac event itself. The resulting 59-item scale is presented in Supplementary Material 4.

Cardiac-induced Lifestyle Change Intention scale

The I-CVI rating for clarity and relevance caused the elimination of three items (5, 11, 15)(25) from the CardiacLCI-scale. Qualitative feedback by experts led to the modification of items 10 and 13 in order to further improve the scale. Following the expert's recommendations, we added two items (e.g. I sometimes think about improving my lifestyle).

The think-aloud sessions on the improved list of 15 items led to a final revision in which the formulation of items 1, 2 and 8 was adjusted to increase readability. Items 9 and 14 were removed to lower possible annoyance due item repetition. Finally, two items were added because one patient felt there was no opportunity to report the conditions already living a healthy lifestyle and being tempted by unhealthy behaviors. The resulting 15-item scale is presented in Supplementary Material 4.

Step 2 and 3: Construct development and construct evaluation

Patient characteristics

The link to the online questionnaire was send to 2606 patients who experienced a cardiac event, of which 625 patients provided us with valid responses (24%). Sociodemographic characteristics of the sample are presented in Table 2. The average age of our sample

was 58.5 (SD = 9.9), and the majority of our sample was male (63%), lived together with a partner (73%), had completed higher education (46%), and was hospitalized for heart rhythm disorder as their most recent cardiac event (29%). The dataset was initially divided random halves to perform EFA (n = 300) and CFA (n = 325).

Table 2. Sociodemographic characteristics of the complete sample (n=625)

Characteristic	**Mean (SD)**	
Age	58.5 (9.9)	
	Frequency (n)	**Percentage (%)**
Gender		
Female/male	228/394	37/63
Living situation		
Living alone/cohabiting	213/604	25/73
Education		
Low/middle/high	127/208/290	20/33/46
Most recent cardiac event		
Angina pectoris	112	18
Myocardial infarction	126	20
Heart failure	78	13
Heart valve disease	44	7
Heart rhythm disorder	179	29
Cardiomyopathy	21	3
Vascular disease	109	17
Stroke	19	3
Time from most recent event		
<6 months ago	119	19
6-12 months ago	75	12
1-3 years ago	152	25
3-10 years ago	198	32
>10 years ago	77	12

Note. Total percentages can deviate from 100% due to rounded numbers. Low education = no, elementary or vocational education; middle education = higher general or secondary vocational education; high education= higher professional and scientific education.

Cardiac Teachable Moment Framework scale

Exploratory Factor Analysis

Of the 59 items, presented in Supplementary Material 4, two (3, 11) were removed based on skewness/kurtosis values <2. The KMO (0.84) and significant Bartlett's test of sphericity ($\chi 2$ (1378, N = 300) = 6617; p <0.001) indicated that data from the first half of the dataset were acceptable for factor analysis(33). Next, seventeen items (4, 5, 7, 13, 32, 33, 37-40, 45, 46, 52-54, 58, 59) were removed from the dataset because they consistently showed communities below <0.30, indicating that they possibly not load sufficiently on any factor. The new EFA showed that nine factors had eigenvalues over Kaiser's criterion 1. Based on the scree plot (Supplementary Material 5), a three to seven factor solution seemed suitable. Further inspection of the item loadings revealed that six factors best fitted the data. Finally, twelve items (16, 17, 18, 21, 23, 34, 41-44, 50, 51) were iteratively removed iteratively due to cross-loading or loading on the wrong factor. The resulting six-factor structure (Table 3; Supplementary Material 6), which explained 61.0% of the variance, consisted of an 8-item Affective impact, a 5-item Perceived risk CVD, a 4-item Perceived risk non-communicable diseases (NCD), a 5-item Changed self-concept, a 3-item CVD group identity, and a 3-item Anticipated regret-factor. The correlations between these factors were small to medium (0.04 - 0.42) (Table 4).

Table 3. Rotated Factor Matrix of the CardiacTM-scale

	Factor					
Item	**1. Affective impact**	**2. Perceived risk CVD**	**3. Changed self-concept**	**4. CVD group identity**	**5. Perceived risk NCD**	**6. Anticipated regret**
1. When I begin to worry about my heart, I cannot stop worrying.	**0.74**	0.02	0.13	-0.12	0.04	0.15
2. I am worried about having health problems in the future.	**0.59**	0.24	0.16	0.00	0.11	0.12
3. When I begin to worry about my health, I cannot stop worrying.	**0.70**	0.02	0.05	-0.07	0.04	0.17
4. The concerns I have about my cardiac event influence my emotions.	**0.78**	0.23	0.17	0.19	0.05	0.08
5. The concerns I have about my cardiac event influence my daily life.	**0.71**	0.19	0.09	0.24	0.09	0.01
6. Due to my cardiac event, I become more easily emotional.	**0.82**	0.05	-0.01	0.20	0.05	0.04
7. Due to my cardiac event, I am more often anxious	**0.86**	0.09	0.03	0.14	0.04	0.09
8. Due to my cardiac event, I feel more often down	**0.81**	0.09	-0.07	0.09	0.05	0.03
9. It is likely that I will experience a/another heart attack or stroke at some point in my life.	0.12	**0.84**	-0.03	0.06	0.09	0.10
10. I think my chances of having a/another heart attack or stroke in the next ten years are high.	0.11	**0.86**	-0.05	0.04	0.11	0.08
11. With my lifestyle as is, I think my chances of having another heart attack or stroke are small.	-0.02	**-0.49**	0.15	-0.01	-0.14	0.03
12. I think my chances of having another heart attack or stroke are higher than those of other people my age and weight.	0.17	**0.66**	0.14	0.13	0.23	0.01
13. Due to my cardiac event, I rate my risk of a/another heart attack or stroke as higher.	0.24	**0.68**	0.06	0.04	0.18	0.07
14. My role as partner/significant other has become more important to me, due to my cardiac event.	0.12	-0.12	**0.65**	-0.09	0.07	0.06
15. My role as parent has become more important to me, due to my cardiac event.	0.20	0.03	**0.70**	0.07	0.03	0.12

Table 3. *(continued)*

Item	Factor					
	1. Affective impact	**2. Perceived risk CVD**	**3. Changed self-concept**	**4. CVD group identity**	**5. Perceived risk NCD**	**6. Anticipated regret**
16. Due to my cardiac event, I realize more how important I am to my loved ones.	0.02	0.07	**0.79**	0.05	-0.03	0.09
17. Due to my cardiac event, I realize how precious life is.	0.01	-0.02	**0.65**	0.24	-0.06	0.19
18. Due to my cardiac event, I value myself more.	0.00	-0.04	**0.51**	0.27	-0.04	0.01
19. I don't feel connected to other heart patients.	-0.10	-0.04	-0.15	**-0.77**	0.03	-0.08
20. Due to my cardiac event, I feel more connected to other heart patients.	0.13	0.08	0.13	**0.92**	0.01	0.10
21. I feel a kinship with other heart patients.	0.18	0.12	0.10	**0.80**	0.00	0.14
22. It is likely that I will experience lifestyle-related diseases at some point in my life.	0.03	0.12	0.04	-0.04	**0.92**	0.05
23. I think my chances that I will experience lifestyle-related diseases in the next ten years are high.	0.04	0.16	0.02	-0.04	**0.92**	0.04
24. Should I continue with my lifestyle as is, I expect to experience health problems.	0.11	0.16	-0.10	-0.02	**0.51**	0.11
25. I think my chances of having lifestyle-related diseases are higher than those of other people my age and gender.	0.11	0.28	0.04	0.08	**0.51**	-0.05
26. Due to my cardiac event, I feel worse about myself if I don't exercise.	0.19	0.02	0.03	0.03	0.07	**0.80**
27. Due to my cardiac event, I feel worse about myself if I don't take time to relax.	0.19	0.07	0.20	0.14	0.03	**0.75**
28. Due to my cardiac event, I feel worse about myself if I don't eat healthily.	0.10	0.10	0.26	0.17	0.06	**0.70**

Note. Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.
CVD = cardiovascular diseases; NCD = non-communicable diseases

Table 4. Inter-factor correlations of the CardiacTM-scale

	Affective impact	Perceived risk CVD	Changed self-concept	CVD group identity	Perceived risk NCD	Anticipated regret
Affective impact	1					
Perceived risk CVD	0.38**	1				
Changed self-concept	0.25**	0.04	1			
CVD group identity	0.21**	0.16**	0.38**	1		
Perceived risk NCD	0.26**	0.42**	-0.02	0.01	1	
Anticipated regret	0.31**	0.08**	0.29**	0.27**	0.14**	1

Note. Pearson correlation. *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).
CVD = cardiovascular diseases; NCD = non-communicable diseases

Confirmatory factor analysis

CFA on the six-factor structure is presented in Figure 1. All standardized factor loadings ranged between 0.45 - 1.3 which is deemed acceptable. The χ^2-value of 850.80 (df = 335) was statistically significant ($p < 0.001$). The goodness-of-fit statistics showed a CFI = 0.87 and a TLI = 0.85. Lastly, the SRMR value = 0.07 indicated adequate model fit.

To explore whether the six-factor structure had a better fit than the original intended three-factor structure, following the proposed framework of McBride et al.(4), we additionally performed CFA on the three-factor structure. Results showed a significant lower model fit compared to the six-factor structure (df = 347; $\chi^2 = 1699.00$, $p < 0.001$; CFI = 0.66; TLI = 0.62; SRMR = 0.11.

Convergent validity

The results demonstrated moderate to high Pearson correlations (Table 5) of our factors with validated measures of related constructs, indicating that the newly developed scale showed good convergent validity. For example, the factor Affective impact demonstrated high convergent validity with the Negative Affect scale of the PANAS ($r = 0.59$; $p < 0.01$) and the PSWQ ($r = 0.74$; $p < 0.01$), and the factor Changed self-concept showed high convergent validity with the Acceptance scale of the IIQ ($r = 0.67$; $p < 0.01$). Only the factor Anticipated regret demonstrated lower convergent validity ($r < 0.30$) with all comparison measures.

Figure 1. Standardized factor loadings of the six-factor structure with maximum likelihood estimation

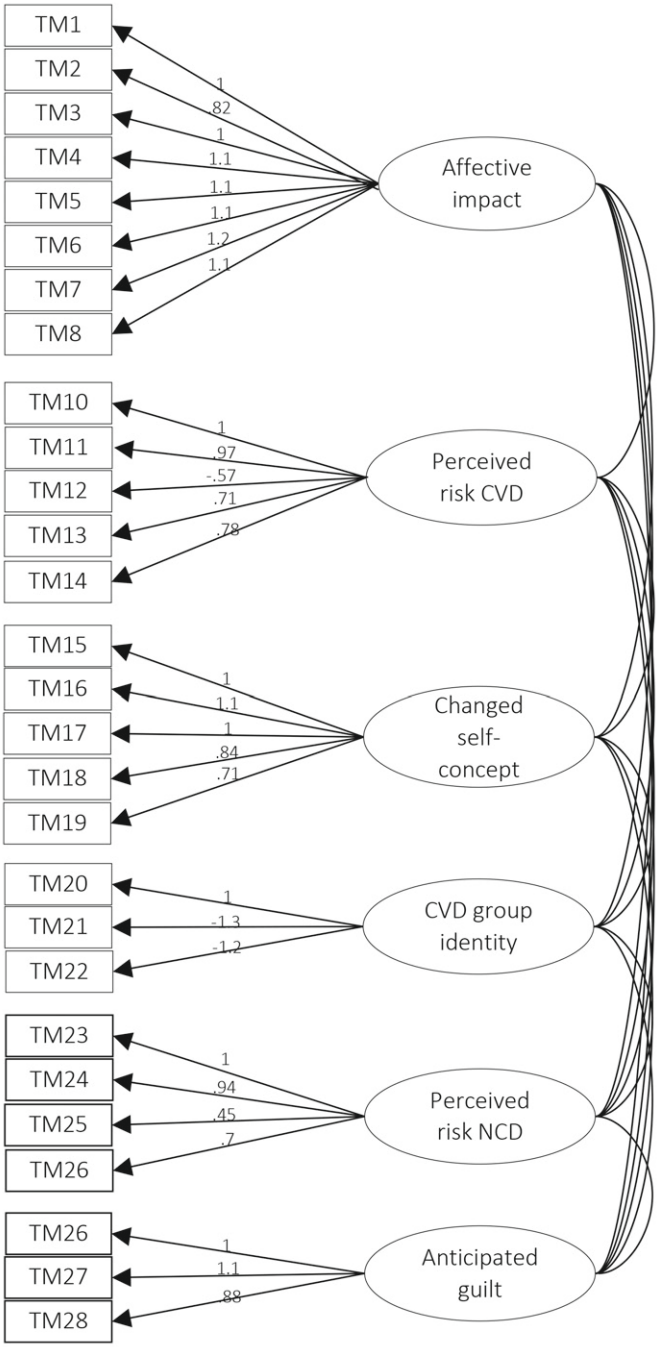


Table 5. Convergent validity between factors from CardiacTM-scale and comparison measures

	Factors from CardiacTM-scale					
Validated measures for convergent validity	Affective impact	Perceived risk CVD	Changed self-concept	CVD group identity	Perceived risk NCD	Anticipated regret
PANAS NA	0.59**	0.22**	0.20**	0.11*	0.11**	0.29**
PSWQ	0.74**	0.23**	0.13**	0.10**	0.16**	0.26**
ABCD	0.40**	0.69**	0.07	0.07	0.39**	0.14**
IIQ	0.13**	-0.04	0.67**	0.35**	-0.05	0.22**

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).
CVD = cardiovascular diseases; NCD = non-communicable diseases

Reliability

The internal consistency (Cronbach's alpha) was excellent for the factor *Affective impact* (α = 0.93), and good for the factors *Perceived risk CVD* (α = 0.86), *Perceived risk NCD* (α = 0.83), *Changed self-concept* (α = 0.80), *CVD group identity* (α = 0.87), and *Anticipated regret* (α = 0.81). The complete CardiacTM-scale demonstrated good internal consistency (α = 0.88).

Cardiac-induced Lifestyle Change Intention scale

Exploratory Factor Analysis

Of the 15 items of the CardiacLCI-scale, presented in Supplementary Materials 4, two (2 and 11) were initially removed based on non-normality. The resulting 13 items showed good sample adequacy and suitability for EFA (KMO = 0.85; Bartlett's test of sphericity $p < 0.001$) when applied to the first half of the dataset. Results of the PAF showed that two factors had eigenvalues over Kaiser's criterion of 1. Item 10 was subsequently removed based on a communality value of < 0.3, and item 6 was removed because of cross-loadings < 0.2. The final two-factor structure (Table 6; Supplementary Material 6) explained 51.5% of the variance and consisted of a 7-item Event-related lifestyle change factor and a 4-item General healthy lifestyle factor. The inter-factor correlation was small but significant ($r = 0.21$; $p < 0.01$).

Table 6. Rotated Factor Matrix of the CardiacLCI-scale

Item	Factor	
	1. Event-related lifestyle change	**2. General healthy lifestyle**
1. I am working hard on improving my lifestyle.	**0.58**	0.01
2. I have made positive changes to my lifestyle.	**0.71**	0.13
3. Due to my cardiac event, I feel the urge to live a healthy lifestyle more.	**0.72**	0.07
4. Due to my cardiac event, I allow myself more time to live a healthy lifestyle.	**0.75**	0.35
5. My cardiac event convinced me that a healthy lifestyle is important for me.	**0.78**	0.09
6. I live a healthier lifestyle now compared to before my cardiac event.	**0.81**	0.11
7. I think of my cardiac event as the start to a new phase in my life.	**0.62**	-0.05
8. I am always motivated to live a healthy lifestyle.	0.18	**0.71**
9. As far as I am concerned, my lifestyle is fine as is.	0.02	**0.64**
10. I usually live a healthy lifestyle.	0.23	**0.67**
11. I am easily tempted to do unhealthy things.	0.09	**-0.69**

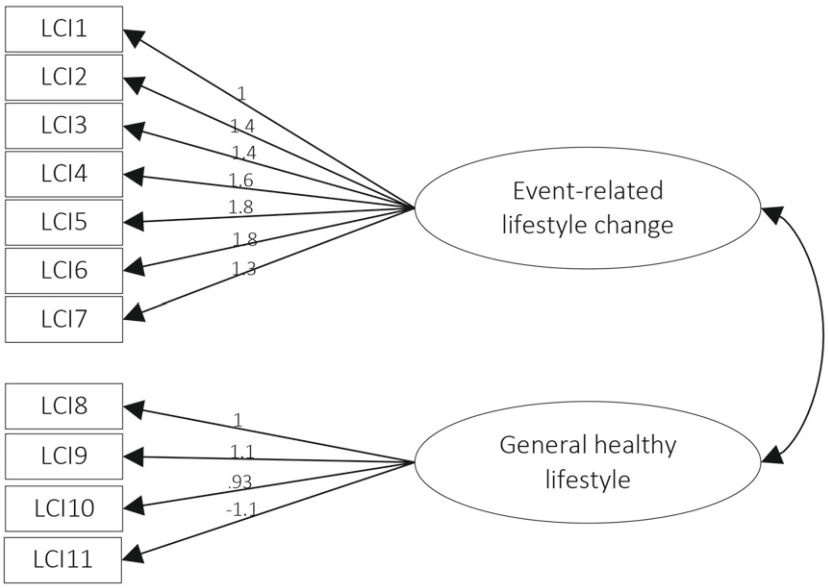
Confirmatory Factor Analysis

Standardized factor loadings of the two-factor structure with maximum likelihood estimation ranged from 0.93 to 1.8 (Figure 2), which are deemed sufficient. A χ^2-value of 1347.27 ($df = 55$, $p < 0.001$) suggested poor model fit. However, the goodness-of-fit statistics of the two-factor structure demonstrated an adequate model fit, based on CFI = 0.92 and TLI = 0.90. The SRMR value of 0.08 was slightly below but near to the cut-off score of ≤ 0.08 for adequate model fit. To test the relevance of multiple factors, we performed a CFA on a one-factor structure and found a substantially poorer fit ($df = 55$; $\chi^2 = 1347.27$, $p < 0.001$; CFI = 0.71; TLI = 0.63; SRMR = 0.14).

Reliability

The internal consistency (Cronbach's alpha) was good for *Event-related lifestyle change* (α = 0.86) and sufficient for *General healthy lifestyle* (α = 0.76). The complete CardiacLCI-scale demonstrated good internal consistency (α = 0.81).

Figure 2. Standardized factor loadings of the two-factor structure with maximum likelihood estimation



Association between factors of the two scales

We additionally explored the association between factors of the CardiacTM-scale and factors of the CardiacLCI-scale. All partial correlations between factors of the scales, controlled for age and gender, are presented in Table 7. These results suggest low to high correlations between the factors of the CardiacTM-scale and *Event-related lifestyle change*, of which *Changed self-concept* ($r = 0.55$; $p < 0.01$) and *Anticipated regret* ($r = 0.45$; $p < 0.01$) had the highest correlations. The correlations to the *General healthy lifestyle* factor were slightly lower, yet mostly significant. *Perceived risk NCD* has the highest (negative) correlation to this factor ($r = -0.21$; $p < 0.01$).

Table 7. Partial correlation between factors from CardiacTM-scale and CardiacLCI-scale

	Factors of CardiacTM					
Factors of CardiacLCI	Affective impact	Perceived risk CVD	Changed self-concept	CVD group identity	Perceived risk NCD	Anticipated regret
Event-related lifestyle change	0.20**	0.09*	0.55**	0.27**	0.02	0.45**
General healthy lifestyle	-0.12**	-0.05	0.14**	0.11**	-0.21**	0.12**

Note. Controlled for age and gender. * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).
CVD = cardiovascular diseases; NCD = non-communicable diseases

DISCUSSION

In the time window following an acute cardiovascular disease (CVD) event, a patient may be more receptive to health behavior advice and more driven to adopt risk-reducing health behaviors(5, 8, 9, 13). The objective of this study was to develop two valid and reliable scales that can be used to conduct empirical research on teachable moments (TMs) in the context of cardiometabolic disorders. The content and construct (factorial) validity of both newly developed scales appeared to be strong. Furthermore, the scales showed good internal consistency reliability and relatively small inter-factor correlations, which confirmed that the factors derived from the factor analyses show meaningful distinctive ability while being intended to measure the same constructs. The types of validity and reliability testing used made it possible to identify and select those items with the best psychometric behaviors.

The first Cardiac Teachable Moment Framework (CardiacTM) scale was developed as a measure to capture whether a cardiac event meets TM characteristics within patients (i.e. affective impact, risk perception, changed self-concept(4)). The final scale consisted of six distinct and reliable (internally consistent) factors, and demonstrated sufficient construct validity and good convergent validity. In total, the scale explained 61.0% of the variance, indicating a good ability to capture variance in perceiving a cardiac event as a TM. The first factor, termed *Affective impact*, consisted of most items that were initially drafted for the affective impact part of the TM framework described by McBride et al.(4). The high association with the Negative Affect scale of the PANAS(20) and the PSWQ(29) provided good evidence that the items sufficiently captured this cognitive antecedent of a TM event.

Items that were initially drafted in relation to risk perception, the second concept of the TM framework(4), appeared to subdivide across two distinct factors; *Perceived risk CVD* and *Perceived risk non-communicable diseases (NCD).* Although CVD and other NCDs share many risk factors(42), patients may differentiate the respective risks. We found that patients who were more aware of their cardiac risk were also more likely to adopt risk-reducing health behaviors after their cardiac event. This positive effect of perceived CVD risk was also noticed by Everett et al.(43), who showed that patients with increased risks perception were more likely to adhere to cardiac rehabilitation. These findings may have important implications for the promotion of accurate risk perception in cardiac care.

Items generated for the third concept of the TM framework(4), a change in self-concept, appeared to subdivide across three distinct factors. This finding is in accordance with previous studies which have defined self-concept as a broad and comprehensive

construct(4, 44). The factor *Changed self-concept* comprised items on changes in one's sense of self and meaningfulness, as well as in the importance of certain social roles in life. Hence, we deem this factor to be conceptually the closest to the intended factor of the TM framework(4). According to the Social Cognitive Theory, the interpersonal or relational self can instill motivation to adhere to the wishes of salient others(45). Someone's health behaviors can thus be influenced by an assessment of the importance of social roles to a person(46). We also found evidence for this phenomenon in the high association between *Changed self-concept* and *Event-related lifestyle change* in the current study, as well as in our previous work(7).

Another identified factor was termed *CVD group identity* and consisted of items related to being part of the group of cardiovascular disease patients. A health event can shift someone's perceived identity towards being an ill person(47), and perceiving an illness as part of one's own identity is in turn associated with optimal disease management behaviors(48). An identity shift towards being a CVD patient may increase personal notions of the importance of adopting healthy behaviors, exactly because these behaviors are part of the accepted disease management guidelines. In order to facilitate a TM effect on behavioral change, cardiac rehabilitation programs could therefore place more emphasis on promoting the adoption of a CVD patient identity among their patients.

The final factor, termed *Anticipated regret*, comprised items that ask about perceived feelings of self-regret when partaking in a risk behavior (i.e. lack of exercise, unhealthy eating or not allowing time for relaxation). Evidence supporting the effect of anticipated regret on health behaviors comes from a large meta-analysis, in which a strong association was found between anticipated regret after not participating in a protective health behavior and engaging in that behavior(49). Surprisingly, we were obliged to remove the risk behaviors smoking and alcohol consumption based on the factor analysis, which may be partly due to the relatively low number of smokers (5%) and consumers of alcohol (65%) in our sample. However, the process of cognitive dissonance reduction(50) might also play a role here. According to cognitive dissonance theory, an individual may justify harmful behaviors to themselves in order to decrease cognitive dissonance, a state of mental discomfort that results from concurrent but mutually inconsistent ideas or beliefs(51). As cognitive dissonance has been instrumental in explaining addictive behaviors(52, 53), it may well be worthwhile to further investigate its role on smoking and alcohol consumption following a cardiometabolic diagnosis.

The second scale in the current study, the Cardiac-induced Lifestyle Change Intention (CardiacLCI)-scale, also appeared to be a reliable measurement tool with sufficient content

and construct validity. The scale captured 51.5% of the variance in event-induced LCI, a figure comparable to similar scales that measure health behavior change(28, 54). Two distinct and reliable factors could be identified. The first factor, termed *Event-related lifestyle change*, comprised items that measure whether lifestyle change, if it occurs, was specifically instigated by the cardiac event. The relatively robust associations between this factor and factors of the CardiacTM-scale, provides supports our conclusion that truly captured the mechanism of TM in both scales. The other factor, termed *General healthy lifestyle*, comprised items that captured the more stable attitudes towards healthy behavior within patients, those less affected by the event itself. As health behaviors are relatively stable throughout the life course(55), it is possible that patients with high scores on this factor were already living a healthy lifestyle prior to their cardiac event.

Although the current study provides preliminary support for the validity of the two scales, there are two important points that require consideration. First, although stressful health events such as a disease diagnosis are primarily linked to TMs(56), positive life events such as pregnancy are also associated with sudden lifestyle changes(57). It is therefore an open question whether affective impact only comprises negative emotions (such as worry and fear) or whether emotions related to positive events (such as being grateful or enthusiastic) also facilitate the TM mechanism. Future studies should consider to also incorporating positive affect when exploring the role of affective impact on behavioral change after life events. Furthermore, according to McBride et al.(4) someone's perceived consequences of engaging in a certain risk behavior, i.e. the expected outcomes, are an important part of the construct risk perception as well as in behavior change theories(58). Although we initially included items that aimed to capture the expected outcomes of health behaviors, these items were deleted based on the factor analysis. During a future optimization of the CardiacTM-scale, this construct thus warrants further attention.

Future perspectives

The current study has important implications both for research and for cardiometabolic healthcare. As scholars have previously stressed the importance of validated measurement tools within TM research(5, 14), the scales developed in this study may lay the foundation for future research on TMs. Adapted versions of our scales could be employed to explore the potential and underlying mechanisms of life events as TMs, both of which are important to deepening our knowledge concerning life events and behavioral change mechanisms(5). Second, the scales are a first step in the further recognition and utilization of TMs in cardiac and other non-communicable healthcare. Research shows that potential TMs in healthcare more often lead to behavioral change when supported by an appropriate response from

healthcare professionals(6, 11). Clinicians could therefore employ the scales in a simplified manner during potential TM situations in order to support and guide the conversation with their patients regarding lifestyle change and appropriate follow-up. In summary, in light of the current findings we recommend that the concepts and measurements of behavior change around life events, and related psychological mechanism, should be further developed.

Strengths and limitations

This study has both strengths and limitations. In our view, the primary strength of this study was the use of a theoretical framework(4) during the development of the CardiacTM-scale. A second strength was the use of development stages, as recommended by Boateng et al.(22), including item development, construct development, and construct evaluation stages. Third, the development of scales in collaboration with an expert panel and representatives of the target population resulted in scales that are relatively easy to understand and administer(59). Fourth, rather than solely focusing on one type of validity, our exploration of several types provided us with information on multiple important psychometric properties. Finally, our patient sample consisted of a heterogeneous group with diverse sociodemographic characteristics, suggesting that our results are likely to be generalizable to the broader CVD patient population.

The most important limitation of our study was that we did not fully reach the threshold for good model fit in both scales, although some scholars suggest that statistics slightly below the threshold are sufficient. Another limitation was the use of a cross-sectional design, which precluded the exploration of other tests such as test-retest reliability(22). A third limitation was the relatively small sample size, although the sample was sufficient for scale development(22, 60, 61). A fourth limitation was that the effect of time since most recent cardiac event was not taken into account. As TMs may be time-dependent, future studies should consider exploring the time factor around TMs. The final limitation was the relatively young average age (59 years) of our sample population. As younger individuals may face different challenges compared to older individuals, some scholars recommend treating younger cardiac patients as a specific population(62).

Conclusion

We developed two scales for the purposes of TM research and provide evidence supporting the reliability and validity of these scales. These easy-to-administer scales can be used by researchers to gain a better understanding of life events as potential TMs, as well as by clinicians to foster a conversation about lifestyle during cardiac rehabilitation or following other life events.

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SUPPLEMENTARY MATERIAL 1: IDENTIFICATION OF DOMAINS

Cardiac Teachable Moment Framework scale

Keywords; teachable moment, health behavior change, lifestyle, risk perception, perceived risk, perceived susceptibility, vulnerability, outcome expectancy, affective impact, affect, affective response, emotions, self-concept, social role, self-identity, social identity, group identity, cardiovascular disease, cardiovascular disease patients, heart attack, myocardial infarction, acute coronary event, cardiac event, cardiovascular disease event.

The first teachable moment (TM) characteristic risk perception is an important factor in behaviour change theories such as the Health Belief Model, and serves as an explanation for the motivation to comply to risk reducing health behaviours in response to a threat(1). The majority of studies that assess risk perception use the assessment of perceived level of vulnerability or susceptibility for acquiring CVD and thoughts about seriousness or severity when getting CVD. We followed these assessments and included items that capture perceived level of susceptibility for acquiring cardiovascular diseases (CVD), as well as thoughts about that being serious or severe(2-5). In addition, we included items that capture someone's perceived risk relative to others of similar age and sex(6, 7). Because perceived risk of acquiring other non-communicable diseases (NCDs) is also often assessed in studies on risk perception(8-10), we added perceived risk for other NCDs as an additional subdomain in our scale as well. Lastly, as McBride et al(11) specifically stress the importance of an 'increase' in risk perception as a mediating factor, we additionally included items that assessed the extent to which the cardiac event has altered perceived risk.

The second TM characteristic affective impact plays an important role for a life event being perceived as significant and meaningful enough to prompt behavior change(11). Emotionally loaden contexts or events could have a cueing effect on behavioral decisions(12), such as the decision to adopt protective health behaviors. Life or health events that have a higher impact on emotions and affect are more frequently perceived as a TM(11, 13). First, level of health-related worry is frequently assessed as a subdomain of affective impact(13). In concordance to McBride et al(9), we assessed not only level of worry for acquiring further cardiac health problems, but also level of worry for acquiring other NCDs in the future. Second, negative emotions such as fear and sadness raise concern about health problems and increase motivation to eliminate health risks by adopting risk-reducing behaviors(13). The extent to which negative emotions are experienced are

therefore often assessed when scholars investigate the affective impact of an event. Hence, we included negative affect in our items as well.

Changed self-concept is the third characteristic of a TM event(11). Self-concept is an umbrella term for one's perception about one's own position in the world and that relative to others(11, 14). For example, one's self-concept is frequently based on social roles (e.g. role as a partner) and on how important these are for a person(15). Behavior is often in accordance with these roles and depends on which role is most salient at the time(15), as well as on social expectations such as role obligation and stigmatization. For example, becoming a patient could be accompanied by role expectations from others that those who are ill should avoid risky health behaviors(9). We therefore included items that comprise various different social roles (such as role as a partner), and ask for perceived stigmatization regarding one's behaviors. In addition, researchers who measure self-concept in the context of healthcare often regard it as illness identity, i.e., the extent to which someone identifies themselves as a patient with an illness(16). We therefore added identity as a CVD patient as a subdomain as well. Another study that explored a lung cancer diagnosis as a TM, captured self-concept by asking participants to rate the extent to which smoking fits with their identity(9). A change in self-concept often goes along with re-evaluating the extent to which certain lifestyle behaviors fits with the new perceived self(17). Similarly, we included lifestyle-related identity as an additional subdomain. Lastly, we included items that capture a shift in future/possible self, feelings of self-worth, and body image, since these concepts are also frequently linked to the concept of self-concept or identity(18-20).

Cardiac-induced Lifestyle Change Intention scale

Keywords; teachable moment, health behavior change, lifestyle, lifestyle change intention, adapting lifestyle, healthy lifestyle, cardiovascular disease, cardiovascular disease patients, heart attack, myocardial infarction, acute coronary event, cardiac event, cardiovascular disease event.

The vast majority of researchers who assessed the occurrence of TM only measured intention for behaviour change as the main outcome variable. For example, McBride et al(9) merely applied a one-item measure which assessed participants' intentions to quit smoking in the next six months. We therefore included items that capture intention to change lifestyle and intention to follow a healthy lifestyle in our scale as well. However, a TM is generally conceptualized as increased behaviour change intentions instigated by an event itself(21). Most studies that investigated TMs took motivation for behaviour change into account, but did not focus on the actual health event as the underlying cause. An

exception is the study by Mazanec et al(22) in which items were included that assessed the extent to which the event itself raised awareness of a participants' health risk and the extent to which the event made them change what they do to take care of their own health. We therefore incorporated items that specifically ask for the impact of the cardiac event on lifestyle and attitude towards lifestyle.

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SUPPLEMENTARY MATERIAL 2: INITIAL ITEM POOL

Cardiac Teachable Moment Framework (CardiacTM) scale

Construct	Subdomain	Item	Source/ adapted from/ inspired by:
Risk perception	Perceived susceptibility and severity of CVD	1. It is likely that I will experience a/another heart attack or stroke at some point in my life.	Woringer et al.(5) & Ammouri et al.(2)
		2. I think my chances of having a/another heart attack or stroke in the next ten years are low.	Woringer et al.(5)
		3. I don't expect to experience a/another heart attack or stroke.	Woringer et al.(5) & Ammouri et al(2)
		4. I would find it serious to experience another heart attack or stroke.	Shiloh et al.(4)
		5. Prior to my cardiac event, my lifestyle was bad for my heart.	New item
		6. My lifestyle, as is, is not bad for my heart.	Ammouri et al.(2)
		7. With my lifestyle as is, I think my chances of having another heart attack or stroke are small.	McBride et al.(9)
		8. With a healthier lifestyle. I think my chance of having another heart attack or stroke is low.	McBride et al.(9)
		9. A healthy lifestyle has little impact on my chance of another heart attack or stroke.	Woringer et al.(5)
	Perceived relative risk	10. I think my chances of having another heart attack or stroke are higher than those of other people my age and weight.	Davidson et al(6)
		11. I think my chances of having lifestyle-related diseases are higher than those of other people my age and gender.	Davidson et al(23)
	Perceived susceptibility and severity of NCD	12. It is likely that I will experience lifestyle-related diseases at some point in my life.	Woringer et al.(5)
		13. I think my chances that I will experience lifestyle-related diseases in the next ten years are low.	Woringer et al.(5)
		14. I don't expect to experience lifestyle-related diseases.	Woringer et al.(5) & Ammouri et al(2)
		15. I would find it serious to experience lifestyle-related diseases.	Shiloh et al.(4)
		16. Should I continue with my lifestyle as is, I definitely expect to experience health problems.	McBride et al.(9)
		17. With a healthier lifestyle, I think my chance of health problems is low.	McBride et al.(9)

Cardiac Teachable Moment Framework (CardiacTM) scale *(continued)*

Construct	Subdomain	Item	Source/ adapted from/ inspired by:
		18. A healthy lifestyle has little impact on my chance of lifestyle-related disorders.	Woringer et al.(5)
	Increase in risk perception after cardiac event	19. Since my cardiac event, I think my chances of a/another heart attack or stroke are higher.	New item
		20. Since my cardiac event, I think my chances of lifestyle-related diseases are higher.	New item
		21. Since my cardiac event, I see myself as more fragile.	New item
		22. Prior to my cardiac event, I rated my chance of lifestyle-related diseases as low.	New item
		23. Due to my cardiac event, I think my chances of lifestyle-related diseases are higher.	New item
Affective impact	Level of worry	24. I am worried about having a heart attack or stroke in the future.	Woringer et al.(5); Berle et al.(23); McBride et al.(9)
		25. When I begin to worry about my cardiac event, I cannot stop.	Berle et al.(23)
		26. I am worried about having health problems in the future.	Woringer et al.(5); Berle et al.(23); McBride et al.(9)
		27. I am worried about the effects of my lifestyle on my health.	New item
		28. When I begin to worry about my health, I cannot stop.	Berle et al.(23)
	Negative affect	29. Since my cardiac event, I worry more about my health.	New item
		30. The concerns I have about my cardiac event influence my emotions.	Butler et al.(24)
		31. The concerns I have about my cardiac event influence my daily life.	Butler et al.(24)
		32. Since my cardiac event, I become more easily emotional.	New item
		33. Since my cardiac event, I am more often anxious.	Moss-Morris et al.(25)
Changed self-concept	Change in …		
	Social role	34. My role as partner/significant other has become more important to me, since my cardiac event.	Okely et al.(26)
		35. My role as parent has become less important to me, since my cardiac event.	Okely et al.(26)
		36. Since my cardiac event, I realize more how important I am to my loved ones.	Okely et al.(26)

Cardiac Teachable Moment Framework (CardiacTM) scale *(continued)*

Construct	Subdomain	Item	Source/ adapted from/ inspired by:
		37. My role as employer/employee has become more important to me, since my cardiac event.	Okely et al.(26)
	Perceived stigmatization	38. Since my cardiac event, I feel others judge me for my lifestyle choices more readily.	New item
		39. Since my cardiac event, I have more feelings of shame due to disapproval by others.	New item
		40. My loved ones are less likely to disapprove my lifestyle after my cardiac event.	New item
		41. Since my cardiac event, I feel others judge me for doing something unhealthy, such as smoking or eating unhealthy, more.	New item
	Illness identity	42. My illness is part of who I am as a person.	Oris et al.(16)
		43. I see myself as a heart patient.	New item
		44. I refuse to see my illness as a part of who I am.	Oris et al.(16)
		45. I accept that I am someone with an illness.	Oris et al.(16)
		46. I don't feel connected to other heart patients.	Cameron (27)
		47. Since my cardiac event, I feel more connected to other heart patients.	New item
		48. I feel a kinship with others who experienced a cardiac event.	Cameron (27)
	Identity and lifestyle	49. Since my cardiac event, I feel less connected to smokers.	Cameron (27)
		50. Since my cardiac event, I feel less connected to people who eat unhealthy.	Cameron (27)
		51. Since my cardiac event, I feel less connected to people who don't exercise much.	Cameron (27)
		52. Since my cardiac event, I feel less connected to people who drink alcohol.	Cameron (27)
		53. Since my cardiac event, I feel less connected to people who take little time for relaxation.	Cameron (27)
		54. Since my cardiac event, not smoking fits more with who I want to be as a person.	Shadel et al.(28)
		55. Since my cardiac event, eating healthy fits more with who I want to be as a person.	Shadel et al.(28)
		56. Since my cardiac event, exercising fits more with who I want to be as a person.	Shadel et al.(28)
		57. Since my cardiac event, not drinking alcohol fits more with who I want to be as a person.	Shadel et al.(28)
		58. Since my cardiac event, taking more time for relaxation fits more with who I want to be as a person.	Shadel et al.(28)

Cardiac Teachable Moment Framework (CardiacTM) scale *(continued)*

Construct	Subdomain	Item	Source/ adapted from/ inspired by:
		59. Since my cardiac event, I feel worse about myself if I smoke.	McBride et al.(9)
		60. Since my cardiac event, I feel worse about myself if I eat unhealthy.	McBride et al.(9)
		61. Since my cardiac event, I feel worse about myself if I exercise little.	McBride et al.(9)
		62. Since my cardiac event, I feel worse about myself if I drink alcohol.	McBride et al.(9)
		63. Since my cardiac event, I feel worse about myself if I take little time for relaxation.	McBride et al.(9)
	Future/possible self	64. My future self now has a healthier lifestyle than how I saw my future self before my cardiac event.**	New item
		65. The way in which I see myself in the future has changed since my cardiac event.	New item
		66. Since my cardiac event, I see myself as sicker or weaker in the future.	New item
		67. Since my cardiac event, the future image I have of myself has become hazy/dim.	New item
	Feeling of self-worth	68. Since my cardiac event, I feel like a lesser person.**	New item
		69. Since my cardiac event, I realize more how precious life is.	New item
		70. Since my cardiac event, I value myself more.	New item
	Body image	71. The way I view my body has not changed since my cardiac event.	New item
		72. I feel less attractive since my cardiac event.	New item
		73. I feel that others consider me more attractive since my cardiac event.	Cheek and Briggs(29)
		74. My appearance has become more important to me since my cardiac event.	Cheek and Briggs(29)

Cardiac-induced Lifestyle Change Intention (CardiacLCI)-scale

Subdomain	Item	Source/ adapted from/ inspired by:
Lifestyle change intention	1. I am motivated to improve my lifestyle.	McBride et al.(9)
	2. I plan to make positive changes in my lifestyle.	Okely et al.(26)
	3. As far as I am concerned, my lifestyle is fine as is.	New item
	4. I am working hard on improving my lifestyle.	New item
	5. For my health, it is not necessary to change my lifestyle.	New item
Impact of event on lifestyle	6. I have made positive changes to my lifestyle.	New item
	7. Since my cardiac event, I feel the urge to live a healthy lifestyle more.	New item
	8. Since my cardiac event, I think more often about wanting a healthier lifestyle.	New item
	9. Since my cardiac event, I think more positively about a healthy lifestyle.	New item
	10. My cardiac event has not affected my lifestyle.	New item
	11. If I don't change my lifestyle, my chances of having another heart attack or stroke increase.	New item
	12. My cardiac event convinced me that a healthy lifestyle is important for me.	New item
	13. It feels as my responsibility to live healthier now compared to before my cardiac event.	New item
	14. Since my cardiac event, I find it more important to live a healthy life.	New item
	15. Since my cardiac event, I feel more than before that a healthy lifestyle is necessary for my health.	New item
	16. I think of my cardiac event as the start to a new phase in my life.	New item

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SUPPLEMENTARY MATERIAL 3: I-CVI RATING FOR CLARITY AND RELEVANCE

Table 1. Cardiac Teachable Moment Framework (CardiacTM)-scale: I-CVI rating for clarity and relevance (n=6)

Items	I-CVI Clarity	I-CVI Relevance
Risk perception		
1. It is likely that I will experience a/another heart attack or stroke at some point in my life.	1	1
2. I think my chances of having a/another heart attack or stroke in the next ten years are low.***	0.83	0.83
3. I don't expect to experience a/another heart attack or stroke.***	1	1
4. I would find it serious to experience another heart attack or stroke.*	0.66	0.66
5. Prior to my cardiac event, my lifestyle was bad for my heart.	1	1
6. My lifestyle, as is, is not bad for my heart.**	0.83	1
7. With my lifestyle as is, I think my chances of having another heart attack or stroke are small.	0.83	1
8. With a healthier lifestyle, I think my chance of having another heart attack or stroke is low.**	1	0.83
9. A healthy lifestyle has little impact on my chance of another heart attack or stroke.***	1	1
10. I think my chances of having another heart attack or stroke are higher than those of other people my age and weight.	0.83	1
11. I think my chances of having lifestyle-related diseases are higher than those of other people my age and gender.	0.83	1
12. It is likely that I will experience lifestyle-related diseases at some point in my life.	0.83	0.83
13. I think my chances that I will experience lifestyle-related diseases in the next ten years are low.***	0.83	1
14. I don't expect to experience lifestyle-related diseases.*	0.66	0.66
15. I would find it serious to experience lifestyle-related diseases.*	0.66	0.66
16. Should I continue with my lifestyle as is, I definitely expect to experience health problems.**	1	1
17. With a healthier lifestyle, I think my chance of health problems is low.**	0.83	1
18. A healthy lifestyle has little impact on my chance of lifestyle-related disorders.***	1	1
19. Since my cardiac event, I think my chances of a/another heart attack or stroke are higher.**	1	1
20. Since my cardiac event, I think my chances of lifestyle-related diseases are higher.**	1	1

Table 1. *(continued)*

Items	I-CVI Clarity	I-CVI Relevance
21. Since my cardiac event, I see myself as more fragile.**	0.83	1
22. Prior to my cardiac event, I rated my chance of lifestyle-related diseases as low.***	0.83	1
23. Due to my cardiac event, I think my chances of lifestyle-related diseases are higher.***	0.83	0.83
Affective impact		
24. I am worried about having a heart attack or stroke in the future.	1	1
25. When I begin to worry about my cardiac event, I cannot stop.***	0.83	1
26. I am worried about having health problems in the future.	1	1
27. I am worried about the effects of my lifestyle on my health.	1	1
28. When I begin to worry about my health, I cannot stop.***	0.83	1
29. Since my cardiac event, I worry more about my health.	1	1
30. The concerns I have about my cardiac event influence my emotions.	0.50	0.83
31. The concerns I have about my cardiac event influence my daily life.	0.66	1
32. Since my cardiac event, I become more easily emotional.	1	1
33. Since my cardiac event, I am more often anxious.	1	1
Changed self-concept		
34. My role as partner/significant other has become more important to me, since my cardiac event.	0.83	1
35. My role as parent has become less important to me, since my cardiac event.	1	1
36. Since my cardiac event, I realize more how important I am to my loved ones.	1	1
37. My role as employer/employee has become more important to me, since my cardiac event.	1	1
38. Since my cardiac event, I feel others judge me for my lifestyle choices more readily.	1	0.83
39. Since my cardiac event, I have more feelings of shame due to disapproval by others.	1	0.83
40. My loved ones are less likely to disapprove my lifestyle after my cardiac event.*	0.83	0.66
41. Since my cardiac event, I feel others judge me for doing something unhealthy, such as smoking or eating unhealthy, more.*	0.66	0.66

Table 1. *(continued)*

Items	I-CVI Clarity	I-CVI Relevance
42. My illness is part of who I am as a person.***	0.83	0.83
43. I see myself as a heart patient.	1	1
44. I refuse to see my illness as a part of who I am.	1	0.83
45. I accept that I am someone with an illness.**	1	1
46. I don't feel connected to other heart patients.	1	1
47. Since my cardiac event, I feel more connected to other heart patients.	1	1
48. I feel a kinship with others who experienced a cardiac event.**	1	1
49. Since my cardiac event, I feel more connected to people who don't smoke.	1	1
50. Since my cardiac event, I feel more connected to people who eat healthy.	1	1
51. Since my cardiac event, I feel more connected to people who exercise.	1	1
52. Since my cardiac event, I feel more connected to people who don't drink alcohol.	1	1
53. Since my cardiac event, I feel more connected to people who take time for relaxation.	1	1
54. Since my cardiac event, not smoking fits more with who I want to be as a person.*	0.83	0.66
55. Since my cardiac event, eating healthy fits more with who I want to be as a person.*	0.83	0.66
56. Since my cardiac event, not drinking alcohol fits more with who I want to be as a person.*	0.83	0.66
57. Since my cardiac event, exercising fits more with who I want to be as a person.*	0.83	0.66
58. Since my cardiac event, taking more time for relaxation fits more with who I want to be as a person.*	0.83	0.66
59. Since my cardiac event, I feel worse about myself if I smoke.	1	1
60. Since my cardiac event, I feel worse about myself if I eat unhealthy.	1	1
61. Since my cardiac event, I feel worse about myself if I exercise little.	1	1
62. Since my cardiac event, I feel worse about myself if I drink alcohol.	1	1
63. Since my cardiac event, I feel worse about myself if I take little time for relaxation.	1	1
64. My future self now has a healthier lifestyle than how I saw my future self before my cardiac event.**	0.83	0.83

Table 1. *(continued)*

Items	I-CVI Clarity	I-CVI Relevance
65. The way in which I see myself in the future has changed since my cardiac event.	1	1
66. Since my cardiac event, I see myself as sicker or weaker in the future.	1	0.83
67. Since my cardiac event, the future image I have of myself has become hazy/dim.***	0.83	0.83
68. Since my cardiac event, I feel like a lesser person.*	0.5	0.66
69. Since my cardiac event, I realize more how precious life is.**		
70. Since my cardiac event, I value myself more.	1	1
71. The way I view my body has not changed since my cardiac event.**		
72. I feel less attractive since my cardiac event.	1	0.83
73. I feel that others consider me more attractive since my cardiac event.*	1	0.66
74. My appearance has become more important to me since my cardiac event.	1	1

Note. Items with * are eliminated based on I-CVI < 0.80, items with ** are adapted based on feedback from expert panel and items with *** are eliminated or adapted based on feedback during the think-aloud sessions.

Table 2. Cardiac-induced LCI (CardiacLCI)-scale: I-CVI rating for clarity and relevance (n=6)

Items	I-CVI Clarity	I-CVI Relevance
1. I am motivated to improve my lifestyle.***	1	1
2. I plan to make positive changes in my lifestyle.***	1	1
3. As far as I am concerned, my lifestyle is fine as is.	1	1
4. I am working hard on improving my lifestyle.	1	1
5. For my health, it is not necessary to change my lifestyle.*	1	0.66
6. I have made positive changes to my lifestyle.	1	1
7. Since my cardiac event, I feel the urge to live a healthy lifestyle more.	1	1
8. Since my cardiac event, I think more often about wanting a healthier lifestyle.***	0.83	1
9. Since my cardiac event, I think more positively about a healthy lifestyle.***	1	1
10. My cardiac event has not affected my lifestyle.**	1	1
11. If I don't change my lifestyle, my chances of having another heart attack or stroke increase.*	0.83	0.66
12. My cardiac event convinced me that a healthy lifestyle is important for me.	1	1
13. It feels as my responsibility to live healthier now compared to before my cardiac event.**	1	1
14. Since my cardiac event, I find it more important to live a healthy life.***	1	1
15. Since my cardiac event, I feel more than before that a healthy lifestyle is necessary for my health.*	1	0.66
16. I think of my cardiac event as the start to a new phase in my life.	1	1

Note. Items with * are eliminated based on I-CVI < 0.80, items with ** are adapted based on feedback from expert panel and items with *** are eliminated or adapted based on feedback during the think-aloud sessions.

SUPPLEMENTARY MATERIAL 4: ITEMS RESULTING FROM STEP 1: ITEM DEVELOPMENT

Cardiac Teachable Moment Framework (CardiacTM)-scale

Risk perception

1. It is likely that I will experience a/another heart attack or stroke at some point in my life.
2. I think my chances of having a/another heart attack or stroke in the next ten years are high.
3. A healthy lifestyle can reduce my chances of having a heart attack or stroke.*
4. Prior to my cardiac event, my lifestyle was bad for my heart.*
5. My lifestyle, as is, is bad for my heart.*
6. With my lifestyle as is, I think my chances of having another heart attack or stroke are small.
7. A healthier lifestyle will make my chances of having another heart attack or stroke smaller.*
8. I think my chances of having another heart attack or stroke are higher than those of other people my age and weight.
9. It is likely that I will experience lifestyle-related diseases at some point in my life.
10. I think my chances that I will experience lifestyle-related diseases in the next ten years are high.
11. A healthier lifestyle will make my chances of having a lifestyle-related disease smaller.*
12. Should I continue with my lifestyle as is, I expect to experience health problems.
13. A healthier lifestyle will make my chances of having health problems smaller.*
14. I think my chances of having lifestyle-related diseases are higher than those of other people my age and gender.
15. Due to my cardiac event, I rate my risk of a/another heart attack or stroke as higher.*
16. Due to my cardiac event, I rate my risk of lifestyle-related diseases as higher.*
17. Due to my cardiac event, I see myself as a more fragile person.*

Affective impact:

18. I am worried about having a heart attack or stroke in the future.*
19. When I begin to worry about my heart, I cannot stop worrying.
20. I am worried about having health problems in the future.
21. I am worried about the effects of my lifestyle on my health.*
22. When I begin to worry about my health, I cannot stop worrying.

23. Due to my cardiac event, I worry more about my health.*
24. The concerns I have about my cardiac event influence my emotions.
25. The concerns I have about my cardiac event influence my daily life.
26. Due to my cardiac event, I become more easily emotional.
27. Due to my cardiac event, I am more often anxious.
28. Due to my cardiac event, I feel more often down.

Changed self-concept:

29. My role as partner/significant other has become more important to me, due to my cardiac event.
30. My role as parent has become more important to me, due to my cardiac event.
31. Due to my cardiac event, I realize more how important I am to my loved ones.
32. My role as employer/employee has become more important to me, due to my cardiac event.*
33. Due to my cardiac event, I feel others judge me for my lifestyle choices more readily.*
34. Due to my cardiac event, I have more feelings of shame due to disapproval by others.*
35. Due to my cardiac event, I realize how precious life is.
36. Due to my cardiac event, I value myself more.
37. I look at my body in the same way now as always.*
38. Due to my cardiac event, I feel less attractive.*
39. I feel that others consider me more attractive since my cardiac event.*
40. My appearance has become more important to me due to my cardiac event.*
41. The way in which I see my lifestyle in the future has changed due to my cardiac event.*
42. The way in which I see myself in the future has changed due to my cardiac event.*
43. Due to my cardiac event, I see myself as sicker and weaker in the future.*
44. I see myself as a heart patient.*
45. I refuse to see my heart problem as a part of who I am.*
46. I accept that I am someone with a heart problem.*
47. I don't feel connected to other heart patients.
48. Due to my cardiac event, I feel more connected to other heart patients.
49. I feel a kinship with other heart patients.
50. Due to my cardiac event, I feel more connected to people who exercise.*
51. Due to my cardiac event, I feel more connected to people who take time for relaxation.*
52. Due to my cardiac event, I feel more connected to people who eat healthy.*
53. Due to my cardiac event, I feel more connected to people who don't smoke.*
54. Due to my cardiac event, I feel more connected to people who don't drink alcohol.*

55. Due to my cardiac event, I feel worse about myself if I don't exercise.
56. Due to my cardiac event, I feel worse about myself if I don't take time to relax.
57. Due to my cardiac event, I feel worse about myself if I don't eat healthily.
58. Due to my cardiac event, I feel worse about myself if I smoke.*
59. Due to my cardiac event, I feel worse about myself if I drink alcohol.*

Cardiac-induced Lifestyle Change Intention (CardiacLCI)-scale

1. I am always motivated to live a healthy lifestyle.
2. I plan to live healthier soon.*
3. As far as I am concerned, my lifestyle is fine as is.
4. I am working hard on improving my lifestyle.
5. I have made positive changes to my lifestyle.
6. I sometimes think about improving my lifestyle.*
7. I usually live a healthy lifestyle.
8. I am easily tempted to do unhealthy things.
9. Due to my cardiac event, I feel the urge to live a healthy lifestyle more.
10. Due to my cardiac event, I think more negatively about a healthy lifestyle.*
11. I live a less healthy lifestyle now compared to before my cardiac event.*
12. Due to my cardiac event, I allow myself more time to live a healthy lifestyle.
13. My cardiac event convinced me that a healthy lifestyle is important for me.
14. I live a healthier lifestyle now compared to before my cardiac event.
15. I think of my cardiac event as the start to a new phase in my life.

Note. * excluded in the analyses.

SUPPLEMENTARY MATERIAL 5: SCREE PLOTS

Figure 1. Scree plot to identify factor extraction – CardiacTM-scale

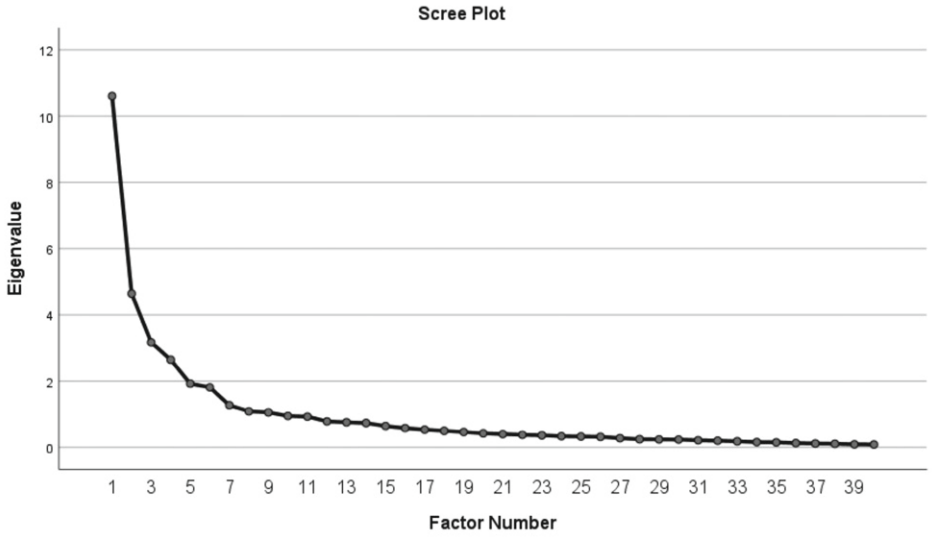
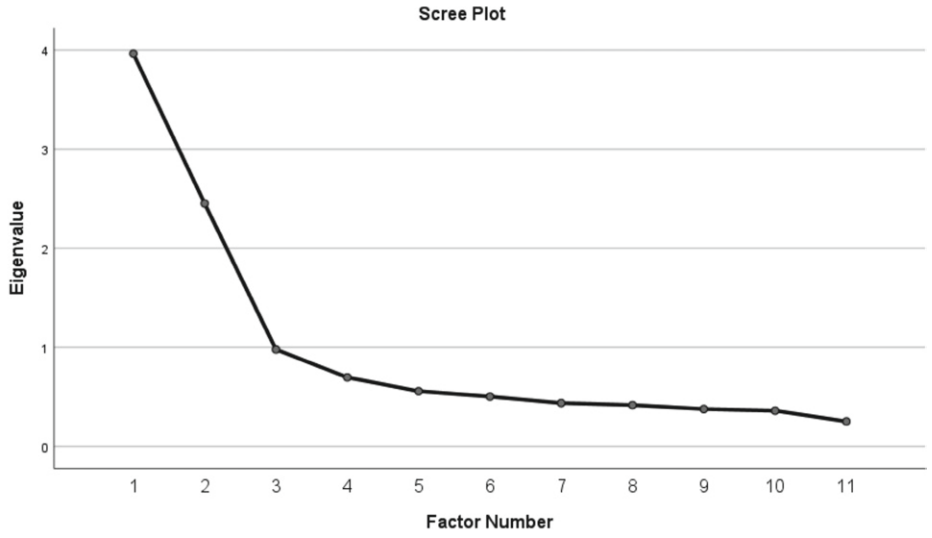


Figure 2. Scree plot to identify factor extraction – CardiacLCI-scale



SUPPLEMENTARY MATERIAL 6: FINAL SCALES

Cardiac Teachable Moment Framework (CardiacTM)-scale

Affective impact

1. When I begin to worry about my heart, I cannot stop worrying.
2. I am worried about having health problems in the future.
3. When I begin to worry about my health, I cannot stop worrying.
4. The concerns I have about my cardiac event influence my emotions.
5. The concerns I have about my cardiac event influence my daily life.
6. Due to my cardiac event, I become more easily emotional.
7. Due to my cardiac event, I am more often anxious
8. Due to my cardiac event, I feel more often down.

Perceived risk cardiovascular diseases:

9. It is likely that I will experience a/another heart attack or stroke at some point in my life.
10. I think my chances of having a/another heart attack or stroke in the next ten years are high.
11. With my lifestyle as is, I think my chances of having another heart attack or stroke are small. (reversed)
12. I think my chances of having another heart attack or stroke are higher than those of other people my age and weight.
13. Due to my cardiac event, I rate my risk of a/another heart attack or stroke as higher.

Changed self-concept:

14. My role as partner/significant other has become more important to me, due to my cardiac event.
15. My role as parent has become more important to me, due to my cardiac event.
16. Due to my cardiac event, I realize more how important I am to my loved ones.
17. Due to my cardiac event, I realize how precious life is.
18. Due to my cardiac event, I value myself more.

Cardiovascular disease group identity:

19. I don't feel connected to other heart patients. (reversed)
20. Due to my cardiac event, I feel more connected to other heart patients.
21. I feel a kinship with other heart patients.

Perceived risk for non-communicable diseases:

22. It is likely that I will experience lifestyle-related diseases at some point in my life.
23. I think my chances that I will experience lifestyle-related diseases in the next ten years are high.
24. Should I continue with my lifestyle as is, I expect to experience health problems.
25. I think my chances of having lifestyle-related diseases are higher than those of other people my age and gender.

Anticipated regret:

26. Due to my cardiac event, I feel worse about myself if I don't exercise.
27. Due to my cardiac event, I feel worse about myself if I don't take time to relax.
28. Due to my cardiac event, I feel worse about myself if I don't eat healthily.

Cardiac Lifestyle Change Intention (CardiacLCI)-scale

Event-related lifestyle change

1. I am working hard on improving my lifestyle.
2. I have made positive changes to my lifestyle.
3. Due to my cardiac event, I feel the urge to live a healthy lifestyle more.
4. Due to my cardiac event, I allow myself more time to live a healthy lifestyle.
5. My cardiac event convinced me that a healthy lifestyle is important for me.
6. I live a healthier lifestyle now than before my cardiac event.
7. I think of my cardiac event as the start to a new phase in my life.

General healthy lifestyle

8. I am always motivated to live a healthy lifestyle.
9. As far as I am concerned, my lifestyle is fine as is.
10. I usually live a healthy lifestyle.
11. I am easily tempted to do unhealthy things. (reversed)

5

Exploring timing and delivery of lifestyle advice following an acute cardiac event hospitalization: the cardiac patient's perspective

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ABSTRACT

Objective: To explore the perspective of cardiac patients regarding the timing and manner of delivering lifestyle advice following an acute cardiac event hospitalization.

Methods: Dutch cardiac patients who experienced a cardiac event hospitalization participated in a semi-structured interview (n=14) or a cross-sectional survey study (n=119).

Results: Our findings indicate that cardiac patients are receptive to lifestyle advice throughout the care trajectory. Advice delivered by a cardiologist had the highest self-reported impact. Furthermore, receiving advice at multiple phases during the care trajectory was associated with a greater intention to change lifestyle (B=0.37, CI=0.17–0.57). Patients favored clear-cut, feasible, and friendly but confronting advice. Moreover, they stressed the importance of advice being aligned with their identity and beliefs about the causes of their disease.

Conclusion: The period following an acute cardiac event provides a unique opportunity to offer tailored and patient-centered lifestyle advice. This "teachable window" for lifestyle change, when used wisely, may improve health outcomes for cardiac patients.

Practice Implications: Healthcare professionals should initiate lifestyle advice already during hospitalization and continue during follow-up appointments and cardiac rehabilitation. Advice should be feasible and empathy-based, as well as tailored to the patient's needs, values, and perceptions of the causes of their cardiovascular disease.

Keywords: Behavior change, life event, lifestyle counseling, patient education, teachable moment.

INTRODUCTION

Cardiovascular diseases (CVDs) are associated with high rates of morbidity and mortality. As such, they represent a significant global health burden, and thus affect not only individuals but society as a whole(1, 2). A person who has suffered an acute cardiac event is particularly susceptible to subsequent cardiac events(3). Adopting lifestyle changes can greatly improve health outcomes, making lifestyle counseling crucial for the secondary prevention of CVDs(4-7). The European Society of Cardiology (ESC) guidelines, therefore, recommend that patients after an acute cardiac event participate in a Cardiac Rehabilitation (CR) program(8, 9). These programs foster recovery and secondary prevention, focusing on supporting lifestyle modification, psychosocial wellbeing, and closely monitored exercise(8-10). Numerous reviews have highlighted the benefits of CR programs for improved lifestyle outcomes, morbidity and mortality, and quality of life(11-17). Nonetheless, challenges persist in the uptake and adherence to CR, as well as in sustaining long-term lifestyle changes post-CR(18, 19).

Following a cardiac event, patients can experience a "teachable moment" for lifestyle change, wherein they have an increased motivation to adopt risk-reducing health behaviors(20-22). This teachable moment is often the consequence of a continuous process whereby patients try to make sense of their recent experience(23). Brust et al.(23) have noted that this sensemaking process commences during hospitalization and continues after hospital discharge, leading to the term "teachable window" (TW) being deemed more fitting. This TW presents an opportune opportunity for healthcare providers to offer lifestyle advice, capitalizing on patients' receptivity due to their recent experiences(24-27).

To utilize the full TW, it is important to initiate lifestyle advice during hospitalization. Patients who receive such guidance during their hospital stay are more likely to exhibit positive behavioral changes(26). Accordingly, the ESC guidelines recommend early initiation of CR following hospitalization(8). However, despite these recommendations, lifestyle advice during hospitalization is not consistently provided(28). Also in the Netherlands, where CR typically begins several weeks after discharge, lifestyle counseling during hospitalization in practice remains far from standard. This underscores the urgency of prioritizing lifestyle support throughout the entire TW, from admission to the final patient contact. Additionally, the manner and timing of delivering lifestyle advice to cardiac patients should also be considered, as this can impact adherence and therefore effectiveness of the advice(12, 29, 30). Integrating patient-centered care, involving understanding patients' needs and preferences, often results in more personalized and cost-effective approaches(31).

Currently, however, these needs and preferences are rarely considered when designing lifestyle support interventions post cardiac event hospitalization.

Understanding how and when lifestyle advice is effective (i.e., what works, why, in what context, and for whom (32)) is essential for a better understanding of the optimal form and timing of lifestyle advice(33). The aim of this study was therefore to explore, from the point-of-view of the cardiac patient, optimal timing and best practices regarding lifestyle advice in secondary care shortly after an acute cardiac event hospitalization. The insights gained from this study may help improve the delivery of lifestyle advice in cardiac care, allowing a potential TW to be used optimally, leading to enhanced long-term compliance to lifestyle advice and ultimately better cardiac health outcomes.

METHOD

Study design and participants

This study employed a multi-methods approach, using both qualitative (sub-study 1) and quantitative (sub-study 2) methods to address the research questions. Both sub-studies obtained ethical approval from the Medical Ethics Committee Leiden University Medical Centre and were registered under METC-nr 18-112. In sub-study 1, data were collected through interviews conducted as part of a previous study by researchers MB, WAG, MEN, and JCK, aimed to elicit the experiences of cardiac patients regarding their myocardial infarction in relation to their lifestyle(23). Participants in sub-study 1 were cardiac patients who had experienced their first ST-elevated myocardial infarction, were hospitalized at either of two general hospitals in The Hague, aged 18 years or above, proficient in Dutch, and without severe psychiatric or neurodegenerative disorders. These participants engaged in two semi-structured interviews, approximately one and five months post-myocardial infarction.

In sub-study 2, a cross-sectional survey was employed to gather data. Participants in sub-study 2 were cardiac patients who had been hospitalized for a myocardial infarction (both ST-elevated and non-ST elevated) or an acute event related to heart failure or heart rhythm disorder, who subsequently completed the Capri CR program. A program description is provided in Supplementary Material A. Consistent with sub-study 1, participants were required to be 18 years or older, proficient in Dutch, and without severe psychiatric or neurodegenerative disorders. Based on a power calculation, we determined that to detect an estimated correlation r of 0,15 (based on previous research(34), with 95% power, $\alpha = 0.05$, we required a minimum of 75 participants for the analysis.

Procedure

Participants in sub-study 1 were recruited by cardiologists and nurse practitioners in 2019 and 2020 at hospital discharge. The first researcher (MB) contacted interested patients, obtained informed consent, and conducted the interviews. Participants received a voucher of 25 euros upon completing the second interview. The procedure has been described in more detail by Brust et al.(23).

Recruitment of participants for sub-study 2 took place in 2022. A research assistant from Capri CR identified eligible patients who had completed the program within the last year and sent invitation emails, including a participant information letter and a link to an online survey administered by Qualtrics. Participants could provide informed consent on the first page of the survey. All patients were informed that participation was voluntary and that data was collected anonymously.

Measures

We followed principles from a realist evaluation approach, i.e., a methodology used for understanding mechanisms behind interventions(35), to study the perspective of cardiac patients regarding the timing and manner of delivering lifestyle advice. To gain insight into "what works and why" regarding lifestyle advice, we used semi-structured interview data from sub-study 1 (Brust et al.(23)) that involved patient's needs, preferences, and experiences regarding lifestyle advice. Additionally, we used the survey of sub-study 2. Specifically, data of an open-ended question ("Could you describe which lifestyle advice has had the most impact on you and why?") and the 11-item validated Cardiac Lifestyle Change Intention (CardiacLCI) scale(36), which assesses lifestyle change intention due to a cardiac event. The survey of sub-study 2 also included questions regarding the preferred context of lifestyle advice, involving: a. the preferred time for receiving lifestyle advice (i.e., after admission to hospital, during hospitalization, at discharge, at home after discharge, during CR, during follow-up appointments, during a GP appointment, or never), b. the source of the lifestyle advice that had had the greatest impact on the patient (i.e., cardiologist, surgeon, nurse, nurse specialist, general practitioner, other doctor, dietician, physiotherapist, social worker, lifestyle coach, or general-practice nurse specialist), c. the perceived receptiveness to lifestyle advice during four phases in their treatment journey (i.e., during hospitalization, at home in the weeks after discharge, during follow-up appointments in hospital, and during CR), and d. the patient's evaluation of the received advice on three 7-point Likert scales (ranging from unpleasant to pleasant, bad to good, and unimportant to important). The survey also included socio-demographic characteristics, including age, sex, Body Mass Index (BMI), relationship status, children,

educational background, employment status, and the number of previous significant life events as assessed by the 12-List of Threatening Experiences (LTE)(37, 38).

Analysis

To explore "what works and why" regarding lifestyle advice, the semi-structured interviews of sub-study 1 and the open-ended survey question of sub-study 2 were analyzed using inductive thematic analysis(39). Patterns of responses were identified and grouped into emergent subthemes, which were further grouped into main themes. To investigate the preferred "context" for lifestyle advice, descriptive statistics were computed on preferred timing, the healthcare professional who provided the most impactful advice, receptiveness to receiving advice during different phases of care, and the evaluation of received advice across the phases. One-way ANOVAs were conducted to examine whether receptiveness and the evaluation differed across phases. Linear regression analyses were performed to examine the association between received lifestyle advice and intention to change lifestyle, after checking for linearity, normality of the residuals, and absence of multicollinearity. The univariate linear regression analyses used lifestyle advice received during hospitalization, follow-up appointments, and CR (dichotomic; no or yes) and the sum score (received lifestyle advice 0 – 3 times) as independent variables, and the subscales of the CardiacLCI scale(36) as linear dependent variables. Since individuals of different age, sex, and BMI have varying risks for CVD(40), and healthcare professionals may provide advice differently based on these characteristics, we additionally adjusted for these factors in the multivariate model. Lastly, in order to explore patient characteristics associated with receptiveness to lifestyle advice, we first assessed the univariate relationship between sociodemographic characteristics and the mean score on receptiveness to lifestyle advice, followed by multivariate analysis with an enter selection strategy, including all sociodemographic characteristics simultaneously. All analysis were performed with SPSS (version 25; IBM; Armonk, NY) and p values of < 0.05 were considered significant.

RESULTS

Sociodemographic characteristics

The sample in sub-study 1 involved fourteen cardiac patients who participated in the semi-structured interviews and the sample of sub-study 2 consisted of 119 cardiac patients who had completed the cross-sectional survey. Their sociodemographic characteristics are provided in Table 1.

Table 1. Sociodemographic characteristics of the samples of sub-study 1 and 2

	Sample sub-study 1 (n = 14)		Sample sub-study 2 (n = 119)	
Characteristic	**Mean (SD)**		**Mean (SD)**	
Age	63.2 (7.1)		56.3 (9.2)	
BMI (kg/m2)	-		26.7 (4.3)	
Number of life events	-		2.75 (2.0)	
	Frequency (n)	**Percentage (%)**	**Frequency (n)**	**Percentage (%)**
Sex				
Female/male	4/10	29/71	28/91	24/77
Living situation				
Relationship/single	12/2	86/12	96/23	81/19
Children				
Yes/no	11/3	79/21	98/21	83/18
Education*				
Low/middle/high	4/6/4	29/43/29	29/34/50	26/30/44
Employment				
Employed/unemployed	10/4	71/29	43/75	36/63
Myocardial infarction	14	100	46	39
Heart failure	-	-	41	34
Heart rhythm disorder	-	-	42	28

Total percentages can deviate from 100% due to rounded numbers.
* Level of education was classified according to the International Standard Classification of Education(33) into lower education (none, elementary or vocational education), middle education (higher general and secondary vocational education), or higher education (higher professional and scientific education).

"What works and why" – sub-study 1

From the data of sub-study 1 three main themes and several subthemes could be identified regarding "what works", as presented in Figure 1. The first main theme "Lifestyle counseling practices that facilitate patient compliance", included four subthemes. Firstly, participants expressed a preference and need for clear, practical, and feasible lifestyle advice that provides unambiguous guidance on which behaviors are beneficial or detrimental to their cardiovascular health, for instance regarding the healthiness or unhealthiness of certain food products [quote 1-2] (Supplementary Material B). Secondly, some participants noted that they were influenced by advice that increases their awareness of the consequences of lifestyle for their health. Furthermore, when healthcare professionals helped them understand the relevance of living healthy for their own personal health, their motivation

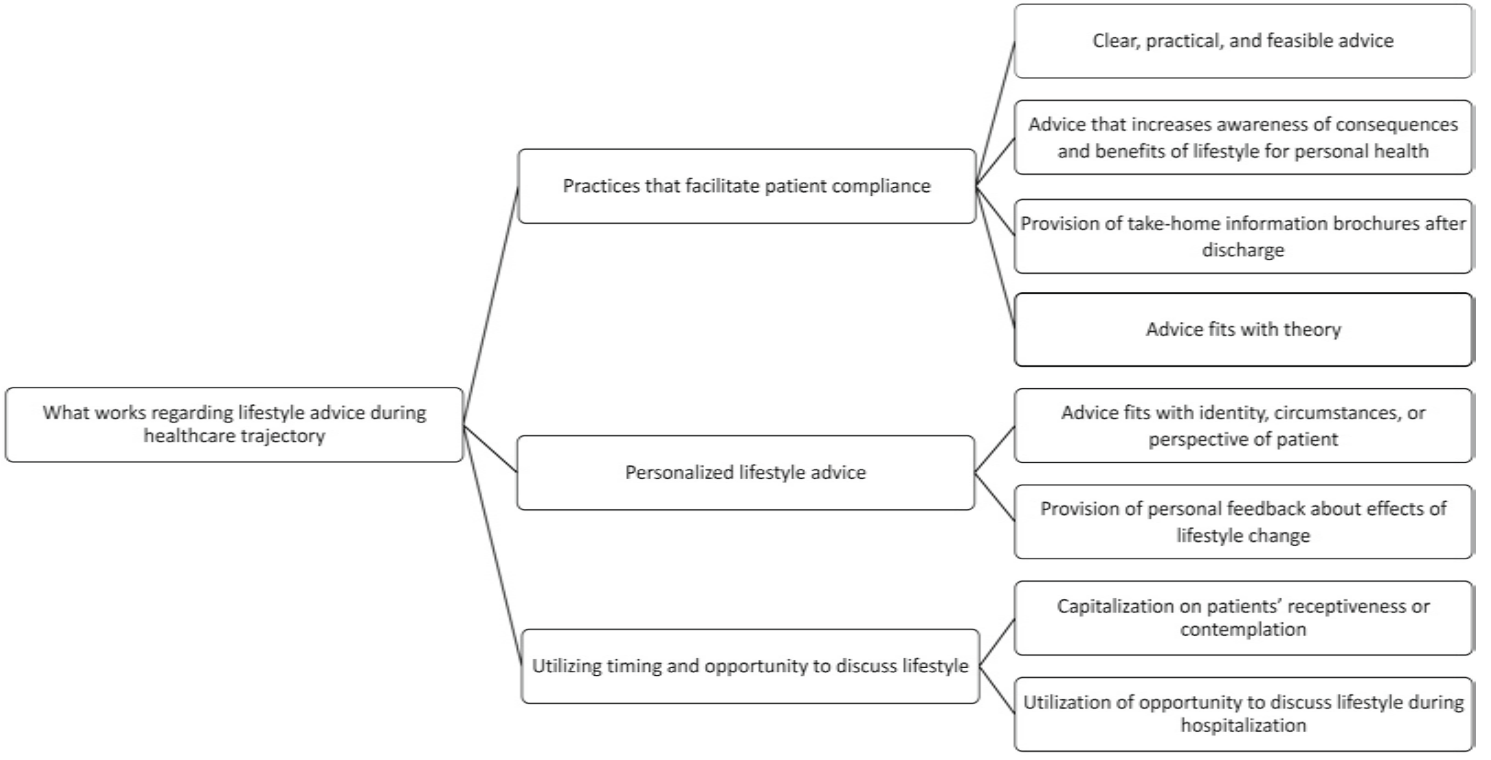


Figure 1. Main themes and corresponding subthemes.

to do so also increases [quote 3-4]. Thirdly, while some found post-discharge lifestyle-related information brochures helpful, efficacy varied [quote 5-7]. Finally, aligning advice with personal theories about the cause of their cardiac event was appreciated [quote 8-9].

The second main theme "Personalized lifestyle advice" emphasized the preference and need for advice that fits a patient's unique identity, circumstances, or perspective. Advice aligned with someone's values, daily routines, and life goals seemed better appreciated and easier to follow [quote 10-11]. For instance, one participant found it easy to implement advice of eat an apple a day because it suited his existing daily routine [quote 11], whilst another participant struggled with the advice to eat fewer sweet products because she regarded eating these products as part of her identity as a 'sociable, cozy' person [quote 12]. Additionally, participants sought personal feedback on health improvements resulting from lifestyle changes, such as changes in blood pressure and cholesterol [quote 13-14].

The third main theme, "Timing and opportunity to discuss lifestyle", emphasizes the importance of discussing lifestyle. Firstly, some participants were very interested in behaviors that they could adopt to improve their health status and reduce their risk [quotes 15-16]. This period of receptiveness and contemplation could be capitalized upon by healthcare providers. Secondly, many participants felt motivated by a lifestyle assessment conducted by their doctors or cardiologists right after their surgery [quote 17-18]. This underlines the importance of discussing lifestyle during this critical opportunity.

"What works and why" – sub-study 2

Table 2 outlines the main themes and subthemes derived from open-ended survey responses regarding "why" lifestyle advice was regarded as impactful. The first main theme is "Advice is clear, practical, and feasible", highlights that advice that was clear and simple or advice that included practical and feasible tips on how to live healthily, was helpful. Patients found it helpful when they were provided with new knowledge about lifestyle and particularly giving detailed explanations of why certain behaviors are healthy or unhealthy. The second main theme identified, "Advice is friendly and sincere", indicated that participants appreciated empathetic guidance and felt supported when healthcare providers demonstrated genuine concern. In particular, suggestions to be kind to oneself and take things gradually resonated with many participants. The third subtheme, "Advice fits with theory and person", revealed that some participants found that advice was impactful if it was aligned with their own theory regarding the cause of their acute cardiac event or with their current identity and life. For example, some participants believed that their event was due to a lack of physical activity, and receiving advice to exercise more was regarded as impactful because it aligned with this perceived behavioral cause.

Table 2. Qualitative analysis of responses on the question: "Could you describe what lifestyle advice had had the greatest impact on you, and why?" (n = 66)

Code	Number of participants	Example quote
Main theme: Advice is clear, practical, and feasible		
Clear and simple message focused on behavior change	10	Better awareness of one's eating habits. Burn fat rather than sugar.
Practical, feasible tips: reducing salt/sugar intake, reading food labels, or differentiating between (un)saturated fats	12	Paying attention to salt intake. It was only then that I recognized how much salt you can consume without realizing it, for example via so-called spice mixes that are 75% salt.
New knowledge or good explanation	7	Actually, none of the advice was "new" but when supported by evidence all advice was useful.
Main theme: Advice is friendly and sincere		
Genuine and kind	5	It came across as genuine and sincere.
Encouraged to take easy on oneself	4	Take it easy, avoid stress, do enjoyable things and be kind to myself. It helped; the way it was said.
Main theme: Advice fits with theory and person		
Advice linked to perceived behavioral cause	5	Moderately intensive exercise five times a week, and intensive twice a week. I think a lack of physical activity was a major contributor to my heart attack.
Advice aligned to perceived necessity	6	I was in bad shape so I understand I have to make drastic improvements. I am certainly convinced that this is absolutely essential.
Advice fits who I am or what I do	5	I believe in being active and keeping busy.
Main theme: Advice is rightly confronting		
Being confronted with the urgency of behavior change	10	I am now 70 and hope to have many more years. There's not really that much time left...

Similarly, for those who believed that their acute cardiac event was mainly due to stress levels, advice to better manage stress was welcomed. The fourth subtheme, "Advice is appropriately confronting", concerned participants who regarded advice as helpful when confronted with the reality of their situation and with the urgent need to change behavior.

"Context", perspective of the patient, sub-study 2

Participants' responses on preferred timing of lifestyle advice and the healthcare professional from which they received the most impactful lifestyle advice are presented in Figure 2 and Figure 3. As seen in these figures, the majority of participants preferred to receive lifestyle advice during CR (n=63), followed by at discharge (n=39), at home after discharge (n=37), and during hospitalization (n=37). Moreover, the majority found that the most impactful advice was given by a cardiologist (n=45), followed by a dietician (n=27) or a physiotherapist (n=23).

Table 3 provides the means (SD), ranges, and medians (IQR) of the reported receptiveness to lifestyle advice and the evaluation of the received lifestyle advice. Of our participants, 56% reported to have received lifestyle advice during hospitalization, 50% during follow-up appointments, and 90% during CR. Overall, participants were found to be quite receptive to lifestyle advice throughout all four phases in treatment, with the highest reported receptiveness during CR, followed by advice at home after discharge, during follow-up appointments, and during hospitalization. A one-way ANOVA analysis indicated a significant difference in reported receptiveness across the phases ($F = 8.55$; $df = 3$; $p < 0.01$). However, no significant differences were found in reported evaluation of received advice across the phases ($F = 1.42$; $df = 2$; $p > 0.05$).

Table 4 presents the results of the univariate regression analysis of received lifestyle advice and intention to change lifestyle. The findings indicate that receiving lifestyle advice during hospitalization, follow-up appointments, and CR were significantly associated with a higher score on the Event-induced lifestyle change intention-subscale, remaining significant after controlling for age, sex, and BMI (resp. $B = 0.46$, $CI = 0.06 – 0.87$; $B = 0.59$, $CI = 0.08 – 1.11$; and $B = 0.81$, $CI = 0.15 – 1.48$). Moreover, receiving lifestyle advice at multiple phases was additionally associated with a higher increased intention to change lifestyle ($B = 0.37$, $CI = 0.17 – 0.57$). Lastly, receiving lifestyle advice at CR was negatively associated with the General Healthy Lifestyle-subscale, but this association became non-significant after adjusting for age, sex, and BMI, suggesting that the association may be reversed, indicating that patients with a healthier general lifestyle may receive fewer lifestyle advice during CR.

Figure 2. Responses on question "When would you have preferred to receive lifestyle advice?"

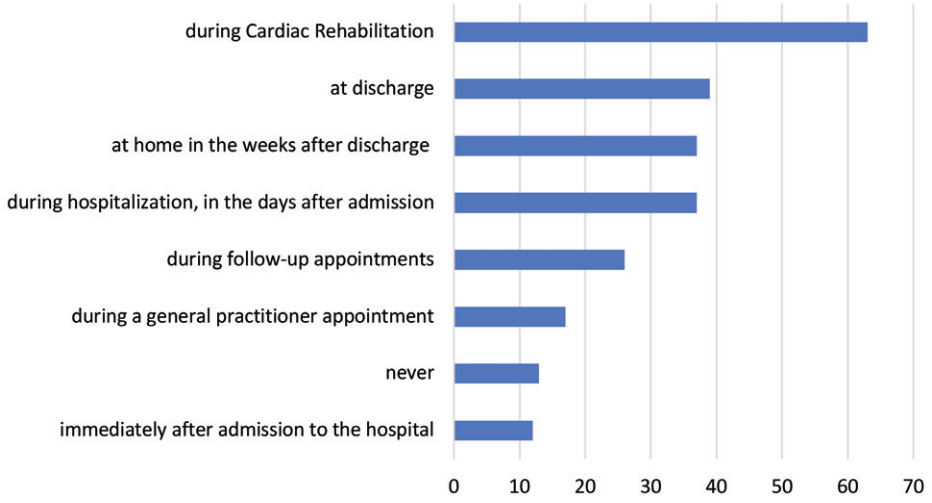
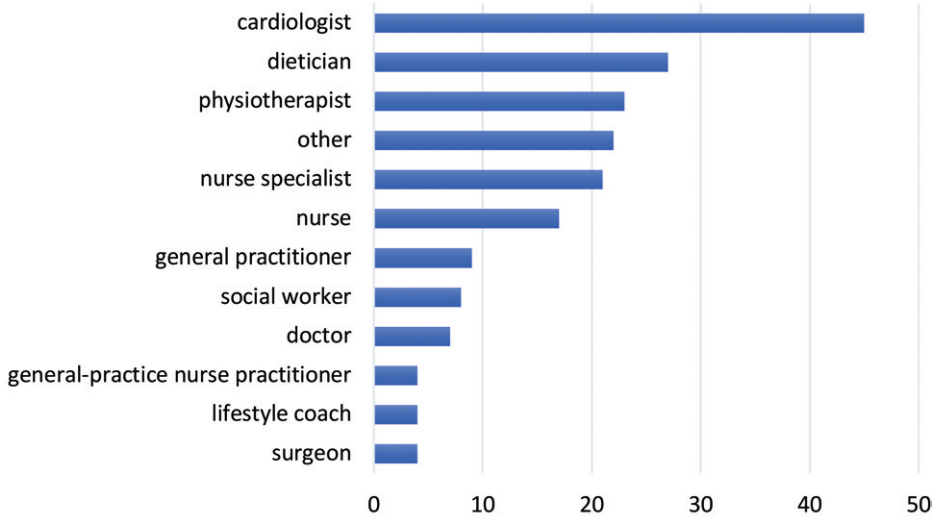


Figure 3. Responses on question "From which healthcare professional have you find the lifestyle advice to have the greatest impact on you?"



Note. Open-ended answers of answer option 'other' consisted of Capri Cardiac Rehabilitation (n = 8), family members (n = 7), or self (n = 4)

Table 3. Receptiveness to and evaluation of lifestyle advice

Phase in treatment	Receptiveness to lifestyle advice			Evaluation of received lifestyle advice		
	Mean (SD)	Range	Median (IQR)	Mean (SD)	Range	Median (IQR)
Hospitalization	3.88 (1.69)	1 - 7	4 (3 – 5)	5.8 (0.9)	1 – 7	6.0 (5.0 – 6.7)
At home after discharge*	4.52 (1.66)	1 - 7	5 (4 – 6)	-	-	-
Follow-up appointments	4.23 (1.67)	1 - 7	4 (4 – 5.5)	5.6 (1.1)	1 – 7	6.0 (5.0 – 6.0)
Cardiac rehabilitation	4.95 (1.50)	1 - 7	5 (4 – 6)	5.9 (0.9)	1 – 7	(5.7 – 6.6)

* Response option "At home after discharge" was only shown at receptiveness to lifestyle advice.

Table 4. Association of received lifestyle advice and intention to change lifestyle

	Univariate analysis B	95% CI	Multivariate analysis B	95% CI
Event-induced LCI-subscale				
Hospitalization (no, yes)	0.62***	0.23 – 1.0	0.46**	0.06 – 0.87
Follow-up appointments (no, yes)	0.71***	0.19 – 1.23	0.59**	0.08 – 1.11
Cardiac rehabilitation (no, yes)	-1.0***	0.38 – 1.70	0.81**	0.15 – 1.48
Sum score (received advice 0 – 3 times)	0.43***	0.23 – 0.63	0.37***	0.17 – 0.57
General Healthy Lifestyle-subscale				
Hospitalization (no, yes)	-0.19	-0.58 – 0.20	-0.13	-0.52 – 0.26
Follow-up appointments (no, yes)	-0.21	-0.73 – 0.32	-0.07	-0.58 – 0.44
Cardiac rehabilitation (no, yes)	-0.84**	-1.48 – -0.20	-0.80	-1.43 – -0.17
Sum score (received advice 0 – 3 times)	-0.19	-0.39 – 0.15	-0.15	-0.35 – 0.05

* $p < .10$ ** $p < .05$, *** $p < .01$. Multivariate analysis are adjusted for age, sex, and BMI.

"For whom": characteristics associated with receptiveness to lifestyle advice, sub-study 2

The univariate regression analyses between sociodemographic factors (i.e. age, sex, BMI, relationship status, children, migration background, education, employment, previous life events) and receptiveness to lifestyle advice, presented in Supplementary Material D, revealed that a lower age (B = -0.04, CI = -0.07 - -0.01) and having children (B = 0.80, CI = 0.11 – 1.49) was significantly associated with an increased receptiveness to lifestyle advice. In the multivariate model, only a lower age (B = -0.05, CI = -0.09 - -0.01) remained significantly associated to a higher receptiveness to lifestyle advice.

DISCUSSION

The period following an acute cardiac event is often perceived as a "teachable window" (TW) for lifestyle change, offering a unique opportunity for timely behavioral advice(20, 21, 23). However, there remains a lack of clarity regarding when lifestyle advice after a cardiac event hospitalization is effective, how patients perceive such advice, and how healthcare professionals can best support patients in making lifestyle changes(33). We therefore used realist evaluation principles(35) to uncover best practices and optimal timing of lifestyle advice from the perspective of cardiac patients. Our findings indicate that patients are generally receptive to lifestyle advice across all phases of the cardiac care trajectory, and evaluate it positively when offered, suggesting the presence of a potential TW(21). This underscores the importance of delivering lifestyle advice at the right moments during the cardiac care trajectory. These findings resonate with prior research demonstrating the acceptability of advice during potential teachable moments(22, 41-43).

We additionally discovered that patients who received lifestyle advice demonstrated a greater intention to adopt healthy lifestyle changes, particularly when the advice was provided at multiple points during the care process. These findings contribute to the ongoing conversation surrounding the efficacy of brief lifestyle advice. While they align with prior research demonstrating positive outcomes of brief lifestyle advice in secondary care(33, 44-46), they stand in contrast to many studies conducted in primary care, where such effects have been less pronounced(47). One potential explanation could be that patients in a primary care setting may perceive less urgency to act upon the advice, as they may lack the heightened receptivity associated with a strong TW.

Our study revealed important insights into patients' preferences regarding the manner of lifestyle advice, complementing previous research findings. Similar to our findings, previous research also underscored the importance of providing clear information on healthy diets and practical and feasible tips for modifying daily habits(30, 48, 49). Our results reinforce that how healthcare providers present educational content, influences engagement with lifestyle change(30, 50). Also, similar to previous research, we found that tailoring advice to each patient's unique identity and context is crucial, as behavior changes that align with one's identity are easier to maintain (51, 52). Therefore, cardiac healthcare providers should adopt patient-centered principles, engaging in open conversations and collaboratively setting personalized behavior change goals with their patients; a strategy linked to improved outcomes(27, 50, 53, 54). Additionally, our finding that patient preferred genuine, non-judgmental, and empathetic conversations about

cardiac disease management, reiterates previous findings(30, 55). Furthermore, in a review towards identifying effective behavioral change techniques, risk communication emerged as one of the most effective strategies(56). Similarly, we found that patients prefer raising their awareness of how lifestyle impact theirs health. However, the review also highlighted the efficacy of self-monitoring of behavior and the use of social support, strategies that we did not specifically uncover but are nonetheless valuable to consider.

Our finding that nearly half of our participants reported not receiving any lifestyle advice during their hospital stay or follow-up appointments underscores an important missed opportunity. While it is possible that some patients did receive advice but not perceive it as such, the relatively low numbers are generally comparable to previous studies in cardiometabolic care(28, 57, 58). Additionally, similar instances of missed opportunities have been noted in other healthcare settings(59, 60). Considering that patients are most receptive during the early recovery phase, possibly due to an increased readiness to regain control of their health(48, 61), it is crucial to provide lifestyle advice already in the hospital setting. Although receptiveness persisted across all phases, there was a preference for receiving lifestyle information during CR, potentially influenced by the majority of advice being offered during that period. Patient preferences for the timing of health information vary across studies as well(30, 62).

Our results also indicated that patients perceived lifestyle advice from cardiologists as having the greatest self-reported impact, followed by other healthcare professionals involved in CR such as dieticians and physiotherapists. These findings align with a previous study by O'Higgins et al.(63) and emphasize the crucial role of these physicians in providing lifestyle advice during cardiac care. However, differences in the self-reported impact across the various healthcare professionals were relatively minor. It is plausible that patients' perceptions of the trustworthiness and knowledgeability of their healthcare providers have a greater influence on the impact of lifestyle advice(51). Overall, patients see physicians as their primary source of health information and consider it their responsibility to offer advice(64). They regard lifestyle advice as an expression of care and responsibility, particularly when tailored to their unique life circumstances(65).

Younger cardiac patients seemed more receptive to lifestyle advice, consistent with Alsaqri et al.(61)'s findings. Possibly, younger CVD patients exhibit less healthy lifestyle behaviors compared to their older counterparts(66), potentially making them feel more vulnerable and motivated to take action to reduce their risks. Interestingly, we found no other demographic characteristics significantly linked to receptiveness to lifestyle advice. This differs with studies on the acceptability of advice during cancer screening, which identified

factors such as non-white ethnicity, higher education, and being female as influencing higher acceptability(43, 67). Our findings suggest that lifestyle advice should be targeted to all patients following a cardiac event, regardless of their sociodemographic characteristics. It is worth tailoring the content of advice based on various characteristics, however, as patient preferences for the type of health education may differ across various groups(68). For instance, younger patients might be more inclined to prefer online education(69, 70).

The present study had several strengths, including the use of a realist evaluation approach that incorporates the patient perspective when seeking to understand how lifestyle advice should be delivered(35). Furthermore, the use of both qualitative and quantitative measures provide a comprehensive understanding of the subject matter(71). In addition, the study's results have immediate practical implications, with especial relevance to cardiac care settings. Several limitations should also be acknowledged. The retrospective nature of the study and the use of self-reported data introduce potential recall and self-report biases(72), as participants may not accurately remember the content and manner of delivery of lifestyle advice, the healthcare provider from whom they received it, or their original preferences concerning advice. Additionally, selection bias may have led participants with the most interest in lifestyle advice to participate in the study. Furthermore, the study did not consider demographic or provider characteristics of healthcare providers, such as their age, gender, or years of working experience, which may have impacted patients' willingness to comply with advice. This is a worthwhile subject for future research. Finally, the study's cross-sectional design precludes the determination of the most effective approach to sustaining a healthy lifestyle over the longer term. Therefore, future studies should employ a prospective approach with objective lifestyle measures to validate these findings.

Conclusion

In conclusion, this study provides useful insights concerning the optimal use of the teachable window (TW) that occurs following an acute cardiac event. Cardiac patients are open to receiving lifestyle advice throughout their treatment journey, and receiving advice at various phases in this journey can have a positive impact on their willingness to make healthy lifestyle changes. Healthcare professionals in cardiac care should take advantage of the TW by providing feasible, patient-centered, and tailored lifestyle advice at the appropriate time to motivate and inspire patients to adopt healthier lifestyle habits.

Practice implications

This study has important implications for the timing and delivery of lifestyle advice following an acute cardiac event. To optimize impact, lifestyle advice should be initiated immediately after hospital admission, preferably by a cardiologist, and continued during follow-up appointments and CR. Healthcare providers working in cardiac care may benefit from training in effective methods and timing of lifestyle education, with skill training known to yield positive results(50). To promote the formation of positive behavioral habits, advice should be emphatic, tailored to individual needs and values, and include simple and feasible behavioral suggestions(73). Furthermore, understanding patients' perceptions of the causes of their CVD can help healthcare providers enhance their impact. Short questionnaires can be utilized to assess perceptions and align advice accordingly. Moreover, given that patients tend to underestimate the contribution of modifiable risk factors and the discrepancy between the views of physicians and patients concerning risk factors(74), patient education about these risk factors may also be valuable. Our study also highlights an unfilled need for lifestyle support during the time gap of several weeks between hospital discharge and start of CR, a problem identified previously(75). This underscores the potential for (eHealth) support interventions during this gap(70, 76, 77). To optimally exploit the TW, future studies should investigate barriers and facilitators experienced by healthcare providers when providing lifestyle advice in cardiac care, using approaches such as the Theoretical Domains Framework(78). Finally, understanding healthcare providers' needs and perceptions of best practices can inform the development of new approaches to provide lifestyle advice in the most effective manner.

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SUPPLEMENTARY MATERIAL 1

The Capri Cardiac Rehabilitation program offers a multidisciplinary approach to provide a comprehensive and individualized treatment for patients who are diagnosed with cardiovascular disease. The rehabilitation program typically lasts for six till twelve weeks and is conducted in an outpatient setting. The program includes exercise training, patient education, and psychosocial support, and involves collaboration between various healthcare professionals such as cardiologists, nurses, doctors and rehabilitation physicians, physiotherapists, dietitians, social workers, psychologists and psychiatrists. The exercise training component of the program typically involves supervised exercise sessions, which patients can attend twice a week, that combines aerobic, resistance training, and relaxation exercises. The patient education component consist of group meetings in which patients are informed about cardiovascular disease, its risk factors, and lifestyle modifications that may help prevent it. If necessary, participants can participate in treatment programs that supports them in lifestyle modification (e.g. smoking cessation, healthy diet) and receive individual guidance (e.g. from a social worker or dietician). The psychosocial support component of the program provides strategies to help patients cope with the emotional and psychological effects of their cardiac event. Patients may receive individual or group counseling, stress management techniques, and social support to aid in their recovery.

SUPPLEMENTARY MATERIAL 2

Table 1. Example quotes of main theme 1: Lifestyle counseling experiences and needs that facilitate patient compliance

Quote nr.	Participant	Example quote
		Subtheme: Clear, practical, and feasible advice
Quote 1	13	That's one good thing that came out of the whole episode, that conversation with the dietician in a sort of lecture hall […] and the girl says "Hey, this is bad for you, and that, and that, and that they are allowed to sell it, wow, because it's so bad for you!"
Quote 2	11	Well it's just because they said it so clearly, "It's better that you quit smoking". Well okay, then I agreed to stop.
		Subtheme: Advice that increases awareness of consequences and benefits of lifestyle for personal health
Quote 3	11	You know, as long as you're fit you think 'Yeah, it's all going well'; until this happens to you. Okay, you know it's unhealthy to smoke and then they give you the facts. That's when I said, 'Okay, I'll stop right now'.
Quote 4	7	Well, I was already aware of it, of course, that exercise is good for you, but even so I am much more conscious of it now. And that it's important and good for me, not in the general sense that people should exercise, but particularly for me in this situation, that I have to do my best to stay healthy.
		Subtheme: Provision of take-home information brochures after discharge
Quote 5	4	So yes, if you then read the Heart Foundation brochures on what is and what isn't good for you, yes, then you start to think about it. Yes, okay, that's how it is. And if you do it, things will improve a lot, or can improve a lot. It's of course nice that you can look at the information again. Especially when you've just left hospital, when you're reading all those leaflets and brochures. That's when you think, 'Yes, there are things I could still change'.
Quote 6	2	Of course, the hospital occasionally provides information about your eating habits. You took that all of that home with you naturally, that entire form with everything you can and can't eat. But I've never really been bothered by all of that myself.
		Subtheme: Advice fits with theory
Quote 7	11	Yeah, that's how I look at it now, because it didn't just happen, so something was wrong somewhere. That's what they said, that was it, a bottleneck, because I had that constriction and you don't have a stent and angioplasty for nothing. And yes, that's why it's better if you stop smoking. I now think, 'Okay it's commonsense; I'm going to give it a try'.
Quote 8	3	Interviewer: "And why is it that you wanted to deal with that [stress] now?" Patient: "Because I… I really understood the sense of what they were saying. I thought, 'Yes, this.. this is the way it is, with everything'.

Table 2. Example quotes of main theme 2: Personalized lifestyle advice

Quote nr.	Participant	Example quote
		Subtheme: Advice fits with identity, circumstances, or perspective of patient
Quote 9	7	Yes, I found it very enjoyable, very good, in line with what I, actually, can manage, so I really liked the fact that rehabilitation didn't focus on your performance, but on what's right for you now and how you can improve. I thought that was a very nice approach that they carry out with great care.
Quote 10	7	Yes, it's actually already partly in my routine, so you're already doing it, but not in a way that you really think about it all the time. No, I just make sure that I also have an apple in my lunch box, so to speak, that's about it. Interviewer: "Why did you decide to add that apple to your lunch box?" Patient: "Due to information from Cardiac Rehabilitation. I thought 'Okay, that suits me, I can do that easily enough'."
Quote 11	3	Sweet has something about it that's cozy and nice, yes. So yes, that fits with me, I enjoy being cozy and sociable. So I'm unhappy that it's no longer allowed.
		Subtheme: Provision of personal feedback about effects of lifestyle change
Quote 13	4	Yes, and I want to see what actually comes out of it, you know. Naturally, they have the original levels written down, everything is in the computer, they can get everything out of there. So now I'm waiting to see what effect it has. It has got to have an effect, otherwise it's pointless. If you change it all.
Quote 14	3	If you say, 'Hey, your blood pressure is elevated, stop eating licorice', then I'll stop .. maybe one.. no .. no, I'll really stop eating licorice. If that's the issue. Or if butter really raises your cholesterol, and amongst all those other things, I don't use that many things that raise cholesterol. Well, then I'm going to choose a low cholesterol alternative.

Table 3. Example quotes of main theme 3: Timing and opportunity to discuss lifestyle

Quote nr.	Participant	Example quote
		Subtheme: Capitalization on patients' receptiveness or contemplation
Quote 15	4	Zeker ja, van wat zou ik mogelijk fout hebben gedaan, dat ik dan toch in het ziekenhuis terecht ben gekomen. Dus ik zocht heel erg naar aanwijzingen van heb ik het wel goed gedaan en hoe kan ik het beter doen?
Quote 16	3	Dus ik ben nu van plan, plan he, om me in te lezen en te denken en te vragen wat zijn nou van die cholesterolverhogers. […] Ik word absoluut niet gehinderd door enige kennis van zaken, dus als de dokter tegen mij zegt van nou dat heb je, dan heb ik dat, en wat moet ik dan doen moet ik dat doen dan ga ik dat doen.
		Subtheme: Utilization of opportunity to discuss lifestyle during hospitalization
Quote 17	13	"Nou me aangeraden, want ik heb het gevraagd toen ik op de operatietafel lag van joh, hoe is het met de alcohol. Hij zei, nou 2 glazen mag."
Quote 18	4	Dat was meteen in het ziekenhuis wel duidelijk gemaakt. Dat ik echt om mezelf moet denken. Ze zei ook ja.. die kwam wel binnen, u bent uw hele leven nu echt hartpatiënt. Toen dacht ik, ja, ze heeft gelijk. […] Ik heb nooit gerookt, dat is het eerste als je binnenkomt in het ziekenhuis dan willen ze een oorzaak zoeken. Roken. Nooit gerookt. En drinken, ja.. 2 glaasjes wijn per dag. Nou dat was het ook niet. En dus nog even navragen en toen zeiden ze nou u heeft pech gehad. Nou ja oké. Maar eh na dit verhaal hebben we wel het eten nog meer aangescherpt.

SUPPLEMENTARY MATERIAL 3

Table 1. Association of sociodemographic characteristics and receptiveness to lifestyle advice

	Univariate analysis B	95% CI	Multivariate analysis B	95% CI
Age	-0.04***	-0.07 - -0.01	-0.05**	-0.09 - -0.01
Gender (male, female)	-0.34	-0.97 – 0.30	-0.39	-1.09 – 0.32
BMI	0.04	-0.02 – 0.10	0.01	-0.06 – 0.08
Relationship status (yes, no)	-0.11	-0.79 – 0.58	-0.18	-0.88 – 0.53
Children (yes, no)	-0.80**	-1.49 – -0.11	-0.53	-1.31 – 0.25
Migration background (yes, no)	-0.04	-0.94 – 0.86	-0.10	-1.06 – 0.86
Education dummy low	-0.35	-0.98 – 0.27	-0.11	-0.82 – 0.60
Education dummy middle	0.18	-0.42 – 0.78	-0.01	-0.69 – 0.68
Employment (yes, no)	-0.17	-0.73 – 0.40	0.46	-0.27 – 1.19
Previous life events	0.0	-0.13 – 0.14	-0.04	-0.19 – 0.10

* $p < .10$ ** $p < .05$, *** $p < .01$. In the multivariate analysis, all sociodemographic characteristics are included in the model using an enter selection strategy.

6

General discussion

"Teachable moments" describes periods when individuals suddenly become more open to lifestyle advice and changing lifestyle, often following important events or experiences in life(1, 2). In this dissertation, we empirically investigated life events as potential teachable moments for lifestyle change. A well-known theoretical framework proposed by McBride et al.(1) suggests that the factors 'increased risk perception', 'affective impact', and 'change in self-concept' determine the intention to change lifestyle following critical health-affecting events. Studies have indeed found links between these factors and lifestyle changes, particularly surrounding pregnancy and the diagnosis of lung cancer or type 2 diabetes(3-7). However, it remains unknown until now how these factors interact, and whether there are other psychosocial processes that also play a role in explaining why health-impacting events become teachable moments that lead to sudden health behavioral changes. The studies outlined in this thesis aimed to explore the potential of acute events as teachable moments for improving health behaviors, the underlying psychosocial mechanisms that explain why certain life events become teachable moments, and how these moments can be utilized in healthcare practices by providing targeted lifestyle counseling at the right moment in the care trajectory. In this dissertation, we focused on events related to acute cardiac disease to address these research objectives, with the overarching goal of broadening our understanding of teachable moments in general.

Several approaches were used to investigate the main study objectives, which resulted in an overall broad exploration of acute cardiac evens as potential teachable moments. This final chapter will first address the main research objectives by summarizing and discussing the main findings of the chapters. Second, it will outline the most important implications for practice and future research. Third, it will discuss the methodological and conceptual considerations regarding the design of the thesis and the empirical work.

MAIN FINDINGS

Research objective 1: Exploring the potential of acute events as teachable moments

Prior to addressing the first research objective, it is essential to establish a clear definition of a teachable moment. According to McBride et al.(1), it can be defined as "naturally occurring life transitions or health events thought to motivate individuals to spontaneously adopt risk-reducing health behaviors" (p. 156). Furthermore, teachable moments are often described as opportunities for learning(2), suggesting that individuals that experience teachable moments are more open to learning about optimizing their lifestyle and, thus, more receptive to behavioral messages(2, 8). This perspective underscores the significant

role that healthcare providers play in facilitating these opportunities(2, 9, 10). Combining these definitions, teachable moments can be defined as urgent life or health events after which individuals become more open to receiving behavioral advice and more inclined to make positive changes in their lifestyle. Consequently, the chapters of this dissertation explored the potential of acute events to serve as teachable moments by investigating whether they lead individuals to become both more *inclined* to improve their lifestyle and more *open* to receiving behavioral advice following such events.

This dissertation commenced with the cross-sectional study in **Chapter 2**. This chapter employed a quantitative approach to explore whether the onset of the COVID-19 pandemic was perceived as a teachable moment for Dutch cardiovascular disease (CVD) patients, a group at high risk for adverse health outcomes. Our findings confirmed that the COVID-19 crisis triggered a desire to enhance various health behaviors, with the strongest intention to improve concerning 'lifestyle in general', followed by 'physical activity' and 'dietary behavior'. These findings concluded that societal crises impacting people's lives can indeed prompt them to become more willing to improve their lifestyle, thus serving as a teachable moments. Similar conclusions emerged from **Chapter 3** and **Chapter 5**. **Chapter 3** employed an Interpretative Phenomenological Analysis (IPA) approach to qualitatively explore how patients made sense of a myocardial infarction in the context of their lifestyle. The findings revealed that the majority of patients viewed their myocardial infarction as a life-changing experience that motivated them to adopt a healthier lifestyle. In the months following the event, these patients actively contemplated changing their health behaviors, implemented behavioral changes in their lives, and sought ways to improve their lifestyle. As this period of increased willingness and receptiveness took place over an extended window of time following the event, this dissertation concludes that the term "teachable window" better encapsulates the phenomenon than "teachable moment". This gradual process of change, as opposed to change prompted by a single, specific moment, aligns with previous research on events and behavior change(11, 12). The notion of a teachable window, rather than a moment, was further supported in **Chapter 5**, where it was observed that cardiac patients after their CVD diagnosis generally showed receptivity to behavioral advice at multiple phases in the healthcare trajectory (including hospitalization, post-hospital discharge, follow-up appointments in the hospital, and Cardiac Rehabilitation).

Taken together, the findings of this dissertation demonstrated that important life events, exemplified by the COVID-19 crisis and a CVD diagnosis, indeed possess the potential to evoke intentions to improve lifestyle (**Chapter 2** and **Chapter 3**) and enhance individuals'

receptiveness to behavioral messages (**Chapter 3** and **Chapter 5**). Consequently, it can be concluded that certain events during life may be experienced as teachable windows.

Research objective 2: Exploring the underlying psychosocial mechanism that turn life events into teachable moments

To address the second research objective, we adopted a combination of quantitative and qualitative approaches. Beyond exploring the potential of the COVID-19 crisis as a teachable moment, **Chapter 2** additionally investigated whether increased intentions to change health behaviors were linked to risk perception, affective impact, and changes in self-concept, thereby verifying the theoretical framework proposed by McBride et al.(1). To further explore this matter in a qualitative and bottom-up approach, **Chapter 3** explored sensemaking processes that contributed to intentions and changes in lifestyle following a myocardial infarction. During the research, we encountered a considerable variability in how teachable moments were assessed due to the absence of validated scales for this purpose. Consequently, in **Chapter 4**, we adopted a more fundamental approach and aimed to validate questionnaires designed to facilitate research on teachable moments. Following the methodology outlined by Boateng et al.(13), we successfully validated two newly developed scales: the Cardiac Teachable Moment (CardiacTM) scale, which assesses the characteristics of cardiac events as teachable moments (research objective 2), and the Cardiac Lifestyle Change Intention (CardiacLCI) scale, which measures whether an acute cardiac event triggers patients' intentions to make lifestyle changes (research objective 1). The CardiacTM scale finally consisted of six internally consistent factors (affective impact, risk cardiovascular disease, changed self-concept, cardiovascular disease group identity, risk noncommunicable disease, anticipated regret), and the CardiacLCI scale resulted in two internally consistent factors (event-related lifestyle change and general healthy lifestyle). Both scales demonstrated good internal reliability and sufficient content, construct (factorial), and convergent validity.

The findings of **Chapter 2**, **Chapter 3**, and **Chapter 4** provided valuable insights into psychosocial factors instrumental in transforming acute life events into teachable windows. **Chapter 2** concluded that a desire to make lifestyle changes in response to the COVID-19 crisis was predominantly linked to shifts in patients' self-concept, specifically how they believed that they or their outlook on life had changed due to the pandemic. In **Chapter 3**, a closely related theme emerged as a key concept in explaining teachable windows: the re-evaluation of life goals, self, and social roles. Similarly, in **Chapter 4**, items related to the factor 'changed self-concept' of the CardiacTM scale focused on changes in one's sense of self, meaningfulness, and the importance of certain social roles in life. This factor

demonstrated the highest association with self-reported cardiac event-related lifestyle change. Together, these findings suggest that teachable windows may be elucidated by the extent to which individuals felt that their life goals, selves, and social roles had altered, especially when they realize that a healthy lifestyle is essential for achieving what they value in life, who they are or aspire to be, and fulfilling social roles responsibilities. This finding aligns with Michie et al.(14, 15)'s recognition of identity as an important factor in shaping health behaviors. Additionally, previous literature has also identified the important role of identity and identity shifts in behavior change and maintaining behavioral changes(16-20).

Both **Chapter 2** and **Chapter 4** found that experiencing an affective impact of a life event was associated with intentions for lifestyle change due to the event, although to a lesser degree compared to self-concept. This finding was confirmed in **Chapter 3**, which also identified the important role of experiencing an emotional impact in acute cardiac events, along with a clear recall of the event. Moreover, the chapter that also encountered emotions of loved ones, particularly partners, was important in turning life events into teachable windows, providing evidence that dyadic coping is important in health behavior change of couples(21).

In contrast to the lack of a significant role for risk perception in **Chapter 2**, **Chapter 3** revealed several related concepts important in explaining lifestyle change during teachable windows. These concepts were primarily linked to an increased perception of one's vulnerability and establishing a connection between one's vulnerability and adopting a healthier lifestyle. This suggests while McBride et al.'s(1) forwarded critical factor of increased risk perception is likely to have an influence during teachable windows, it needs to further operationalization. Specifically, heightened risk perception may lead to an intention to change lifestyle only when patients causally attribute their vulnerability to unhealthy behaviors, and when perceived risk is associated with a degree of outcome expectancy (i.e. beliefs about the specific consequences of engaging in healthy or unhealthy behaviors)(22, 23).

These findings suggest that elements of McBride et al.'s theoretical framework(1) may be important in elucidating the underlying mechanisms of teachable windows, yet they should be further operationalized and may not be sufficient without other psychological processes taking place. For instance, both **Chapter 3** and **Chapter 4** found that a desire to avoid anticipated regret regarding the continuation of unhealthy behaviors serves as a motivation for enhancing lifestyle after a life event. Furthermore, **Chapter 3** showed that when patients want to maintain autonomy over their life after a life event, and interpret the narrative of the event in relation to its behavioral causes, this motivates lifestyle

improvement as well. Additionally, a desire to reduce medication intake together with a belief that this can be achieved through improving lifestyle, can trigger motivation in patients. Therefore, when we want to fully understand the underlying mechanisms of teachable windows, integration from other theoretical frameworks such as the self-determination theory(24, 25) and the factors involved in the Sense of Coherence of the Salutogenic model(26) is valuable.

Research objective 3: Exploring how we should utilize teachable windows in healthcare

In **Chapter 5**, we aimed to address the knowledge gap related to the practical utilization of teachable windows. This mixed-methods study therefore explored the perspective of cardiac patients concerning the timing and manner of delivering lifestyle advice following an acute cardiac event. Our findings indicated that the teachable window after an acute cardiac event offers a unique opportunity to provide tailored and patient-centered lifestyle advice. Cardiac patients, in general, showed receptiveness to behavioral advice throughout the care trajectory, allowing healthcare professionals to initiate lifestyle advice already during hospitalization and continue it through follow-up appointments and cardiac rehabilitation. The findings revealed that cardiac patients preferred advice that was practical, empathetic, and tailored to their individual needs, values, and perceptions of the causes of their cardiovascular disease.

The scales developed and validated in **Chapter 4** can serve as useful tools for facilitating discussions on lifestyle changes following significant life events. While these scales were specifically developed for acute cardiac events, they can be further adapted to foster discussions about lifestyle during other events in life (such as pregnancy, exemplified in our study of Uzan et al. (68)). These scales can serve conversation aids to facilitate brief lifestyle discussions with patients(27). Adapted versions of the CardiacLCI scale can assist healthcare providers in screening the extent to which their patients might be experiencing a potential teachable window and, thereby being receptive to behavioral advice. Providing advice when patients are most open to it ensures greater appreciation and likelihood of compliance(28, 29). Similarly, adapted versions of the CardiacTM scale can initiate discussions about psychosocial themes related to a teachable window, potentially triggering patient motivation during a physician-patient interaction(9). How to capitalize on teachable windows will be further elucidated in the following paragraph.

IMPLICATIONS FOR PRACTICE

The findings of this dissertation offer valuable implications for healthcare concerning how to respond to a life event with the potential to become a teachable window. This section provides practical implications based on the dissertation's findings.

Role for healthcare providers and organizations

The findings of **Chapter 5** that patients are receptive to advice following life events, their positive evaluation of received advice, and the link between received advice and their intention to improve lifestyle, emphasize the significant role of healthcare providers and organizations during such critical periods. Healthcare professionals in primary and secondary care can then play an important role in emphasizing the significance of a healthy lifestyle(12), as they frequently interact with patients around these life events. Research indicates that advice from physicians is highly regarded by patients(30) and can facilitate healthy lifestyle changes(12, 31). Maximizing the effectiveness of potential teachable window situations in healthcare therefore requires healthcare professionals to recognize and acknowledge that certain life events can trigger an intention to change lifestyle among patients. To make the most of these opportunities as they arise, they then could proactively offer lifestyle advice(9, 10). According to patient preferences demonstrated in **Chapter 5**, this should preferably be done in an empathetic and genuine manner to respect the patient-provider relationship.

However, relatively passive attitudes towards lifestyle counseling in primary and secondary care settings(32-35) suggest that lifestyle does not receive the emphasis it deserves in healthcare. This may be due to a lack of specific knowledge about lifestyle, limited time during consultations, and having other priorities that hinder care workers from discussing lifestyle in the clinical setting(35, 36). To overcome these barriers, it is crucial for hospital and primary care settings to adapt policies to include lifestyle medicine as part of their treatment protocol. For example, they are well advised to implement a time- and content-specific protocol or roadmap regarding brief lifestyle counseling in hospital settings, to ensure that lifestyle support becomes an integral part of the treatment process. Perceiving the provision of lifestyle advice as a professional responsibility has been linked to better implementation of providing such advice(37), highlighting the importance of healthcare organizations demonstrating their commitment to lifestyle support. Moreover, it is important that skill development regarding how to best support a patient in the process of changing their behavioral habits receives more attention. This can be incorporated into medical and nursing education and reinforced through skill development training

sessions and follow-up education(38). These educational sessions are probably preferably led by trained behavioral experts or health psychologists who are specialized in evidence-based behavioral change conversation techniques(15). Passive attitudes among healthcare providers may also be caused by perceiving that many patients still struggle to effectively implement lifestyle advice into their daily life (33, 39), leading them to doubt the effectiveness of their guidance(33). It would be advantageous to find a way to share positive feedback with healthcare providers, ensuring that their efforts in facilitating behavioral change are acknowledged. Moreover, it is important that educational sessions emphasize to healthcare providers that even minor changes in health-related behaviors can yield significant benefits for patients, and certainly on a population basis. For example if 10% of smokers successfully quit smoking this may seem a small effect in a singular practice, but is a huge effect on a population basis. Encouraging healthcare providers to hold positive beliefs about the consequences of their actions will further enhance their commitment to the provision of lifestyle advice(37).

Timing matters

The findings of this dissertation further emphasize that in order to fully utilize the opportunity of the teachable window, it is important that lifestyle counseling begins immediately following an acute health event such as a myocardial infarction or a chronic disease diagnosis. This includes the initiation of lifestyle advice for example immediately after hospital admission, during disease screening, or during a primary care consultation. Healthcare providers should be given the opportunity to actively inquire about their patients' lifestyle behaviors at any time during any care trajectory. **Chapter 5** highlights that behavioral advice may have the greatest impact when provided by specialists, such as cardiologists in the context of acute cardiac events. Patients hold a high level of trust in these specialists, considering them experts, including in the field of prevention(30). We therefore expect that when specialists start with "priming" the idea of lifestyle among their patients immediately after a life-changing event, the teachable window will be perceived most strongly. Subsequently, more extensive lifestyle support can be continued by other healthcare providers or paramedics who can invest more time in understanding the patient's unique circumstances. This allows them to adapt their advice to a patient's context and to support patients in acquiring the necessary skills (see also paragraph "manner of advice").

We additionally found that patients generally take longer to make sense of a life event, hence the previously introduced term "teachable window". This indicates that an intention to change lifestyle may evolve over time. It is important for healthcare providers to be

aware of this and to continue to offer lifestyle advice after hospital discharge and during the remainder of the care trajectory, including during follow-up visits in the hospital and beyond. This highlights the potential of strong collaboration between healthcare providers, to ensure that lifestyle support is repeated and continued in a consistent manner. Collaboration between primary and secondary care also appears promising, with general practitioners taking over the role of monitoring patients and providing lifestyle support after a certain period, continually reminding patients of the importance of a healthy lifestyle and subsequently refer to different forms of lifestyle counselling.

Particularly in the case of acute cardiac events, **Chapter 5** highlighted a noteworthy gap in lifestyle support between the moment of hospital discharge and the onset of cardiac rehabilitation programs. In line with the concept of the "fresh start effect", individuals tend to be better at implementing changes at new beginnings(40). As **Chapter 3** showed that many participants saw the time after their acute cardiac event as a new beginning, during which they were actively searching for ways to prevent another future cardiac event to happen, additional lifestyle support should be also organized in between hospital discharge and onset of cardiac rehabilitation. For instance, future studies should investigate how we can develop blended eHealth interventions for this purpose, with particular attention to tailoring them to individual needs of patients. This may also be organized for other illness diagnoses, as similar gaps in between health event and treatment are also expected in follow-up care of other conditions such as in cancer treatment. Special attention may be given to patients with a lower socioeconomic position as they potentially have the greatest substantial health benefits from such interventions(41, 42).

Manner of advice

The psychosocial processes that emerged as underlying mechanism of teachable windows in **Chapter 2, 3, and 4** also revealed several implications regarding how healthcare providers should capitalize on such situations. For instance, the results show that it is important to prompt patients to engage in reflection about their identity, life goals, and social role responsibilities, after potential teachable window situations. By doing so, healthcare providers can support patients in forming new, healthier, conceptions about themselves, and they can connect lifestyle advice to what a patient considers important in life, who a patient really is or aspires to be, what a patient wants to achieve in their life, and the social roles they wish to fulfill. This way, the healthcare provider can more easily link the urgency of why patients need to optimize their lifestyle in a way that resonates with the patient's values and higher order motivations. For example, a patient may not be directly motivated to improve their health, but their true desire might be to stay active to

enjoy playing with their grandchildren. Motivational interviewing techniques can prove especially valuable in encouraging patients to construct and pursue personal goals(43).

Both **Chapter 3** and **Chapter 5** demonstrate the value of aligning lifestyle advice with a patient's experience of a life event. This dissertation revealed that patients tend to make sense of an event, in which they try to comprehend why it happened. Healthcare providers could encourage this sensemaking process, encouraging patients to construct a personal narrative around a life event and assisting patients in making a connection to their lifestyle as strong determinant of their (future) health. In addition, healthcare providers could investigate the health behaviors to which patients attribute their illnesses or health problems, and consequently aligning their advice with what patients perceive as most impactful on their health. Tailoring advice to align with what patients consider as attributional factor to their illness seems to have a more profound impact on their willingness to comply, according to the findings of **Chapter 5**.

Another implication drawn from this dissertation involves that healthcare providers are well advised to emphasize a patient's sense of personal control and autonomy in managing their health and future through lifestyle changes, as this dissertation showed that this will increase the likelihood of the occurrence of a teachable window. Healthcare providers could for instance make patients aware of their susceptibility and educate them about their own role in lowering their susceptibility by adopting healthier lifestyle behaviors. Moreover, they could use the facilitating role of anticipated regret in teachable windows by encouraging patients to imagine consequences of not engaging in health protective behaviors, as previous literature shows that especially anticipated inaction regret is associated with health behavior(44). In addition, to foster patients' sense of control over their health, it could be worthwhile to show patients the benefits of an improvement in lifestyle through presenting them the effects of lifestyle change on health indicators such as cholesterol and blood pressure, as in Chapter 5 it was encountered that patients preferred such personalized feedback. Chapter 3 further showed that life events sometimes trigger a sudden perception of deteriorating health and a fear of losing independence accordingly. Healthcare professionals could identify if patients experience these concerns and emphasize that maintaining good physical condition can significantly prolong their independence.

Chapter 2, 3, and 4 determine the importance of incorporating psychosocial consultation into patient care after significant health events, to discuss the emotional impact of such events. By providing an opportunity for patients to reflect on the emotional impact of life-changing events, healthcare professionals can foster the emergence of a teachable

window within patients. As we encountered that witnessing emotional responses of partners and family members, can further trigger a teachable window in patients, there should be created opportunities for patients to discuss the emotional impact of the health event together with their partners and family members. It is beneficial to invite partners to lifestyle support as well, such as participation in cardiac rehabilitation programs. Not only is behavior change more likely to occur in patients when their partners also change their behavior(45), but involving partners can potentially lead to their own teachable window, thus improving the partner's own lifestyle and health(5).

The findings of **Chapter 5** highlight the wish of most patients that healthcare providers deliver clear, practical, and feasible lifestyle advice that includes unambiguous guidance on which behaviors are beneficial or detrimental to a patient's health, for instance regarding the (un)healthiness of certain food products and how one should read food labels. Patients are also likely to highly benefit from personal consultations with healthcare providers during which their behavioral habits can be discussed, minor yet advantageous adaptations that easily integrate into their daily routines and unique circumstances can be explored, and behavioral change goals can be collaboratively determined. Such tailored advice that fit patients' identity and circumstances tends to be more impactful(38, 46, 47). In order to support patients in healthy habit formation, advising patients on how they can change their behaviors may offers the best potential for life-long impact(48, 49).

METHODOLOGICAL CONSIDERATIONS AND FUTURE RESEARCH

This section describes methodological considerations of the study designs, measures, and findings of the chapters, and proposes recommendations for future research to advance the understanding of teachable windows. The first limitation concerns the study designs employed. In **Chapter 2, 4, and 5**, the quantitative assessments were carried out using cross-sectional survey data. This use of a cross-sectional design limited our ability to establish causal relationships between the variables(50, 51). Consequently, we were limited in establishing the nature of the associations between psychosocial factors and lifestyle change intention, and thus were unable to draw definite conclusions regarding the sequencing of these associations over time(51, 52). Future studies should prioritize the adoption of longitudinal designs to enable a more comprehensive exploration of the temporal order in which the psychosocial factors, lifestyle change intentions, and actual behavioral changes occur, which in turn lead to the possibility of making causal inferences.

To fully explore the underlying mechanism of the teachable window, psychosocial factors should ideally be measured in the months following an acute life event, whilst intention to change lifestyle as well as the actual occurrence of lifestyle change should be assessed over a longer period of time. This longitudinal approach would further allow to test mediation and moderation effects of the psychosocial factors identified in **Chapter 3**, to explore how variables may interact in their role to initiate a teachable windows and whether specific psychosocial factors play a role in specific subgroups of patients.

Another limitation concerns the use of self-reported measurements that may have affected biases and caused measurement errors and validity issues. For instance, self-report measurements are often linked to social desirability bias, wherein respondents may provide socially acceptable responses, especially concerning sensitive topics(53). Considering that lifestyle behaviors could be perceived as a sensitive topic(54), social desirability bias might have influenced the responses of participants involved in this dissertation. Additionally, recall bias could have affected the findings as participants were asked to retrospectively recall details about their life event. Although efforts were made to limit recall bias by including participants soon after an event, there remains a possibility that it influenced the answers. Measurement errors and validity issues could for instance play a role in **Chapter 2**, where the Box-score method was used to assess intention to change lifestyle due to a life event. This method focused on calculating a percentage of participants who, on average, demonstrated at least a slightly increased intention to change health behaviors in response to the COVID-19 crisis (indicated by a arguably arbitrary mean score exceeding 3.5 on a Likert scale ranging from 1 = no intention to 7 = full intention). In an effort to reduce validity issues, **Chapter 4** described the development and validation of scales for the purpose of conducting research about teachable moments, which appeared reliable and valid. This has led to a more valid measurement to assess intention to change. Nonetheless, it is important to recognize that for a more comprehensive understanding, for example ideally a comparison should be made between an individual's lifestyle intentions before and after a significant life event.

The focus on intentions to change lifestyle and short-term lifestyle changes following acute life events presents another limitation. First, the predominant focus on lifestyle change intention as outcome elucidates the essence of a teachable window, but it should be recognized that the connection between intention and actual lifestyle change may be rather limited(55, 56). Future studies should therefore further investigate to what extent an intention, instigated by a teachable window, also translates into actual changes in lifestyle. This exploration could involve the incorporation of additional approaches of data collection such as ecological momentary assessment(57), and the use of more objective

devices such as accelerometers. In a study conducted by Fong et al.(58), improvements in smoking outcomes were found to last at least until one year after participants underwent surgery, suggesting that the teachable moment effect triggered by surgery may indeed hold promise for longer-term behavior change. While there is some evidence for long-lasting effects of behavior change interventions(59-61), it is imperative to emphasize that more research towards sustainable effects of teachable windows is needed. For instance, it would be beneficial to investigate whether patients develop lasting behavioral habits and successfully implement healthier practices in their daily lives(48, 49, 62). Lastly, it would be fruitful to investigate whether behavioral changes observed in the first year after acute events yield lasting beneficial effects for a person's health.

The chapters in this dissertation may have been susceptible to selection bias, a common issue in studies that involve additional data collection beyond routine data gathering(50). This bias was evident in an overrepresentation of participants with higher professional and academic backgrounds, potentially introducing bias as this group often is more able to focus on health(63). However, it is important to note that participants with elementary or vocational backgrounds were still sufficiently represented in the study samples, contributing to diversity. It is also possible that individuals with a stronger interest in lifestyle and health were more inclined to participate the studies of this dissertation. In future research, it would therefore be particularly interesting to investigate how individuals with no interest in healthy lifestyles perceive and respond to acute life events, providing a more comprehensive understanding of the subject matter.

Another limitation is its predominant focus on negative urgent events, such as acute cardiac events and the COVID-19 crisis, while the literature also associates positive or less urgent events with lifestyle changes. Positive "transitions in life" have the potential to shift an individual's perspective and induce changes(64). Pregnancy, as an example of a positive event, also often leads to healthy lifestyle changes, with pregnant women typically being very open to such transitions (65)(Uzak et al. submitted). Future studies could explore the extent to which positive events differ from negative events, examining whether similar psychosocial processes play a role. Furthermore, lifestyle changes following less urgent events, such as being informed of a slightly increased risk of developing cardiovascular disease, may also occur. We expect that similar processes may play a role, however to gain a more comprehensive understanding of teachable windows, future studies should verify if our findings are applicable to these other life events as well. It would for example be valuable to employ narrative interview techniques with elderly patients to retrospectively let them identify potential teachable windows throughout their life course(66, 67). This approach could provide insights into the various life events that influence lifestyle changes,

both positively and negatively, and how care and support may be proactively organized around these events to stimulate behavior change.

A final limitation of this dissertation to consider here, is that the perspective of healthcare providers regarding how we should take advantage of the teachable windows was not assessed. Understanding healthcare providers' needs, as well as their perceptions of best practices, can inform the development of new approaches and interventions to provide lifestyle advice in the most effective manner. Moreover, in order to increase the provision of lifestyle advice in healthcare, it is important to investigate what barriers healthcare providers experience in doing so. To optimally exploit the teachable window, future studies should therefore investigate barriers and facilitators experienced by healthcare providers when providing lifestyle advice to patients, based on a thorough understanding of behavior change by applying frameworks such as the Theoretical Domains Framework (TDF)(37).

In addition to the aforementioned recommendations for future research, several additional questions for further exploration remain. For instance, does a teachable window necessarily occur within the initial months following an acute life event, or can this process also occur later in the aftermath of such an event? Furthermore, regarding the psychosocial factors that underlie the mechanism of a teachable window: is there a minimum threshold of a specific factor required to initiate a teachable window effect?, and is there a minimum amount of psychosocial processes that must take place in order to experience a teachable window effect? Additionally, the reference to teachable moments as health events that "spontaneously" motivates behavior change(1), implies the involvement of automatic processes. However, this dissertation highlights that lifestyle changes are mostly the result from a process of reflection rather than occur automatically. It would be interesting to explore whether lifestyle changes are indeed primarily the result of a reflective process or if automatic processes also come into play following significant life events.

CONCLUSION

The chapters of this dissertation demonstrated that certain events in life have the ability to make someone become more motivated to change their lifestyle and more receptive to lifestyle advice. Such events can be health occurrences such as acute cardiac events, but also broader societal crises that impact a person's life such as the COVID-19 pandemic. This dissertation revealed that individuals tend to make sense of important life events in the months that follow. Several interrelated processes of sensemaking within these months will

impact motivation for lifestyle change. Therefore, we can conclude that life events have the ability to trigger a "teachable window" towards lifestyle change. The implications of these findings underscore an important window of opportunity to provide continuous lifestyle support during and after life-changing events. This dissertation provides multiple recommendations on how to enhance lifestyle support during this window of opportunity.

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7

English summary

Following certain events or experiences in life, people may suddenly realize the detrimental consequences of their unhealthy behaviors and become more aware of the urgency of adopting a healthier lifestyle. This, in turn, enhances their intention to make positives changes in their lifestyle. The term "teachable moment" describes such periods of time that increases someone's openness to lifestyle advice and lifestyle change. Teachable moments can arise after important life or health events, such as hospitalization for an acute health event, pregnancy, or the diagnosis of a chronic disease of someone self or in a loved one. As a result of this greater receptiveness, interventions centered around important life or health events have demonstrate great potential.

Although the concept of teachable moments is not new, research on life events as teachable moments was relatively limited and primarily focused on lung cancer as a teachable moment for quitting smoking. Prior to our research, it was unclear whether other life events could similarly stimulate intentions for lifestyle changes. Additionally, an important question for the effective utilization of teachable moments in healthcare was *how* certain events could enhance motivation for behavior change. According to a conceptual framework of teachable moments developed by Colleen McBride and colleagues (2003), the extent to which a person experiences a life event will as a teachable moment is determined by 1) the extent to which the event increases people's perceived risk and expectations about the consequences of unhealthy behaviors, 2) the extent to which an event elicits a strong emotional or affective response, and 3) the extent to which an event causes changes in the self-concept, identity, or social role of an individual. This framework served as a theoretical starting point of our research on teachable moments.

In this dissertation, we aimed to investigate the potential and the underlying mechanism of life events as teachable moments. Specifically, **research question 1** was: Can life events, particularly acute health events related to cardiovascular diseases and societal crises such as the COVID-19 pandemic, serve as teachable moments that suddenly increase individuals' motivation to improve health behavior? **Research question 2** was: What are the underlying psychosocial mechanisms of teachable moments? Are increased risk perception, emotional responses, and changes in one's self-concept indeed crucial factors, as the conceptual framework on teachable moments suggests? How do they interact, and to what extent can other psychosocial factors also play an important role as active mechanisms of teachable moments? Finally, **research question 3** was: How should potential teachable moments be utilized within lifestyle support around acute life events? In this dissertation, we specifically use acute events related to cardiovascular disease as a "case study" to address the research questions, as they are often suggested as potential teachable moments but had not yet been investigated as such.

MAIN FINDINGS

In **Chapter 2**, the first and second research question were addressed through a cross-sectional design with an online survey. The aim of this chapter was to explore whether the start of the COVID-19 pandemic was perceived as a teachable moment among Dutch cardiovascular disease patients, i.e., a group high at risk for adverse health outcomes of a COVID-19 infection. Additionally, we determined whether enhanced intentions to change health behaviors due to the pandemic were associated with risk perception, affective impact, and changes in self-concept, thereby verifying the conceptual framework of McBride and colleagues (2003). The results showed that cardiac patients demonstrated a willingness to enhance health behaviors due to the COVID-19 pandemic, particularly in terms of their overall lifestyle, physical activity, and diet. Intentions to change were mainly associated with changes in the patient's self-concept, namely, the extent to which patients felt that the corona crisis had changed them as a person and their outlook on life. To a lesser extent, the intentions to change behavior were associated with experiencing an emotional impact of the pandemic. These findings suggest that societal crises such as the COVID-19 pandemic can indeed evoke a teachable moment, primarily driven by changes in self-concept. Since not all factors of the conceptual teachable moment framework were associated with intentions to change behavior, we concluded that further research into other psychosocial factors that may influence life events as teachable moments is also necessary.

In **Chapter 3** of this dissertation, we employed a qualitative approach to address the first and second research questions. We used an Interpretative Phenomenological Analysis to explore how cardiac patients made sense of their myocardial infarction in relation to their lifestyle, and which processes of sensemaking were related to experiencing an increased intention to change their lifestyle. The results showed that many of the patients indeed regarded their myocardial infarction as a life-changing experience that motivated them to pursue a healthier lifestyle. In the months following the myocardial infarction, these patients actively contemplated changes in their health behavior, implemented behavioral changes in their lives, and sought ways to optimize their lifestyle. Since this period extended over a longer duration after the myocardial infarction, the term *"teachable window"* described the phenomenon better than *'teachable moment'*. Several processes of sensemaking were encountered that seemed important for experiencing a teachable window, including interpreting an event in terms of behavior causes and consequences, perceiving a link between lifestyle and health, becoming aware of their own vulnerability if continuing unhealthy behaviors, and also anticipating potential future regret if unhealthy behavior is continued, striving to regain autonomy and control over life, experiencing

the heart attack as an emotional event, receiving medication and desiring to reduce medication intake by believing that this can be achieved earlier through an improved lifestyle, and reflecting on identity, goals in life, and social roles in relation to health scares and personal health behavior.

Due to the lack of validated scales to investigate teachable moments, we observed a wide variation in the approaches used in previous research. Therefore, in **Chapter 4**, we validated two newly developed questionnaires: the Cardiac Teachable Moment (CardiacTM) scale, which measures the characteristics of cardiac events as teachable moments, and the Cardiac Lifestyle Change Intention (CardiacLCI) scale, which measures whether an acute cardiac event stimulates the intention for lifestyle change. Both scales demonstrated good internal reliability and sufficient content, construct (factorial), and convergent validity. The CardiacTM scale consisted of six internally consistent factors (affective impact, perceived risk of cardiovascular disease, changed self-concept, cardiovascular disease group identity, perceived risk of noncommunicable disease, anticipated regret). The CardiacLCI scale consisted of two internally consistent factors (event-related lifestyle change and general healthy lifestyle). Both scales can be used in future research to better understand if, when, and how life events can serve as teachable moments (research question 1) and which psychosocial factors play a role (research question 2). In practice, healthcare providers can use adapted versions of the CardiacLCI scale to assess the extent to which their patients experience a potential teachable window and are therefore open to behavioral advice. Adapted versions of the CardiacTM scale can be used to facilitate discussions about psychosocial themes related to a teachable window, which may enhance the patient's motivation during conversations between healthcare providers and patients to initiate a healthier lifestyle.

In **Chapter 5**, the third research question was addressed, which was related to the practical utilization of teachable windows in healthcare. The aim of this mixed-methods study was to investigate the perspective of cardiac patients regarding the timing and approach of providing lifestyle advice after hospitalization due to an acute cardiac event. We found that patients were more receptive to behavioral advice throughout the entire care trajectory (during hospitalization, after hospital discharge, during follow-up appointments at the hospital, and during cardiac rehabilitation). Patients who received lifestyle advice during their care trajectory viewed this positively and showed a higher intention to change their lifestyle, especially when advice was given during multiple phases of the care trajectory. The teachable window after an acute cardiac event thus offers a unique opportunity to provide patient-centered lifestyle advice. Patients preferred advice that is feasible and empathetic, and that is tailored to their needs, values, and perceptions of the causes of their cardiovascular condition.

CONCLUSION AND IMPLICATIONS

Certain events in life can motivate someone to change their lifestyle and be more receptive to lifestyle advice. These events may relate to one's personal health, such as acute heart problems, but also broader societal crises, such as the COVID-19 pandemic. Because this increased motivation and receptiveness typically persist in the months following an event, we concluded that certain events can stimulate a "teachable window" for lifestyle change. We encountered several processes of sensemaking that seemed important for experiencing such a teachable window. For instance, we found that elements of McBride and colleagues' (2003) conceptual teachable moment framework indeed play a role in behavior change, such as changes in self-concept, identity, and social roles, and experiencing an event as emotional. Risk perception seemed to play a role, although particularly in terms of awareness of one's vulnerability when continuing unhealthy behaviors. However, these were not the only important psychological factors. Other key processes include interpreting an event in terms of behavior causes and consequences, wanting to avoid future regret when unhealthy behaviors persist, and striving to regain autonomy over one's life after a life event through positive lifestyle changes.

The conclusions of this dissertation underscore an important window of opportunity to provide continuous lifestyle support during and after life-changing events. Moreover, it provides several implications for practice. First, it highlights an important role of healthcare providers during teachable windows, as they frequently interact with patients during important life events and because patients consider lifestyle advice, particularly when given by specialists, as impactful. Second, it emphasizes an important role of the timing of advice, which ideally initiates immediately following an event, and is continued and repeated in the months afterwards. Third, it provides recommendations regarding the manner of advice, which should ideally be based on the findings related to sensemaking processes, is both practical and empathetic, and should be tailored to individuals' needs, context, values, and perceptions of the causes of their cardiovascular disease.

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8

Appendix

Nederlandse samenvatting
Portfolio
Curriculum Vitae
Dankwoord

NEDERLANDSE SAMENVATTING

Na bepaalde gebeurtenissen of ervaringen in het leven kunnen mensen plotseling beseffen wat de nadelige gevolgen van hun ongezonde gedragingen zijn, en worden ze zich bewuster van de urgentie om gezonder te leven. Dit versterkt hun intentie om positieve veranderingen in hun leefstijl door te voeren. De term 'teachable moment' beschrijft dergelijke periodes waarin iemand ontvankelijker is voor leefstijladviezen en meer open staat voor leefstijlveranderingen. Teachable moments kunnen plaatsvinden na belangrijke levens- of gezondheidsgebeurtenissen, zoals een ziekenhuisopname voor een acute gezondheidsgebeurtenis, zwangerschap, of de diagnose van een chronische ziekte bij iemand zelf of een dierbare. Als gevolg van deze grotere ontvankelijkheid hebben interventies rondom belangrijke levens- of gezondheidsgebeurtenissen een groot potentieel voor gedragsverandering.

Hoewel het concept van teachable moments niet nieuw is, was het onderzoek naar levensgebeurtenissen als teachable moments relatief beperkt, en richtte zich voornamelijk op longkanker als een teachable moment voor stoppen met roken. Het was, voorafgaand aan ons onderzoek, onduidelijk of andere levensgebeurtenissen ook op eenzelfde wijze intenties tot leefstijlverandering kunnen stimuleren. Daarnaast was het een belangrijke vraag voor een effectieve benutting van teachable moments in de gezondheidszorg *hoe* bepaalde gebeurtenissen een verhoogde motivatie voor gedragsverandering kunnen bevorderen. Volgens een conceptueel raamwerk van teachable moments ontwikkeld door Colleen McBride en collega's (2003) wordt de mate waarin iemand een levensgebeurtenis als een teachable moment ervaart bepaald door 1) de mate waarin de gebeurtenis iemands waargenomen risico en verwachtingen over de gevolgen van ongezonde gedragingen verhoogt, 2) de mate waarin een gebeurtenis een sterke emotionele of affectieve reactie oproept, en 3) de mate waarin een gebeurtenis veranderingen in het zelfconcept, de identiteit, of de sociale rol van een individu veroorzaakt. Dit raamwerk diende als een theoretisch uitgangspunt voor ons onderzoek naar teachable moments.

In dit proefschrift wilden we zowel het potentieel als de onderliggende mechanismen van levensgebeurtenissen als teachable moments onderzoeken. Specifiek was **onderzoeksvraag 1**: Kunnen levensgebeurtenissen, met name acute gebeurtenissen gerelateerd aan cardiovasculaire ziekten en maatschappelijke problemen zoals de COVID-19-pandemie, fungeren als teachable moments die plotseling iemands motivatie vergroten om gezondheidsgedrag te verbeteren? **Onderzoeksvraag 2** was: Wat zijn de onderliggende psychosociale mechanismen van teachable moments? Zijn verhoogde

risicoperceptie, emotionele reacties, en veranderingen in iemands zelfconcept inderdaad cruciale factoren, zoals het conceptueel raamwerk over teachable moments suggereert? Hoe werken ze samen, en in hoeverre kunnen andere psychosociale factoren ook een belangrijke rol spelen als werkzame mechanismen van teachable moments? Ten slotte was **onderzoeksvraag 3**: Hoe moeten potentiële teachable moments benut worden binnen de leefstijlondersteuning rondom acute levensgebeurtenissen? In dit proefschrift gebruiken we specifiek acute gebeurtenissen gerelateerd aan cardiovasculaire ziekten als 'casestudy' om de onderzoeksvragen te beantwoorden, aangezien ze vaak werden gesuggereerd als potentiële teachable moments, maar nog niet als zodanig waren onderzocht.

Belangrijkste bevindingen

Hoofdstuk 2 richtte zich op de eerste en tweede onderzoeksvraag door middel van een cross-sectioneel design waarbij een online vragenlijst werd gebruikt. Dit hoofdstuk onderzocht of het begin van de COVID-19-pandemie werd ervaren als een teachable moment door Nederlandse cardiovasculaire patiënten, een groep met een hoog risico op negatieve gezondheidsuitkomsten bij een COVID-19-infectie. Daarnaast onderzochten we of verhoogde intenties tot leefstijlverandering als gevolg van de pandemie waren geassocieerd met risicoperceptie, emotionele impact, en veranderingen in het zelfconcept. Hiermee verifieerden we het conceptuele raamwerk van McBride en collega's (2003). De resultaten toonden aan dat patiënten gemotiveerd waren om hun leefstijl te verbeteren vanwege de COVID-19-pandemie, met name op het gebied van hun algemene leefstijl, lichaamsbeweging, en dieet. Intenties om te veranderen waren voornamelijk geassocieerd met veranderingen in het zelfconcept van een patiënt, namelijk de mate waarin patiënten vonden dat de coronacrisis zichzelf als persoon en hun kijk op het leven veranderd heeft. In mindere mate waren de intenties om gedrag te veranderen geassocieerd met het ervaren van een emotionele impact van de pandemie. Deze bevindingen suggereren dat maatschappelijke crises zoals de COVID-19-pandemie inderdaad een teachable moment kunnen oproepen, voornamelijk gedreven door veranderingen in het zelfconcept. Omdat niet alle factoren van het conceptuele teachable moment raamwerk waren geassocieerd met intenties om gedrag te veranderen, concludeerden we dat ook verder onderzoek naar andere psychosociale factoren die van invloed kunnen zijn op levensgebeurtenissen als teachable moments noodzakelijk was.

In **hoofdstuk 3** van dit proefschrift hebben we een kwalitatieve benadering gebruikt om de eerste en tweede onderzoeksvraag te beantwoorden. We hebben een interpretatieve fenomenologische analyse uitgevoerd om te bestuderen hoe hartpatiënten betekenis gaven aan hun hartinfarct met betrekking tot hun leefstijl, en welke processen van

betekenisgeving waren gerelateerd aan een verhoogde intentie om hun leefstijl te veranderen. De resultaten toonden aan dat veel van de patiënten hun hartinfarct daadwerkelijk beschouwden als een levensveranderende ervaring die hen motiveerde om een gezondere leefstijl na te streven. In de maanden na het hartinfarct dachten deze patiënten actief na over veranderingen in hun gezondheidsgedrag, voerden zij gedragsveranderingen door in hun leven, en zochten zij naar manieren om hun leefstijl te optimaliseren. Omdat deze periode zich uitstrekte over een langere tijdsduur na het hartinfarct, beschrijft de term 'teachable window' het fenomeen beter dan 'teachable moment'. Diverse processen van betekenisgeving leken belangrijk voor het ervaren van zo'n teachable window, waaronder het interpreteren van een gebeurtenis in termen van gedragsoorzaken en -gevolgen, het ervaren van een verband tussen leefstijl en gezondheid, het bewust worden van de eigen kwetsbaarheid bij het voortzetten van ongezond gedrag, en ook het anticiperen op eventuele toekomstige spijt als ongezond gedrag wordt voortgezet, het streven naar het herwinnen van autonomie en controle over het leven, het ervaren van het hartinfarct als een emotionele gebeurtenis, het krijgen van medicatie en daarin de wens om de medicatie-inname te verminderen door te geloven dat dit eerder kan worden bereikt door een verbeterde leefstijl, en de reflectie op identiteit en sociale rollen in relatie tot gezondheidsangsten en eigen gezondheidsgedrag.

Vanwege het ontbreken van gevalideerde vragenlijsten om onderzoek te doen naar teachable moments, zagen we een grote variatie in de benadering hiervan in eerder onderzoek. Daarom hebben we in **hoofdstuk 4** twee nieuw ontwikkelde vragenlijsten gevalideerd: de 'Cardiac teachable moment' (CardiacTM) vragenlijst, die de karakteristieken van hartincidenten als teachable moments meet, en de 'Cardiac Lifestyle Change Intention' (CardiacLCI)-vragenlijst, die meet of een acuut hartincident de intentie tot leefstijlverandering stimuleert. Beide vragenlijsten bleken een goede interne betrouwbaarheid en voldoende inhoudelijke, constructieve (factoriële) en convergente validiteit te hebben. De CardiacTM-vragenlijst bestond uit zes intern consistente factoren (emotionele impact, waargenomen risico op cardiovasculaire aandoeningen, veranderd zelfconcept, cardiovasculaire groepsidentiteit, waargenomen risico op leefstijl-gerelateerde aandoeningen, en geanticipeerde spijt). De CardiacLCI-vragenlijst bestond uit twee intern consistente factoren (leefstijlverandering gerelateerd aan het hartincident en algemene gezonde leefstijl). Beide vragenlijsten kunnen in toekomstig onderzoek worden gebruikt om beter te begrijpen of, wanneer en hoe levensgebeurtenissen kunnen dienen als teachable moments (onderzoeksvraag 1) en welke psychosociale factoren hierbij een rol spelen (onderzoeksvraag 2). In de praktijk kunnen zorgverleners aangepaste versies van de CardiacLCI-vragenlijst gebruiken om in te schatten in hoeverre hun patiënten een

potentieel teachable window ervaren en daardoor open staan voor gedragsadviezen. Aangepaste versies van de CardiacTM-vragenlijst kunnen worden gebruikt om gesprekken over psychosociale thema's gerelateerd aan een teachable window te faciliteren, wat mogelijk de motivatie van de patiënt kan vergroten tijdens gesprekken tussen zorgverlener en patiënt om een gezondere leefstijl in gang te zetten.

In **hoofdstuk 5** werd de derde onderzoeksvraag behandeld, die betrekking had op de praktische benutting van teachable windows in de zorg. Het doel van deze 'mixed-methods' studie was om het perspectief van hartpatiënten te onderzoeken met betrekking tot de timing en aanpak van het geven van leefstijladviezen na een ziekenhuisopname vanwege een acuut hartincident. We ontdekten dat patiënten gedurende het gehele zorgtraject (tijdens ziekenhuisopname, na ontslag, tijdens vervolgafspraken in het ziekenhuis, en tijdens de Hartrevalidatie) meer ontvankelijk waren voor gedragsadviezen. Patiënten die leefstijladviezen ontvingen tijdens hun zorgtraject, beschouwden dit als positief en toonden vaker een hogere intentie tot leefstijlverandering, vooral wanneer adviezen tijdens meerdere fases in het zorgtraject werden gegeven. Het teachable window na een acuut hartincident biedt dus een unieke kans om patiëntgerichte leefstijladviezen te geven. Patiënten hadden de voorkeur voor advies dat haalbaar en empathisch is, en dat afgestemd is op hun behoeften, waarden en perceptie van de oorzaken van hun cardiovasculaire aandoening.

Conclusie en implicaties

Bepaalde gebeurtenissen in het leven kunnen iemand motiveren om zijn levensstijl te veranderen en meer open te staan voor leefstijladviezen. Dit kunnen gebeurtenissen zijn die verband houden aan iemands persoonlijke gezondheid, zoals acute hartproblemen, maar ook bredere maatschappelijke crises, zoals de COVID-19-pandemie. Omdat deze verhoogde motivatie en ontvankelijkheid doorgaans blijven bestaan in de maanden na een gebeurtenis, concludeerden we dat bepaalde gebeurtenissen een 'teachable window' voor leefstijlverandering kunnen stimuleren. We ontdekten verschillende processen van betekenisgeving die belangrijk leken voor het ervaren van zo'n teachable window. Zo vonden we dat elementen van het conceptuele teachable moment raamwerk van McBride en collega's (2003) inderdaad een rol spelen bij gedragsverandering, zoals veranderingen in zelfconcept, identiteit, en sociale rollen, en het ervaren van een gebeurtenis als emotioneel. Risicoperceptie leek met name een rol te spelen in de vorm van bewustwording van de eigen kwetsbaarheid bij het voortzetten van ongezonde gedragingen. Maar dit waren niet de enige belangrijke psychologische factoren. Andere belangrijke processen zijn bijvoorbeeld het interpreteren van een gebeurtenis in termen van gedragsoorzaken en

-gevolgen, het willen vermijden van toekomstige spijt wanneer ongezonde gewoonten worden voortgezet, en het streven naar het herwinnen van autonomie over iemands leven na een levensgebeurtenis door middel van positieve leefstijlveranderingen.

De conclusies van dit proefschrift benadrukken een belangrijke kans om continue leefstijlondersteuning te bieden tijdens en na levensveranderende gebeurtenissen. Het biedt daarnaast verschillende implicaties voor de praktijk. Ten eerste wordt de belangrijke rol van zorgverleners tijdens teachable windows onderstreept, omdat zij regelmatig contact hebben met patiënten tijdens belangrijke levensgebeurtenissen. Bovendien beschouwen patiënten leefstijladviezen, vooral wanneer deze door specialisten worden gegeven, als zeer waardevol. Ook benadrukt het proefschrift het belang van de timing van adviezen, die idealiter direct na een gebeurtenis beginnen en in de maanden voortgezet en herhaald worden. Ten slotte biedt het aanbevelingen voor de aanpak van leefstijladvisering, die idealiter gebaseerd is op de processen van betekenisgeving die een rol spelen bij teachable windows. Adviezen moeten haalbaar en empathisch zijn, en afgestemd op de behoeften, context, waarden, en perceptie van de oorzaken van de cardiovasculaire aandoening van de patiënt.

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International and national congress attendance and presentations

2024 **Poster presentation** at Work conference 'Pionieren voor gezondheid, de innovatieve kracht van de regio', Health Campus The Hague

2023 **Oral presentation** at Association for Researchers in Psychology and Health (ARPH) 2023 conference:

2023 **Poster presentation** at Work conference 'Proactieve zorg', Health Campus The Hague

2022 **Oral presentation** at Symposium Leefstijl & Preventie at Anna Ziekenhuis Geldrop

2022 **Poster presentation** at Association for Researchers in Psychology and Health (ARPH) 2022 conference

2022 **Pitch presentation** at Work conference 'Op weg naar een gezonde stad', Health Campus The Hague

2021 **Oral presentation** at European Health Psychology Society (EHPS) 2021 conference

2021 **Poster presentation** at Association for Researchers in Psychology and Health (ARPH) 2021 conference

2021 **Pitch session** at Work conference Health Campus The Hague

2020 Conference Arts en Leefstijl, Vereniging Arts en Leefstijl

2020 Conference 'Lifestyle as medicine', Lifestyle4Health

2020 **Pitch session** at Work conference Health Campus The Hague

2019 Symposium 'TechTalk eHealth', LUMC and NeLL

2019 Symposium 'Gezondheid in beeld', Amsterdam Center for Health Communication (ACHC)

2019 Symposium 'Geld, Stress en Gedrag', Faculty of Social and Behavioural Sciences (FSW), Leiden University

2019 **Pitch session** at Work conference Health Campus The Hague

Selection of other meetings and presentations

2024 **Pitch session** at LUMC symposium Prevention and Lifestyle

2023 **Oral presentation** at Capri Cardiac Rehabilitation Network Event

2022-2023 **Pitch sessions** at Healthy Society Event, Faculty of Social and Behavioural Sciences (FSW), Leiden University

2021-2023 **Oral presentations** (multiple) at Capri Cardiac Rehabilitation and the department of Cardiology at Haaglanden Medical center and Erasmus Medical Center.

2020 In-depth session: Gender in research, Instituut voor Onderzoek naar Leefwijzen & Verslaving (IVO)

2020 **Oral presentation** at Lifestyle meeting, Heart Lung Center, LUMC

2020 **Oral presentation** at Working group eHealth, LUMC

2019-2024 **Oral presentations** (multiple) and weekly attendance at Coffee & Research meeting Health Campus The Hague

2019-2023 **Oral presentation** and weekly attendance at Science Lunch meeting department of Public Health and Primary Care, LUMC

2019 Leiden Leadership Lunch: 'Publiek leiderschap in de schuldhulpverlening', Faculty of Governance and Global Affairs (FGGA)

2019 Information evening for cardiac patients, LUMC

Teaching activities

2024-current Development of education using the Dialogue trainer, an online conversation training to improve communication skills of students related to motivational interviewing and utilizing teachable moments, master Medicine, LUMC

2022-current Course coordinator of the course 'Professional and Personal Development' and tutorship (multiple working group lectures, orientation weeks, and individual sessions with students), master Population Health Management, LUMC

2022-2023 Teacher working group sessions of the course 'Perspective on Career Planning', bachelor Psychology, Leiden University

2022 Teacher working group sessions of the course 'Designing Interventions in Behavioural Change', master Health and Medical Psychology, Leiden University

2022 Guest lecturer at the course 'Panel Management', master Population Health Management, LUMC

2021, 2022 Guest lecturer at the course 'Health Promotion and Disease Prevention', bachelor Liberal Arts and Sciences, Leiden University College

2020-2022 Expert behavior change and intervention development, bachelor Medicine, LUMC

2021 Course coordinator and lecturer of the course 'Health Promotion and Disease Prevention', bachelor Liberal Arts and Sciences, Leiden University College

2020 Workshop 'Nutrition and a healthy lifestyle' for primary school students of IMC Weekend school.

2020 Lecture 'CVRM and lifestyle change in primary care', minor Taking Care of Tomorrow, Medicine, LUMC

2020 Lecture 'Teachable moments in healthcare', master Medicine, LUMC

2019-2021 Teacher at Working groups Start tot Arts, bachelor Medicine, LUMC

2019-2020 Teacher at Working groups Health and Medical psychology, bachelor Psychology, Leiden University

Student supervision

2022-2023 L. Gefeke, master thesis. Master Health and Medical Psychology at Leiden University. Project title: *Risk confrontation in primary care as possible teachable moment towards healthy lifestyle changes in individuals with high cardiovascular risk.*

2022-2023 L. Uzan, master thesis. Master Health Sciences at Vrije Universiteit Amsterdam. Project title: *Pregnancy, a teachable moment for changing health behavior?*

2022-2023 J. Desku, research internship. Master Medicine, LUMC. Project title: *The current state, facilitators and barriers of delivering lifestyle counselling to cardiac patients after an acute myocardial infarction from the healthcare professionals´ point of view.*

2022 N. Hommes, research internship. Master Medicine, LUMC. Project title: *Hospitalization after a cardiac event as a teachable moment to adopt a healthier lifestyle among Dutch patients living with CVD, the role of affect.*

2021 J. te velde, research internship. Master Medicine, LUMC. Project title: *Needs assessment among healthcare professionals in cardiovascular care applying lifestyle counseling during potential teachable moments.*

2019-2020 M.E. Krémer, master thesis. Master Health and Medical Psychology at Leiden University. Project title: *Developing and validating a questionnaire scale to measure self-concept change in cardiovascular patients.*

2019-2020 N.A.E. Van der Voorde, master thesis. Master Health and Medical Psychology at Leiden University. Project title: *The development and validation of scales to measure risk perception and affective response towards a cardiac event in cardiovascular patients.*

2019 D. van Ravenstein, research intern. Bachelor Health Sciences at Vrije Universiteit Amsterdam. Project title: *De optimale timing van teachable moments voor het aangaan van leefstijlverandering na een myocardinfarct – een kwalitatief onderzoek.*

Courses and training

2023 Basic Course Regulations and Organization for Clinical Researchers (BROK), NFU

2022 BKO course 'Toetsing'. Leiden, The Netherlands

2021 BKO course 'Werkgroepen begeleiden'. Leiden, The Netherlands

2021 BKO course 'Hoorcollege geven'. Leiden, The Netherlands

2021 BKO course 'Schrijfsessie'. Leiden, The Netherlands

2021 Academic writing for PhDs. Leiden, The Netherlands

2020 Basic Methods and Reasoning in Biostatistics. Graduate School LUMC, Leiden, the Netherlands

2020 Communication in science. Leiden, The Netherlands

2020 Managing your references using Endnote. Leiden, The Netherlands

2020 Planning and managing your PhD. Leiden, The Netherlands

2019 Population Health Management summer school. The Hague, The Netherlands

2019 Kwalitatief Interviewen. Rotterdam, The Netherlands

2019 Interpretative Phenomenological Analysis. Dublin, Ireland

2019 PhD Introductory Meeting, LUMC, Leiden, The Netherlands

Other activities and societal impact

2024 Result of the month Dutch Heart Foundation. Interview published at 20 June 2024. Available at https://professionals.hartstichting.nl/actualiteiten/resultaat-van-de-maand-leefstijlonderzoeker-michelle-brust

2024 Podcast Coalitie Leefstijl in de Zorg over 'Teachable moments'. Online at 25 June 2024.

2022 Reviewing manuscript for scientific journal 'Applied Psychology: Health and Well-Being'

2021 News article in Academische Werkplaats Publieke Gezondheid (AWPG) Noordelijk Zuid-Holland: 'Leefstijl van patiënten aankaarten tijdens 'teachable moments' '. Published on 12 February 2021. Available at https://www.awpgnzh.nl/leefstijl-van-patienten-aankaarten-tijdens-teachable-moments/

2020-2024 Reviewing of 6 project proposals for the scientific committee of the department of Public Health and Primary Care, LUMC

2020 Reviewing manuscript for scientific journal 'International Journal of Equity and Health'

2020 Press release at Harteraad news letter: 'Ruim een derde van de hart- en vaatpatiënten last van verminderd mentaal welbevinden in coronatijd'. Published on 22 June 2020. Available at https://harteraad.nl/ruim-eenderde-van-mensen-met-hart-en-vaataandoening-last-van-verminderd-mentaal-welbevinden-in-coronatijd/

2020 News article in Algemeen Dagblad (AD): 'Lage besmettingscijfers onder ouderen: ze beschermen zichzelf tegen corona'. Published on 25 August 2020. Available at https://www.ad.nl/binnenland/lage-besmettingscijfers-onder-ouderen-ze-beschermen-zichzelf-tegen-corona~ae910b6b/

2020 Product owner of the COVID Radar app

2019-2021 Responsible for scheduling junior referees for the Science Lunch meetings, department of Public Health and Primary Care, LUMC

CURRICULUM VITAE

Michelle Brust was born on 9 September 1993 in Assen, the Netherlands. She obtained her VWO diploma at Nassau College Assen in 2012. Afterwards, she moved to Groningen to study Psychology at the University of Groningen. She received the Bachelor of Science degree in 2017. Continuing her education, Michelle pursued a Master of Science degree in Health Psychology and Technology at the University of Twente, graduating cum laude in 2018. During her bachelor's and master's studies, Michelle worked as a student assistant at the Department of Health Psychology at University Medical Center Groningen (UMCG), where she contributed to various research projects focusing on psychosocial and health behavioral support for patients with chronic illnesses and their informal caregivers. She also volunteered in several research projects, conducting interviews and assisting in other data collection methods. These experiences deepened her interest in doing research within health psychology. As part of her master's studies, Michelle did a research internship and completed her master's thesis at the Department of Health Psychology at UMCG. During her research internship, she conducted a scoping review on the design of informal caregiver eHealth interventions. Her master thesis, titled "eHealth after bariatric surgery: determining psychological characteristics and needs regarding a future eHealth support intervention," combined qualitative and quantitative research to identify psychological factors and patient needs in designing an eHealth support intervention for bariatric patients. After receiving her master's degree, Michelle started as a PhD candidate at the Health Campus The Hague of the Leiden University Medical Center. Under the supervision of Prof. Dr. Jessica Kiefte-de Jong, Prof. Dr. Mattijs Numans, and Dr. Winnie Gebhardt, she investigated the potential and the underlying mechanisms of life events as teachable moments, resulting in this thesis. In addition to her research, Michelle has been actively involved in teaching. She has taught various courses on behavior change and health promotion, supervised several master's and bachelor's students with their research internships and theses, and coordinated the tutorship of the master's program Population Health Management. To disseminate her research, she has given presentations at conferences, symposiums, and in hospitals for healthcare providers. She also was a product owner for the COVID Radar during the first year of the pandemic. Michelle continues her academic journey at the Health Campus The Hague. She remains active in teaching and has started as a postdoctoral researcher at the ON TIME project since November 2023. In this project, she investigates the behavior of vascular surgeons regarding the treatment of abdominal aortic aneurysms, alongside the treatment-related needs of patients diagnosed with this condition.

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