

Behavioral Aspects of Healthy Longevity

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Abstract

Addressing the growing burden of noncommunicable diseases to achieve healthy longevity for an aging population has become central to global health policy goals. New policy tools are needed for effectively and efficiently tackling health and lifestyle behaviors and habits linked to the development of noncommunicable disease risk factors. Behavioral science offers insights into psychological barriers, mental models, biases, and other factors that influence decision making and habit formation. Applying these insights can support current policy efforts toward healthy longevity. This paper develops a framework to clarify the relationships

between noncommunicable disease formation, detection, and management and behavioral determinants at the individual, community, and health system levels. Following the framework, the paper documents frequently identified behavioral barriers at the three key stages of patients' noncommunicable disease trajectories. It identifies policy lessons from the behavioral science literature to address such barriers and, together with other policies, reduce the incidence of noncommunicable diseases and improve treatment effectiveness.

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Behavioral Aspects of Healthy Longevity

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I. Introduction

Poor health in old age comes at a high cost for individuals, households, and societies. Increases in life expectancy across countries have not always added years of healthy life. Accordingly, health promotion and disease prevention, particularly as they relate to preventable noncommunicable diseases (NCDs) whose onset occurs later in life, have become a central focus of health policy. This agenda is challenging, as it relates to people's lifestyles and habits, which in turn influence NCD incidence and progression.

In 2019, the three leading causes of deaths around the world -cardiovascular diseases, neoplasm, and chronic respiratory disorders- were largely attributable to behavioral risk factors or lifestyle habits (Vos et al., 2020). Habits such as unhealthy eating, smoking, alcohol consumption, and lack of exercise (in addition to delayed and inconsistent engagement with health care) have been linked across many studies to the development and persistence of risk factors such as hypertension, diabetes, high cholesterol, and high body-mass index (Forouzanfar et al., 2016, Peel et al., 2005). These are, in turn, among the top-ranking contributors to unhealthy aging and deaths from NCDs (Vos et al., 2020). While many NCDs are not associated with aging, and similarly many NCDs are unrelated to health habits and 'lifestyle' factors, this paper will focus on the group of NCDs that typically develop later in life and can be prevented or delayed through changes in habits that address underlying risk factors.

There is, however, substantial complexity in the link between behavioral habits and subsequent NCD risk factors. Behavioral habits can lead to multiple risk factors, and specific risk factors can be caused by a combination of behavioral habits, and both are impacted by structural factors linked to unhealthy aging. Dissecting each habit and/or risk factor independently highlights this complexity. For example, unhealthy eating is associated with a high body-mass index (Rosenheck, 2008), hypertension (Ibrahim & Damasceno, 2012), and diabetes (Malik et al., 2010) – each of which is itself a risk factor for cardiovascular diseases. At the same time, hypertension is also influenced by smoking, alcohol consumption, and lack of exercise. Unhealthy eating is not only dependent on individuals' taste preferences or food choices, but also on foods' availability in their living environments and food costs (Ruhm 2012, Lu and Goldman 2010).

Despite the complex interactions linking behavioral habits and NCD risk factors, evidence shows that changes in underlying habits can reduce the prevalence of NCD risk factors (Blaga et al., 2018), and that this can be achieved via behavior change. According to the WHO, 80% of premature heart disease and stroke are preventable with either changes in individual behavior or with adherence to appropriate treatment guidelines (World Health Organization, 2014). Interventions that address health behaviors as a means to reduce the burden of NCDs have been identified as among the most cost-effective solutions for low- and middle-income countries (LMICs) (Watkins et al., 2022). Thus, if behaviors and in turn their outcomes are modifiable, there is an opportunity for policies to address health habits in the context of promoting healthy longevity.

Even in the face of existing knowledge regarding the magnitude of the link between behavioral habits, NCD risk factors, and disease prevention, it remains the case that a large share of deaths can be attributed to behavioral risks. One explanation for this is the set of barriers that individuals face when attempting to either modify their habits, access care, or manage their risk factors adequately.

Traditional neoclassical economics suggests possible explanations such as a lack of relevant information or large countervailing costs. In turn, policy makers and researchers have often focused on the health system, user fees, or information, in seeking to remove external obstacles and encourage healthy behaviors. But, while effective, these actions alone have been insufficient to address the full complexity of health behavior change and habit formation. Relative ignorance or limited knowledge on these issues might once have been widespread and undoubtedly still exist among certain population groups. However, in most countries, the majority of adults are now aware of the health risks of, for example, tobacco and alcohol use (i.e., WHO Global Adult and Youth Tobacco Surveys). Hence, lack of knowledge is unlikely to be a driving explanation of unhealthy behaviors. Similarly, although for some people in some situations the actual cost of a behavior change (e.g., giving up smoking) might be high enough that the ‘rational’ decision is not to do so, this is not the case across all such behaviors, nor for most people. A modest reduction in unhealthy behaviors such as high calorie consumption, or a modest increase in healthy behaviors such as walking more, generally has both a low cost and often also some direct near-term benefits such as improved energy and sleep, entirely independent of long-term health outcomes. Hence this is again unlikely to be a driving explanation, and indeed many people report that they wish they acted differently in these respects (Faries M. D. 2016), strongly suggesting that they are not in fact optimizing their utility according to the traditional framework.

Policy efforts towards behavioral and psychological obstacles that influence unhealthy lifestyles and habit formation are needed. Unlike many other causes of morbidity and mortality, NCDs are typically delayed - in the sense that negative outcomes occur years or even decades after the precipitating behaviors- and are often only weakly linked to identifiable individual moments in time. Why would I then change my behavior today for something that might (or might not) happen in the future? On the other hand, both accidents and communicable diseases tend to impact one’s life in the short-run (sometimes immediately) and are, for the most part, possible to link to a single causal event -which is therefore both salient and clearly amenable to prevention. This feedback can and often does trigger a suite of self-initiated behavioral adjustments to reduce recurrence.

Behavioral ‘biases’ such as impatience, time inconsistency, and over-optimism are more congruent with weighting long-term consequences in a mistakenly low manner, evaluated by the lights of the individuals themselves. Similarly, other relevant individual biases predict heightened difficulty to assess very small probabilities, as well as a tendency to focus disproportionately on concrete, identifiable consequences at the expense of diffuse accumulated outcomes.

Behavioral science insights into psychological barriers, mental models, biases, and other factors at play in individual decision-making and action can add to the understanding on how to modify habits that lead to NCDs and support a policy and intervention agenda to inform long-term investments in healthy longevity. Long-run flourishing depends as much on what individuals do or do not do as it does on their interactions with health systems – from seeking and obtaining preventive care to treatment adherence and follow-up. Both domains display the same characteristic of delayed and uncertain consequences that leave people vulnerable to inaction and/or repeated deferral.

Furthermore, by applying a behavioral lens to groups as well as individuals, elements such as peer effects and social norms can be considered. Mental health is directly affected by, among other factors, a sense of community connectedness and of agency and confidence about the future (not to mention the emotional disposition of the members of one’s network). Physical health is at minimum indirectly affected by local information flows and self-efficacy: only if someone believes that their actions can make a difference to

their well-being, and ideally observes this narrative in others, is there an impetus to make healthier decisions. In some sense the behavioral perspective centers on how people see themselves in relation to their worlds, which is crucial for robust aging.

Focusing on NCDs, this paper develops a framework of the relation between factors behind individuals' behaviors and the achievement of healthy longevity at the individual, community, and health systems levels. It then uses the framework to discuss policy lessons from the behavioral science literature that can aid efforts to reduce the incidence of NCDs and improve the effectiveness of treatment. These policy lessons are not seen as replacing traditional policy tools, such as taxation, but as complements to increase their efficacy and impact.

The paper is organized as follows. Section II presents the framework. Sections III to V apply it to different stages of NCD trajectories (formation, screening, and management) through individual, community-level, and health system perspectives. Section VI presents policy recommendations stemming from behaviorally informed intervention studies across different fields.

II. A behavioral science framework for NCD policies

We can identify three main stages in people's NCD trajectories: (1) formation -when and how the disease starts occurring; (2) detection -when and how it is identified, both by the individual (i.e., symptoms) and medical professionals; and (3) management -the many actions that are required once the disease is identified to slow its progression, manage symptoms, minimize disability, and support the patient's quality of life. These stages refer to the individual or patient journey (Devi et al., 2020). At each of these stages, we can identify behavioral factors (biases, mental models, beliefs, norms, and others) that are at play at different levels: individual, community, and health system. Drawing on the behavioral science literature, we propose a framework that categorizes the behavioral factors operating at each level and stage (Figure 1).

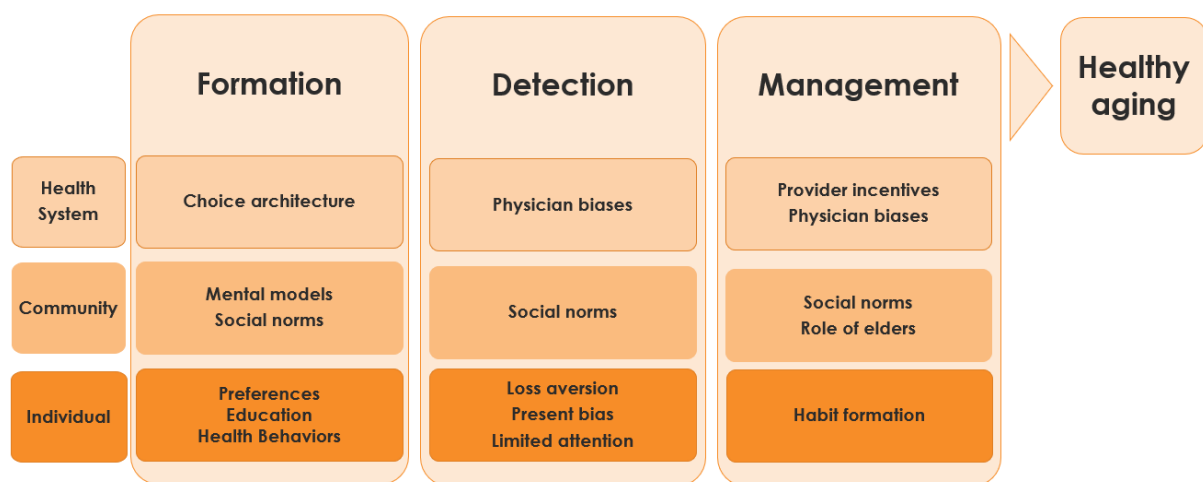


Figure 1: Conceptual model of traditional and behavioral determinants of NCDs and healthy aging

Individual factors refer to characteristics including a person's capabilities, opportunities, and motivation (adapting the COM-B approach from Michie et al., 2011). Our framework assumes that for (desired) behaviors to take place, a mix of elements is required that can be classified under these three headings. Capabilities primarily encompass the knowledge and skills needed to engage in the desired behavior.

Opportunity includes factors such as physical and social resources that are generally not controlled by the individual but facilitate the behavior: for example, having access to health services or to a market where fruits and vegetables are sold. Motivation is not only the intention to act, but the reasons that direct the individual to act, including goals, the ability to make decisions, emotions, habits, identity, and other related mental processes. These three components are interconnected and reinforce each other.

While information is part of the last set of factors, given the cross-cutting role it plays, we distinguish it as a standalone factor. This is because information is not only one of the main elements of policies, and a basic requirement for behavior change, but also the main connector between individuals, social contexts, and health systems. Social and behavioral change campaigns (SBCC) and health communications more broadly are their own category of intervention; therefore, we do not focus on SBCC interventions specifically in this paper; rather, we include information-related interventions when they leverage a specific behavioral insight of interest. The type of information—including its source, framing, format, and the timing of exposure—will influence the knowledge it generates in an individual, and thus whether information turns into effective communication.

Socio-demographic determinants of health, such as socio-economic status and education, are also included among individual factors. While the proposed framework, and this paper, do not focus on socio-demographic determinants in detail, they are strong moderators of behaviors and habits. Behavioral biases, understood as behavior patterns that do not conform with expected rational behavior (Gilovich et al., 2002), for the most part occur at this level. Some of the most salient include cognitive biases such as loss aversion (weighing a loss more heavily than an equivalent gain) and present bias (impatience, weighing the immediate future disproportionately over more distant events). Individual factors related to limited attention are also included at this level. These are factors which describe the inability to focus on a large set of important decisions and information, including cognitive overload (Mullainathan & Shafir, 2013).

Community-level factors refer to social norms, roles in society, and other factors that structure choices and behavior.² Individuals are embedded in community and social contexts that provide constant flows of information about different behaviors. The context and how the community relates to or views a specific behavior will affect the individual's capabilities, motivation, and opportunities. We understand the community as the network of relevant social cues for individual decision-making stemming from reference and influence groups associated with the individual's identity and belonging (i.e., their neighborhood, family, and friends, but also those who share certain core identity elements, for example gender, role in the family, profession, ethnicity, and other factors). According to Akerlof and Kranton (2000), people hold multiple identities and conforming to them creates intrinsic utility that results in people's following a subgroup norm. Norms evolve as shared practices and identities shaping and reinforcing perceptions and behaviors. Community influences can stem directly from peers or be more diffuse. For the most part, they are either normative or provide a framework for action or decision.

² Social norms refer to the unwritten rules of behavior that guide social interactions and are critical for policy makers who attempt to shift behavior, as many health behaviors are adopted to conform to social norms. Choice architecture refers to the ways in which structures influence decision making, including health behaviors and other behaviors impacting healthy longevity.

Regarding NCD risk and healthy aging, social norms and mental models of choice are the two most salient channels of community impact. In many cases, social norms and expectations, as well as mental models (how the world is seen) can, instead of contributing to healthy aging outcomes, inhibit or prevent them. One channel for such effects is *conformity traps* that can reinforce health-detrimental actions.³ For example, some cultures strongly encourage people, often men or youth, to conform to a lifestyle centered around drinking, smoking, and other risky behaviors. In other cases, norms about women’s mobility might restrict their physical exercise or limit other behaviors that promote health.

Health system factors include the structure and characteristics of the health system that influence healthy behaviors and the detection and management of NCDs. People’s interactions with the health system and health workers are affected by their prior experiences with the system and the behaviors of those who work in it. Relevant factors include health workers’ perceptions about the need for and potential benefits of a given intervention, their confidence in their ability to deliver a solution, and their views about their patients (Abry et al., 2013; Durlak & DuPre, 2008).

Pricing and provider incentives play a role here, as does choice architecture, or how the system is structured to motivate decision-making. Issues of bias also affect health care providers. Health workers, like all people, are subject to the biases, heuristics, and mental shortcuts described above, and their decision-making around patient care is impacted by these factors. Similarly, norms and mental models associated with their identity as health care providers are at play as part of the health system environment.

Figure 2 provides an example of how the framework can be applied to the formation, detection, and management of hypertension.

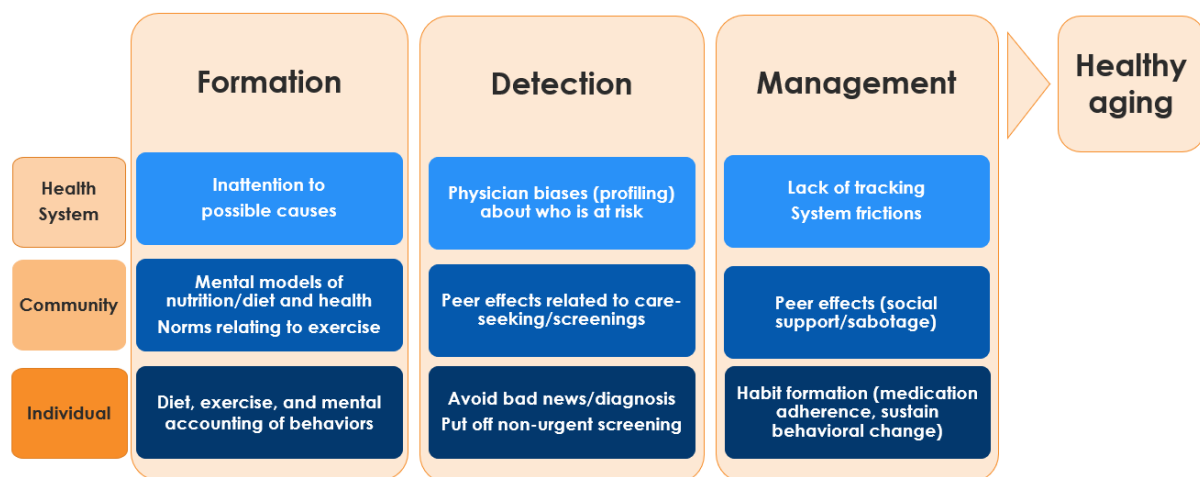


Figure 2: Example of specific biases affecting hypertension formation, detection, and management

³ Andreoni et al. (2017) define conformity traps as those that keep groups and individuals in a bad equilibrium despite knowledge of inefficiency and preferences for a different status quo. The trap is due to the pressure to conform to the behavior of the majority and the resistance to being the first deviant from the established norm. Hence a norm will persist because of the strength of the social payoff to compliance.

A behavioral focus is not foreign to the health sector. However, our proposed framework expands on what has typically been the approach to behavior change in health policy and program implementation, largely related to information and communications. Traditional behavior-change interventions in health have centered on making information available to encourage appropriate action by individuals, communities, and health system actors. Our framework enriches this model using a behavioral science lens. As such, it serves two purposes. First, it allows us to unpack and organize what is known about interventions that address behavioral barriers related to NCD formation, detection, and management (and also to identify knowledge gaps). Second, it facilitates an assessment of the presence and strength of behavioral elements in health policies. This could enable policy makers and program designers to identify interventions that target different challenges, as well as different kinds of potential beneficiaries. For example, interventions could be crafted to focus on motivation for those groups that already possess capability and opportunity factors, while investing in comprehensive packages for those that do not.

Smoking provides one example of an important NCD risk behavior. Many factors that could predict the decision to engage in such behaviors have been extensively studied across different disciplines (Grossman 1972, Becker & Murphy 1988, Orphanides & Zervos 1995, Cawley & Ruhm 2011). If we understand such behaviors as actions, or deliberate inactions, that affect the individual's health or that of others (Cawley & Ruhm 2011), it seems insufficient to see such behaviors as an outcome of trade-offs between the individual's "stock of health capital" and short-run increases in welfare or future discounting. In the classic model, if the individual perceives that the benefit of smoking is greater than the risk of suffering a heart attack or lung cancer in the future, then he or she will be more likely to engage in this risky/unhealthy activity. Seen in this way, the engagement in risky behaviors should depend solely on the weight that the individual gives to the discounted value of his/her life expectancy or future well-being (Grossman 1972, Cawley & Ruhm 2011, Lundberg & Shapira, 2014). However, this is not the case. Risk perceptions are left to the future (time inconsistent preferences leading to present bias), while group pressures, social norms, and role models (what others do) take precedence and motivate behavior. Classic tobacco control policies—providing information about risks, imposing smoking bans, raising excise taxes, and other measures— increase frictions to the behavior by making it more difficult and costly. These established policy approaches can be complemented and made more effective by incorporating insights from behavioral science. This is the perspective that the next sections take. In them, we use concepts from behavioral economic theory that describe the biases, mental models, and heuristics affecting decision-making that are most relevant to healthy aging and NCDs.⁴ The review is not exhaustive and does not cover all the possible behavioral factors at play. Rather, it prioritizes the more prevalent and those best analyzed in the literature.

III. NCD formation: Healthy lifestyle and habit formation

This section examines how behavioral biases influence health behaviors which affect the formation of NCDs. We focus on some of the main risky behaviors, including physical inactivity, tobacco use, and

⁴ Table 1 in the annex summarizes the relevant biases and provides examples related to aging and NCDs.

alcohol use, but the discussions extend beyond these. Following the framework presented above, we disaggregate the policy-relevant factors at work into health system, community, and individual.

A. Health system factors that affect NCD formation

More and more health systems, at least in middle- and high-income countries, have started focusing on NCD prevention, as well as treatment. However, many of these efforts appear to assume that it is enough to create prevention programs or formally include preventative health in primary health care models, in order for doctors to deliver such services effectively and for individuals to use them. This has not proven to be the case. As discussed with regard to individual-level factors, providing information (i.e., generating knowledge) may not by itself be sufficient, because individuals may not act on that information. People might lack the motivation to obtain care for a variety of attitudinal reasons such as perceived need, distrust in physicians or medical institutions, dissatisfaction with previous medical care, and fear of being diagnosed with something (Bailey Merz et al., 2017; Friedman 1994; Hall et al., 2001).

These obstacles can be exacerbated by system features (design, focus on disease versus prevention, complicated processes) that can increase people's "hassle perception" about engaging with the health system, health insurance, and related institutions and processes (Liebman & Zeckhauser, 2008). Markets for medical care are characterized by uncertainty and by asymmetric information between physician and patient (Frank, 2007). How patients obtain information about the health system and doctors prior to an initial contact, how referrals are obtained, how easy or difficult it is to deal with health insurance: all these factors play central roles in the formation of "priors" or pre-existing beliefs and the decision to engage with the health system.

Disease prevention efforts must confront individuals' priors on the health system and physicians, which may stem from personal experiences and/or reports from family and friends (whether or not related to the dimensions of care that most directly affect their health outcomes). The formation of priors can be explained through two behavioral concepts. The first is the "law of small numbers" bias (Rabin, 1998; Rabin, 2002): people's tendency to assume that information derived from observing a small number of events reflects the experience of the larger "population" from which those events are drawn. The second is the availability heuristic, the reliance on more vivid or memorable evidence to construct a prior about the probability of a particular characteristic or outcome: for example, that a physician is high quality, will exert adequate effort, or would detect a worrisome health condition (Tversky & Kahneman, 1973). Reliance on reports from family and friends may thus create distortions. If the system does not address these issues (and/or dismisses them), they are reinforced.

The health system, in its "external" presentation, is largely seen as focused on diseases. This means, from an individual point of view, a signal that you only seek health care, even if preventative, when you have a disease (or symptoms of it). The difficulty of making appointments, the unpleasantness of clinics or hospitals where those around you are ill, and many other factors can act as disincentives to seek preventative health care. Countries have started addressing some of these priors and biases by creating "healthy living centers" or similar support structures (whether online or in person), that remove the disease label from preventative health.

The health system is largely associated with a specific set of individuals: medical professionals. Physicians, like other persons, fall prey to behavioral biases. Partly based on training, they are more prone to mental shortcuts that associate symptoms with diseases than to connecting current habits with future events,

including NCDs. This reflects a common inclination toward the status quo and inertia, referring to people's tendency to maintain the current status of things. This status is used as a reference point, and any change regarding this point is seen as a loss.

Physicians are habitual in their processes when it comes to a patient, and new processes or actions might not be salient to them. Reminders and checklists can work to disrupt automaticity. The literature suggests that more patients receive preventive care when doctors are reminded to order, deliver, or prescribe appropriate preventive care measures such as vaccinations (Austin et al., 1994; Davis et al., 1995; Hunt et al., 1998). For example, a recent systematic review, covering 3,502 individual studies investigating behavior change interventions among primary health care (PHC) physicians, found that reminders improve the rate of screening and vaccination while reducing unnecessary imaging for lower back pain (Chauhan et al., 2017). Other systematic reviews also found a positive relationship between physician reminders and uptake of screening services (Dexheimer et al., 2008).

The health sector's performance when it comes to the added task of preventing future diseases can benefit from more motivated workers. A study investigating major factors influencing job motivation among public health staff in Vietnam found that recognition by managers, colleagues, and the community was the most important motivating factor to improve job performance (Dielaman et al., 2003). Similarly, peer comparison can operate as additional motivation for the system to increase delivery of preventive care services such as vaccinations (Barton & Schoenbaum 1990; Briss et al., 2000). Peer comparison feedback can also boost referrals to other preventative services. For example, in a study on the likelihood that physicians will refer tobacco users to a local smoking quit line, benchmarking doctors against the top 10 percent of performers increased their likelihood of referring patients (Bentz et al., 2007).

B. Community-level factors that affect NCD formation

People follow reference and influence groups and conform to identities and norms because it creates intrinsic utility (Akerlof & Kranton 2000). More dominant identities and strong social norms have been found to promote or discourage certain behaviors. While relevant research on NCD formation has been limited, evidence suggests that reference groups and peers play an important role (see for example Serrano Fuentes et al., (2019) for a review on obesity and social ties). For example, research has consistently shown that men are more likely than women to engage in certain risky behaviors, such as smoking and drinking, and that such behaviors are linked to masculine identity and peer pressure (see for example Keenan et al., 2015).

Social norms can also trigger aspirational consumption, i.e., the purchase of goods or foods prompted by relative deprivation and inequality (Bellet & Colson-Sihra, 2018, Elgar et al., 2005). Examples include aspirational smoking as a sign of emancipation or freedom among women or youth (Amos & Haglund, 2000; Toll & Ling, 2005) or increased rates of obesity among the poor as a result of aspirational food consumption (Schneider et al., 2020). Community-level signals of what is an accepted or desired behavior do not come only from individuals. Physical cues such as ashtrays in public places, 'smoking-friendly' labels, unhealthy or highly caloric foods at social gatherings, and others are all cues in social settings that normalize unhealthy behaviors, more so when they are also associated with identity elements.

Social references and cues are particularly strong for the initiation of behaviors at early ages, such as adolescence and early youth. In considering these issues, behavioral science distinguishes between injunctive norms (people's perceptions of what behaviors are approved or disapproved) and descriptive norms (people's observations of what behaviors are performed in reality). A systematic review examining evidence of the longitudinal associations between different types of social norms towards smoking and youth smoking uptake (initiation and escalation) finds that descriptive norms relating to parents' and close friends' smoking behavior appeared to be consistent predictors of youth smoking initiation, more so than the descriptive norms of more distal social networks and injunctive norms (East et al., 2021). A study comparing adolescent men in the capital cities of Armenia and India found that, in Armenia, adolescent men were more likely to have a smoking father and were 20 times more likely to accept and smoke a cigarette from pressuring peers than male adolescents in India, where smoking prevalence among the adult population is lower (Pandey et al., 2011). Among youth in England, Canada, and the United States, East et al. (2019) find positive social norms around vaping associated with use, with perceived peer approval of vaping being double that of smoking. The same authors explored whether current smokers' social norms towards smoking and electronic cigarettes varied across a wider set of European countries, including Romania, Spain, Hungary, Poland, Greece, Germany, and England (East et al., 2018). At the time of the study, England had the lowest smoking prevalence among these countries. Accordingly, smokers from England had the least pro-smoking norms. Peer smoking broadly aligned with country-level smoking rates, while the approval of e-cigarette use in public similarly aligned with country-level e-cigarette use.⁵

Similarly, community-level factors that affect alcohol use, such as parents' alcohol-related behavior, frequently spending time with friends who drink, and the drinking norms observed in the wider social environment have been found to increase the risk of excessive drinking (Kuntsche et al., 2017). Halim et al. (2012) studied norms influencing alcohol use among college students, considering both descriptive norms (i.e., the individual's perception of the prevalence of alcohol consumption) and injunctive norms (i.e., the individual's perception of whether drinking is approved by their peers). Further distinguishing between distal (socially distant peers) and proximal (socially close peers), the researchers found that descriptive norms, proximal injunctive norms, and social motives all independently predicted alcohol consumption. Kremer and Levy (2008) find that peers (roommates) influence college students' alcohol use and academic performance, hypothesizing that peers exert influence via their impact on preferences and habits. The adverse effects tend to be particularly large for students who drank heavily in high school and are paired with a roommate who drank heavily.

Christakis and Fowler (2007) find that social ties and obesity prevalence are connected. They tracked over 12,000 individuals over the course of more than 30 years, finding clear evidence that obesity spreads through social connections. For example, the risk of an individual's becoming obese increased by 57 percent if a friend became obese in a given timeframe.

⁵ Regulations and laws, such as gradually banning smoking in public places, may also alter social norms (Acemoglu & Jackson, 2014). Laws change material payoffs and thereby affect the factual behavior of the group understood as an equilibrium object, and thus the descriptive social norm associated with it. Laws may also provide information about societal values (Benabou & Tirole, 2011).

C. Individual decision-making that affects NCD habit formation

When it comes to caring for one's health, individuals are asked to make frequent decisions, often without adequate information or the ability to interpret and use information. Behaviors may not be viewed as health risks, or may be driven by a motivation completely unrelated to health. For example, lack of knowledge on the nutritional content of a meal can lead to unhealthy eating, either due to a misperception of the nutritional content of a given meal, or because the decision was made without nutrition as a salient factor. The same is true for lack of knowledge about how to interpret nutritional information or to connect information (e.g., about calories and protein) with foods and serving amounts using the information provided on food labels. Interventions that have changed food labeling by simplifying it and increasing salience suggest that information presentation is as important as its provision. For example, a regulatory change in Chile mandated that a simple warning about high calories and high sugar be placed in front of products in store displays. This change led to a reduction in the consumption of sugary cereals by consumers adjusting their beliefs regarding how healthy certain cereals were (Barahona et al., 2020; Araya et al., 2020).

Information, however, needs to be aligned with individual motivational factors that can affect NCD formation. These factors are related to the internal, both reflective and automatic, processes influencing decision making and human behavior. Present bias, our tendency to value instant gratification more than future benefits, and time inconsistency, our tendency to be impatient when choosing between receiving benefits today and receiving them in the future, are two examples of these automatic processes. The emphasis on the short term at the expense of the long term occurs because people perceive the present as tangible, while the future is abstract and hypothetical. Present bias creates self-control problems that affect many health behaviors, from exercising, eating healthy foods, and getting a mammogram to other preventive or protective health behaviors (defined by effort today and benefits tomorrow). Benefits today versus costs tomorrow factor in when people smoke, overeat, skip health visits, and more (Luoto & Carman, 2014). A short-term gratification focus is at odds with healthy habit formation. Reflexive thinking that continuously prioritizes instant gratification (watch television over exercising) or impulses to smoke, drink, or eat unhealthy foods can end in unhealthy habits being formed.

Another psychological barrier informing NCD formation is overconfidence; both overestimating one's performance and over-ranking one's performance relative to others. Overconfidence explains risk-taking behavior, including risky health behaviors. Some people understand heart attack and cancer risks from unhealthy behaviors such as overeating and smoking but tend to believe themselves less vulnerable to negative outcomes than their peers, even if they adopt risky behaviors (Khwaja et al., 2007, Khwaja et al., 2009). Della Vigna and Malmendier (2006) show overconfidence in habit formation related to exercise: many gym members overpay, as they exercise too little, and propose overconfidence about future self-control as one possible explanation for such observed behavior.

Arni et al., (2021) measured health perception biases -- their label for overconfidence -- using objectively measured cholesterol and blood pressure in Germany and found that 30 percent of the population have biased perceptions about their cholesterol levels. The researchers also found that about 30 percent of respondents overestimated their rank in the population health distribution by at least 30 ranks relative to a reference group. Furthermore, greater overestimation of own health was associated with more engagement in unhealthy behaviors, such as consuming unhealthy food, not exercising, and sleeping fewer hours. This

is akin to saying: “Because I believe I am very healthy and can afford it, I eat more fast food and exercise less.” Notably, this study finds that smoking is not correlated with biased health perceptions.

The finding concerning smoking is consistent with Darden (2017), who finds that cardiovascular biomarker information provided at repeated health exams does not significantly alter smoking behavior. Cognitive dissonance, our tendency to often hold contradictory opinions, may explain these results. People smoke, for example, even when knowing of its danger. This self-contradiction is unpleasant (causes dissonance), so people develop cognitive tools that justify the contradiction. The most obvious way to address the contradiction, of course, is to stop smoking, but that is difficult to do (Rice, 2009). Instead, people use other strategies, such as exaggerating how much pleasure they get out of smoking (that is, overweighting the present) or underestimating the future costs (“Aunt Anna smoked her whole life and lived to age 89 without health problems”). Another possible explanation is that signals and information about own health, be it objective as in Darden (2017) or perceived as in Arni (2021), are not powerful drivers of smoking behavior, possibly because its addictive nature prevents the proper evaluation of the health consequences of smoking.

Other biases to consider in disease formation at the individual level are loss aversion -- the idea that a loss causes greater distress than the happiness caused from a gain of similar magnitude -- the endowment effect -- the overvaluation of a good when we possess it -- and framing effects -- the tendency to draw different conclusions depending on how the information is presented. Cawley (2011) found that subsidizing healthy food options was less effective in promoting healthy eating than was taxing the unhealthy food options. People viewed the discount on healthy foods as a gain, which was subsequently valued less than the loss of having to pay more for the unhealthy food. Another example from Kahneman (2011) is that cold cuts described as “90% fat-free” sound a lot better than cold cuts that have “10% fat.”

Many of the aspects previously cited also influence the information and motivation dimension. However, individual biases can also impact opportunity factors that lead to NCD formation. These are related to external factors that make execution of a behavior possible. Physical opportunity, opportunities provided by the environment, and social opportunity, for instance to perform regular exercise, can promote or diminish healthy behaviors. For example, Zimmerman (2011) argues that obesity is not a rational choice, and that weight gain is not the result of people maximizing their utility given fixed preferences, but rather it relates primarily to the influence of food-producing companies, which attempt to change people's tastes toward fatty and high-calorie foods. This takes several forms, including direct advertising, product placement, and advertising in schools. It is important to note that this does not explain increasing obesity in low- and middle-income countries. In such contexts, the growth of income per capita as well as the increasing affordability of fast food relative to healthy food have been important drivers in the growth of unhealthy eating habits. Consequently, behavioral factors such as the one described for obesity are more likely to explain larger variations in high-income countries than in low- and middle-income countries.

Finally, individual capabilities, skills, and abilities also affect NCD formation. Decision fatigue and cognitive overload, for instance, make the decision-maker prone to poorer decisions. In marketing, sweets or other foods that people might not specifically search for in a supermarket are placed near the checkout aisles: customers having already made dozens of decisions on what to buy have reduced mental resources available, thus becoming more prone to impulse buying (known as ego depletion) (Cohen, 2012a; Cohen, 2012b; Baumeister, 2002). Examples of cognitive overload and food choices have been tested experimentally, for example by asking study participants to choose between cake and fruit salad while having to remember

a number. Compared with a two-digit number, those with a seven-digit number were 50 percent more likely to choose cake over fruit (Shiv & Fedorikhin, 1999).

Decision fatigue does not have to emerge from a single domain of decision-making. While some individuals might face decision overload in a given moment, others may confront a constant demand to make decisions due to limited opportunities. Poor people are particularly subject to decision fatigue because so many of their decisions involve significant trade-offs that even the smallest decision can have far-reaching monetary and welfare implications (Spears, 2011; Mani et al., 2013). As suggested by Bertrand et al. (2004) and Shah et al. (2012), among others, poor individuals may exhibit the same basic weaknesses and biases as do people from other walks of life, except that, in poverty, with its narrow margins for error, the same behaviors often manifest themselves in more pronounced ways and can lead to worse outcomes. Material scarcity, for example, has been found to change the allocation of attention, promoting tunnel vision and forcing people to focus on immediate needs over longer-term goals (Mullainathan & Shafir, 2013). In these situations, health decisions, if not obviously critical, might take second place to many other, more urgent and immediate needs. Similarly, consumption of what is available now (whether healthy or not) and impulsive behavior might be a simpler choice.

This section has so far discussed how different behavioral biases can impact the formation of NCDs along the pathway to healthy aging. However, it is important to highlight that behavioral biases- and therefore the toolkits discussed in later sections- may be different when dealing with positive habit formation as opposed to eliminating negative habits. Different behavioral biases may become dominant in certain circumstances, and therefore the tools required to address them need to adapt to the setting. Most positive habits, such as beginning to exercise regularly, require fairly prolonged exposure and often convenient access to an appropriate contextual environment, so overconfidence (in time management and/or self-efficacy) is a common issue. While stopping some negative behaviors (such as unhealthy eating) may follow a similar dynamic, many behaviors in this category are instead more like smoking or other addictions, where loss aversion and present bias, for example, can make it difficult to overcome the initial hurdle.

IV. NCD detection: Screening

The second main phase of the individual journey to healthy aging has to do with screening and identification of illnesses. As in the previous section, our analysis follows health system, community, and individual-level factors and discusses, within each, behavioral barriers and biases influencing health-seeking behavior and screening and detection practices.

A. Health system factors that affect NCD screening

The role of health system factors in the uptake of NCD screenings involves both the doctor-patient interaction and broader system characteristics. In each of these areas, we find behavioral components that influence the appropriate uptake and use of NCD screening.

The doctor-patient relationship is often presented as an agency relationship: the physician makes informed decisions on behalf of the patient (McGuire, 2000). Under this model, the physician makes decisions in line with the patient's preferences- including with regard to risk and time. However, such a decision-making process is also prone to potential behavioral biases that may influence the physician's choices.

Several studies have highlighted how physician risk preferences impact treatment and screening decisions. Some show, for example, that physician risk aversion is strongly associated with patient charges and expenditures over time (Allison et al., 1998; Fiscella et al., 2000). This highlights how, independent of the patient's preferences, physician risk preferences and biases could impact people's health care seeking behaviors. Even though a recent study found that risk preferences between patients and physicians were generally aligned (Galizzi et al., 2016), they may be misaligned in certain settings or when patients inaccurately estimate their own risks, and this possible misalignment may help explain why NCD screening remains low.

In contrast to the risk preference scenario, a field experiment in Greece found a significant difference in time preferences between patients and their physicians (Galizzi et al., 2016). This study highlights that, while improving communication between physicians and patients could improve the uptake of screening, it is of even greater importance to integrate a wide set of characteristics in the communication process, including the potential mismatch in time preferences.

Physicians are important drivers of patients' health care seeking choices insofar as they are the choice architects for patients within the health care realm. A mixed-method study in the United States highlighted how physicians determine patients' choice possibilities, even though doctors proved not to be fully competent in their roles as choice architects (Hart et al., 2021). This reaffirms the physician-patient interaction as a key stage in which physician biases can influence the appropriate uptake of screenings and other procedures.

Physicians themselves are, as part of the system, affected by coordination failures and social influence. A systematic review of health care provider barriers to hypertension awareness, treatment, and follow up found that a common barrier was social influence in the form of a lack of care coordination with colleagues, along with social pressures and conflicting roles within a medical practice. Professional identity, expressed as a lack of trust in the evidence on which guidelines were based, was also found to influence hypertension treatment (Khatib, et al., 2014).

Health care accessibility issues, particularly direct costs and opportunity costs, are a primary reason why individuals forgo screenings. In a recent review of the cost-effectiveness of interventions to reduce NCDs in LMICs, Watkins et al. (2022) find that increased screenings for diabetes and cervical cancer are among the most cost-effective. Reducing barriers within the health system itself will be crucial to increasing screening for these and other conditions. While health system accessibility is mainly influenced by policies, there is an interaction between access and personal biases that further reduces the likelihood of people's accessing screening services. A large share of biases also falls within the motivation dimension from the individual perspective. For instance, higher access or opportunity costs have routinely been linked with a greater likelihood of delaying screening (Lagarde et al., 2007). One explanation for this is the simple demand and supply theory, whereby higher prices discourage people from seeking health care, but another behavioral explanation is that higher costs counterbalance discounted future benefits. This issue links back to individual motivation, but it is important to note that health system factors such as prices or distance to health care establishments can further strengthen behavioral biases that hinder access to screening services.

B. Community-level factors that affect NCD screening

As social and community forces sometimes support unhealthy or risky behaviors that can, over time, lead to an NCD, they might also play a role in when and for what reasons people seek health care. While preventative care is not always offered when individuals show no signs of illness, screening might not take place even when these signs are present. Despite widespread evidence of the benefits of screening, many cultural norms may deter individuals from pursuing it. For instance, men seem to be less likely to seek mental health services, as doing so clashes with traditional masculine identity around strength and self-sufficiency (Pattyn et al., 2015). Similarly, as discussed earlier, if social networks and communities are formed by individuals with similar characteristics (e.g., people who smoke or are overweight), these networks are less likely to see the behavior and/or its consequences as warning signs to seek help.

The role of norms has been tested when making them salient in, for example, reminders to attend screenings or other health messages that refer to peer behaviors (Camilloni et al., 2013). A recent study in Armenia found that messages appealing to peer behaviors increased screening attendance about 15 percentage points for hypertension and diabetes (De Walque et al., 2020). However, the personalized invitation referencing peer behaviors did not have an add-on impact compared to standard personalized invitation.⁶ A further study with the same population found that participants described learning that neighbors and peers attended screenings as a potential motivator for service use, more so if the screening helped uncover a disease or obtain treatment (Gong et al., 2020). Social norms may not only influence initial access or use of screening services, but are probably also relevant to the subsequent interactions that occur within the health system, which can then influence the full uptake of screening options. Cultural aspects like personal health beliefs and qualities linked to interpersonal relationships, such as distance, trust, and directness, influenced patients' judgment of a physician-patient interaction (Gao et al., 2009).

Stigma and fear are related to social norms and community assessment of health-seeking behaviors and can operate as enforcement mechanisms of prevailing norms. Early work highlighted how structural stigma- a social phenomenon with roots in social structures- exerted substantial influence in health care-seeking behavior for many causes (Hatzenbuehler, 2014). Even though evidence on stigma remains scarce in the literature, a growing number of studies now highlight how social perceptions of a disease, its causes, and its consequences can influence individual health care-seeking behavior. A recent systematic review found that blame, shame, and fear were the main factors behind stigma for diseases such as cancer and that this had social, behavioral, psychological, and medical consequences (Rai et al., 2020).

Fear of stigma as a community judgement can stem from different conditions. Conventional body image norms and failure to meet these may deter people, especially women, from seeking screening services (Kilpela, et al., 2015; Fingeret et al., 2014). In the United States, as in many other countries, the uptake of disability programs became stigmatized to the extent that it discouraged participation in the screening process for individuals to be declared disabled (Hansen et al., 2014). Stigma can also influence the uptake of cancer screening. For example, McCaffery et al. (2006) report that, in the UK, screening and testing

⁶ The intervention tested 1) personalized invitations from a physician, 2) personalized invitations with information about peer screening behavior, 3) personalized invitations with a labeled but unconditional financial incentive, and 4) personal invitations with a conditional financial incentive.

positive for the human papillomavirus (HPV)- a risk-factor for certain forms of cancer- was accompanied by feeling stigmatized. Stigma associated with mental diseases is amongst the leading reasons for the underuse of mental health services (Evans-Lacko et al., 2012). Similarly, the stigma associated with degenerative diseases like Alzheimer or other forms of dementia is likely to discourage individuals from following a screening procedure, for fear of the consequences that might follow it.

C. Individual decision-making that affects NCD screening and identification

In the case of aging-related diseases, two behavioral factors are largely responsible for the low uptake of prevention. The first is that, in contrast to other illnesses, most NCDs remain asymptomatic for a long period of time (Bovet et al., 2015) and lack early saliency. The second is inaccurate individual beliefs and overconfidence, which lead people to undervalue the benefits of screening (Baicker et al., 2015).

Even with a clear understanding of which risk factors lead to NCDs, individuals tend to underestimate their likelihood of suffering from an NCD. This issue relates to the risk-taking behaviors described earlier concerning the formation of NCDs, whereby individuals believe themselves to be less likely than their peers to suffer such poor fortunes (Khwaja et al., 2007, Khwaja et al., 2009). Evidence demonstrates that actual risk and perceived risk for CVDs were weakly correlated, with most high-risk individuals being incorrectly optimistic (Van der Weijden et al., 2007), and that people underestimate their own risk for high cholesterol while overestimating the risk of others (Arni et al., 2021). As individuals underestimate their own risk, they are then less likely to value the benefits of screening and to consider that these benefits are larger than the costs of attending a screening session.

This highlights the role of present bias in the low uptake of screening. People generally tend to be time-inconsistent and delay screenings, and the reduced value that people attribute to screenings reinforces the impact that present bias can have in postponing appropriate preventive care. A theoretical study using US data found that time-inconsistent health investment behaviors -including with regard to screenings- could explain a loss of about four years in life expectancy (Strulik & Wener, 2021). Further studies have also shown that high discount rates are associated with lower screening rates for cancer and measurements of blood cholesterol (Bradford, 2010). It is important to emphasize the relevance of motivation in terms of healthy aging, since preventive screenings are not a one-time process. Usually, screening for NCDs needs to be conducted annually after certain ages. Therefore, these biases can have long-term consequences if motivation for screening uptake remains low.

Loss aversion also influences the motivation to attend health screenings in a subtle way. Even people with accurate perceptions may not take up screening to avoid the realization of a foreseeable bad outcome. A qualitative study in the United States found that fatalism and negative outcome perspectives were important barriers to participation in screening for breast cancer (Peek et al., 2008). Similar findings were obtained across multiple countries, linking fatalism to lower attendance at cancer screening programs (De Los Monteros & Gallo, 2011). Another literature review based on the UK population found fear of a negative outcome as one of the reasons individuals did not attend the regular health checks proposed by the NHS (Harte et al., 2018). While one might think that loss aversion would only affect voluntary attendance at screenings, other studies suggest that this fear also leads people to reject explicit invitations to screening programs (Witte & Allen, 2000). More importantly, loss aversion does not only have a personal impact. A field experiment in Australia showed that loss aversion among relatives can influence an individual's

enrollment in health management programs (Beatton et al., 2021). Overall, these studies emphasize that loss aversion is an important driver in declining motivation and procrastination around screening.

Finally, decision fatigue and cognitive overload can also lead to poor decision-making processes with regard to screening. A potential diagnosis of a chronic condition that would entail regular expenditures may lead to unmanageable situations in poorer households. As in the case of habit formation, households unable to afford possible treatment in the future may prefer to avoid attending a screening consultation (Spears, 2011). Cognitive overload can also have an impact on an individual's capability to follow up on the different stages of a screening process. Even though invitation letters increase the uptake of preventive screening programs, often they contain an overwhelming amount of information, limiting the potential of the invitation to increase screening uptake.

V. NCD management

This section discusses how behavioral factors influence the long-term management of NCDs via sustained lifestyle changes, medication adherence, continued medical care, and other measures necessary for managing chronic conditions.

A. Health system factors that affect NCD management

Traditional behavioral change approaches to better align clinical practice with guidelines have mainly focused on improving access to information and guidelines. These methods are based on conventional economic theory and presume that physicians are perfectly rational decision-makers whose main barrier is lack of information.

Physicians, however, make numerous complex decisions on diagnostic and treatment plans daily, often with limited information and under time pressure (Blumenthal, 2015). When making a high volume of decisions under conditions of uncertainty, the decision-making process may be guided by environmental cues and heuristics (Blumenthal, 2015; Scott et al., 2017). These make physicians especially vulnerable to systematic cognitive biases (Saposnik et. al., 2016), for example, distorting probability estimation and impairing information synthesis (Wang & Groene, 2020).

Behavioral science can help explain why, for example, prescription rates of guideline-directed therapies seem to be lower than appropriate (McCarthy, 2019; Greene et al., 2018; Salami et. al., 2017d) or why physicians treating cardiovascular disease under-prescribe statins and fail to intensify treatment when indicated (Asch et al., 2015). Due to the cognitive biases impacting their decision-making in the context of NCD treatment, doctors may judge risk to be low without available personal experiences (for example, knowing someone or experiencing themselves the consequences of under- or over-prescription), may be less careful than expected when not observed, and may falter without an injunction from authority (Doctor et al., 2018). Such biases may explain why physicians sometimes continue to deliver care that robust evidence has shown to be of low value (Scott et. al., 2017).

B. Community-level factors that affect NCD management

Some of the community-level factors mentioned in prior sections -- social norms, peer pressure, roles, identities, and stigma -- also affect NCD management, both through patient and provider behavior.

On the providers' side, norms about treating "someone else's patient," identity related to health providers' scope of work (i.e., nurse vs. doctor), and shared beliefs about treatments, medications, clinical guidelines, and actual capabilities to help patients manage and control NCDs can hinder how much providers engage with patients in their ongoing care. Khatib et al. (2014) find evidence that providers doubt the efficacy of certain hypertension medications, are reluctant to initiate aggressive anti-hypertensive drug treatment due to possible side effects, and question whether following clinical guidelines would improve outcomes.

On the patients' side, shared beliefs, myths and misinformation, social norms, and community practices can also hinder appropriate treatment and medication adherence. For example, in the United States, African American and Latino patients' beliefs about the effectiveness and side-effects of medications have been found to lower adherence (Wexler et al., 2009; Peters, et al., 2008). In Zimbabwe, poor awareness from both patients and the community has been found to result in the use of alternative, and potentially harmful, remedies (Kamvura et al., 2022). Community suspicion of government has also been found to hinder NCD management (Heller et al., 2019).

Lack of social support, mainly from family and friends, is an important barrier to treatment and medication adherence and healthy lifestyle changes (Devassy et al., 2020; Khatib, et al., 2014). The ability to make lifestyle changes to control NCDs in many cases involves changing social practices. Improving eating patterns, for instance, may entail new cooking patterns within a household or having to cook a healthier meal for oneself (Khatib, et al., 2014). Social interactions that involve smoking or drinking exert peer pressure on the person undergoing treatment. The opposite holds, as well: a positive social environment and good social support have been shown to have a significant impact on compliance with the medical management of chronic disease (Basu & Millett, 2013).

Finally, apprehension about stigma and stereotypes, often stemming from past negative interactions with the health system, can lead patients to fear discrimination based on factors including race/ethnicity, age, gender, and weight. This has been associated with higher distrust of physicians and dissatisfaction with health care, poorer mental and physical health (including self-rated health, hypertension, and depressive symptoms), and lower odds of receiving the influenza vaccine (Abdou et al., 2016).

C. Individual decision-making that affects NCD management

Management of NCDs in most cases requires adherence to medications, ongoing follow-up medical care, and sustained changes to lifestyle and health behaviors, such as physical activity or smoking, which are difficult to achieve. Adherence to one regime (medicines) might displace cognitive resources from these additional sets of changes and new habits, potentially enabling other biases related to decision-making to take hold. Cognitive biases particularly relevant to NCD management are those that affect how people perceive losses (Kahneman & Tversky, 1979), value the present vs. the future (O'Donoghue & Rabin, 1999), and understand ambiguity (Fox & Tversky, 1995, Fox & Weber, 2002). In cases where habit change is difficult, the immediate negative side effects of giving up certain unhealthy behaviors (tobacco or specific foods, for example) may be perceived as worse than the potential long-term consequences of non-

adherence to the recommended behaviors, even though those consequences are in fact greater, even when accounting for their occurrence in the distant future (Luoto & Carman, 2014).

Even when people are motivated, limited attention can interfere with medication adherence, care-seeking, and lifestyle changes. The limited ability to notice, store, and process information can help explain the difficulty many individuals have in adhering to a prescribed course of treatment (Kessler & Zhang, 2014). The formation of habits (or changing existing ones) requires self-efficacy, effort, and investment in the creation of an opportunity “event” that links the needed healthy behavior to an environmental cue or trigger, such as placing medicines in a visible location in the morning, even when the motivation (feeling sick or fear of future consequences) becomes less salient.

As people also rely upon knowledge that is salient and easy to retrieve from memory when judging probabilities and making decisions (Tversky & Kahneman, 1973; Bruine de Bruin et al., 2016), the salience of a given piece of information, or the degree to which that piece of information stands out relative to other information, can also affect decisions related to medication adherence and habit change. If a piece of information is not particularly salient or becomes less salient over time, it might be overlooked or more easily forgotten. The salience of symptoms and of the treatment itself can influence medication adherence (Kessler & Zhang, 2014). Over time, if a medication’s beneficial effects become less noticeable, adherence can fade, as in the case of low adherence to tuberculosis treatment regimens (Munro et al., 2007; Pradipta et al., 2020).

VI. Recommendations for a policy toolkit: Behaviorally informed interventions for NCD formation, detection, and management

Traditional policy tools based on the rational subject model have been moderately effective in changing unhealthy behaviors. In the case of tobacco use, for instance, raising prices through taxes on cigarettes, providing information about the perils of smoking, and introducing barriers to the purchase and use of tobacco have curbed the behavior, but large shares of the population continue to smoke. Similarly, information about the risks of overeating, drinking alcohol, sedentary lifestyles, and other unhealthy habits does not seem to be enough to inflect these behaviors. Insights from the behavioral sciences can complement these traditional tools, increasing their efficacy and impact.

Behavioral interventions that aim to address the factors behind risky behaviors appear to support the reduction of NCD lifestyle risk factors. Systematic reviews have assessed the evidence around these interventions. Blaga et al. (2018) reviewed the effectiveness of strategies used to promote tobacco cessation, reduce alcohol consumption, promote healthful diets, and increase physical activity, finding promising results with potential impact on NCDs. Möllenkamp et al. (2019) studied the effectiveness of behavioral interventions in improving self-management among adults with chronic diseases and reported positive impacts. These reviews and other studies find that the most commonly tested (and successful) behavioral interventions are reminders, planning prompts, nudges (i.e., indirect influencers inspired by cognitive biases and boundaries), and feedback focused on self-management. Most financial subsidies, fines, and other attempts to directly change the cost-benefit calculation of a decision do not count as behavioral, but small financial incentives constitute a nudge if they work primarily via salience or signaling of norms. Other reviews have focused on behavioral tools such as choice architecture (Hollands et al., 2013; Skov et al., 2013; Thapa & Lyford et al., 2014), finding promising but under-researched impacts. Moderate impacts

have been found on time discounting when it comes to obesity (Barlow et al., 2016; Barlow et al., 2016), while altering default settings and providing social reference points have been found to have positive effects on changing physician behavior (Wang & Groene, 2020). Ongoing management of NCDs, mainly via medication adherence, is among the most cost-effective strategies for NCD control (Watkins et al., 2022); the policy tools discussed here can support adherence by addressing barriers that currently prevent individuals from entering and remaining in care, thereby improving the effectiveness of such interventions.

The behavioral science toolkit is large. No single policy tool can address the complexity of behavioral barriers across the whole journey towards healthy aging. Nor should these be considered stand-alone interventions that can operate independently of other services, health system resources, and other structural factors. It is in the combination of a strong structure of opportunities to adjust behaviors and habits, supported by motivation and a sense of ability to act, that behavior change can take place and be sustained over time. The policy toolkit outlined here is both ample and complimentary to existing policy efforts. These efforts include classical interventions such as taxation, subsidies, or restrictions. The purpose of this review is not to compare the effects of behavioral and classical interventions; however, we emphasize the need for future studies to evaluate how different combinations of behavioral and classical tools can maximize the effect to achieve healthy aging.

In terms of interpretation, the tools described below can be linked to the original framework by way of identifying the *'Behavioral Phenotype'* of a given policy's intended target population. This means identifying and segmenting the target population not only by risk characteristics or sociodemographic traits but based on a larger set of profile elements, including behavioral and psychological variables, motivation, ability, and opportunity factors. While for some people reminders are all that is needed to close gaps in treatment adherence, for others more complex interventions to inform, motivate, and create adequate social support might be required.

The tools and literature presented in this section are a selection of the relevant evidence that speaks to the three stages of NCD formation, detection, and management. We leveraged randomized field interventions and systematic reviews to showcase the behavioral toolkit available to policymakers to tackle NCDs. However, the selection is not the result of a systematic review. The literature search strategy comprised English-language, peer-reviewed electronic records from Google Scholar published between 2000 and 2022. Reference lists of relevant studies were also hand searched for eligible papers. The approach prioritized studies from low- or middle-income countries and was supplemented with evidence from high-income countries. The selected field studies, mega-studies, and systematic reviews conducted or assessed randomized controlled trials (RCT) to measure the interventions' effectiveness.

We gave precedence to mega-studies and systematic reviews to ensure the external validity or generalizability of the tools. However, there are gaps where evidence is mixed or very limited, and this is reflected in the toolkit. There is a more robust evidence-base related to financial incentives on a wide range of behaviors, as compared with salience or plan-making. We also have little information about the persistence of the reported effects for even the most successful interventions, as studies of this kind rarely follow participants for more than a few months after the intervention. This limitation is most important for interventions that aim to build habits, for example around exercise, as opposed to interventions focused on one-time (or infrequent) behaviors such as screenings.

The review does not include interventions focused on leveraging peer effects (e.g., role models) or community mechanisms (e.g., support groups): not because these don't exist, but because the strategies presented below (incentives, goal setting and planning, reminders, and others) can all benefit from a community focus to increase support for healthy behaviors and reduce the potential negative impacts of social networks. Continuing efforts to communicate and inform for behavior change, and to update people's perceptions of beliefs or behaviors among their peers, can complement strategies more focused on the individual.

A. Small financial incentives

Financial incentives have been tested as means to reward healthy behaviors across a variety of contexts, including exercise (Charness & Gneezy, 2009; Cawley & Price, 2013), weight loss (Cawley & Price, 2013; John, Loewenstein and Volpp, 2012; Volpp, John, et al., 2008), smoking cessation (Volpp et al., 2006), and adherence to chronic disease medications (Volpp, Loewenstein et al., 2008). Overall, financial incentives seem to promote healthy behaviors in the short term, but effects disappear when the incentives are removed. Combinations with other behavioral insights such as peer and framing effects tend to render better lasting results. One study focused on US school children found that incentives can increase rates of fruit and vegetable consumption, particularly among lower-income children, who are most likely to benefit (Just & Price, 2011).

Financial incentives to patients and physicians are increasingly used to manage NCDs. According to a meta-analysis by Haff et al. (2015) and a mapping review by McGill et al. (2018), contemporary incentive designs that leverage people's "decision biases" may improve the efficacy of incentive interventions. A meta-analysis of financial incentives including 23 RCTs to promote physical activity found that modest incentives (\$1.40 US/day) increased mean daily step counts during the intervention periods for interventions of short and long durations and after incentives were removed (Mitchell, 2020).

An additional body of evidence supports the notion that financial incentives could motivate weight loss (Finkelstein et al., 2007, 2017; Volpp et al., 2008; John et al., 2011; Kullgren et al., 2013; Adams et al., 2017). Finkelstein et al. (2016) found that participants who received a FitBit and cash-based financial incentives had significantly more minutes of moderate to vigorous physical activity compared with a control group (29 additional minutes weekly), but participants who received a FitBit and charity-based financial incentives, or a FitBit alone, did not (Finkelstein et al., 2016)—providing evidence that financial incentives may be more effective when received directly. Kullgren et al., (2013) examined individual versus group-based financial incentives for promoting weight loss among obese employees. A group-based financial incentive was more effective than an individual incentive and monthly weigh-ins at promoting weight loss among obese employees at 24 weeks.

Financial incentives have also been tested for treatment management. Volpp and Loewenstein and colleagues conducted a randomized trial of the use of financial incentives to encourage greater adherence to warfarin, a blood thinning medication (Volpp, Loewenstein, et al., 2008). This study found that a variable rewards mechanism — incentivizing people with a daily lottery that offered a small chance of a large payout — resulted in a significant reduction in the fraction of missed doses. However, after the variable rewards were removed 28 weeks later, adherence returned to baseline levels. John et al. conducted an extended version of the same intervention in 2011 and replicated the pattern that incentivized participants to lose

significantly more weight by 32 weeks but that this effect was not significantly sustained at 68 weeks (John, Loewenstein et al., 2011). In 2020, Barankay et al. conducted a trial where participants were given lottery-framed financial incentives when adherent to statins. Each intervention group had a significantly higher rate of statin adherence compared to the control group at six months (0.84–0.87% vs. 0.69%), but mean reductions in low-density lipoprotein cholesterol (LDL-C) levels were non-significantly different between the intervention group and the control group at 12 months.⁷

These interventions' designs included many insights from behavioral economics, including people's tendency to overestimate small probabilities and be particularly emotionally attracted to small probabilities of large rewards, therefore often preferring a lottery-based incentive over a known, consistent incentive amount. Also, the daily lottery incentive provided regular feedback, which addressed present bias, as even small rewards and punishments can have large effects on behavior when they occur immediately. This feedback also addressed people's tendency to wish to avoid regret, because people found out each day if they would have won had they been compliant (Luoto & Carman, 2014).

In an intervention tying physician financial incentives to clinical goals to increase attention to patient lipid management, primary care physicians were randomly assigned to control, physician incentives, patient incentives, or shared physician-patient incentives. In primary care practices, shared financial incentives for physicians and patients, but not incentives to physicians or patients alone, resulted in a statistically significant difference in reduction of LDL-C levels at 12 months (Asch et al., 2015).

To examine the effect of combining financial incentives with a team-based approach, Patel et al. conducted a randomized clinical trial where financial incentives were delivered to participants when they met their step counts as individuals, teams, or a combination of both (Patel, Asch et al., 2016). The combined financial incentive arm had a significantly greater mean proportion of participants achieving their step goal as compared with the control group (35% vs. 18%), highlighting the power of both social norms and individual accountability to influence physical activity. Similarly, but leveraging gamification, Patel et al. (2016) found that families who received a daily intervention that assigned points and levels based on step counts achieved step goals on a significantly higher proportion of days compared with the control group (53% vs. 32%) and had significantly higher mean step counts compared with their baseline (1,661 vs. 636) (Patel et al. 2016). Patel, Volpp et al. (2016) examined peer comparisons in a trial where participants received team-based step count feedback compared with either the 50th or 75th percentile, with or without financial incentives. The peer comparison to the 50th percentile and financial incentives were most effective at increasing physical activity (Patel et al., 2016).

Incentive framing can also impact NCD management. Patel et al. (2016) conducted a subsequent study to test the efficacy of “gain-framed,” “loss-framed,” and lottery-based financial incentives (Patel et al., 2016). Only participants in the loss-framed arm achieved a significantly greater mean proportion of days meeting their step goal compared with the control group, revealing the importance of framing when delivering. In 2019, Chokshi et al. replicated the finding that loss-framed financial incentives are the most effective at increasing physical activity but in patients with ischemic heart disease (Choksi et al., 2019). A pilot study by

⁷ The discrepancy in statistical significance between the intervention's impact on statin adherence and the more clinically meaningful metric of LDL-C levels highlights the continued need for similar studies to directly measure health outcomes in addition to the health behaviors which lead to such outcomes (Hare, 2021).

Riegel et al. (2020) examined the impact of loss-framed financial incentives on patients' adherence to aspirin following admission for acute coronary syndrome. At 90 days, the incentive-receiving patients had a nonsignificantly higher rate of aspirin adherence compared with the usual care group (90% vs. 81%) and a nonsignificantly lower rate of rehospitalization (13% vs. 24%).

Contingency management is another tool offered to provide incentives, for instance, to addicts to abstain from consuming the addictive good (Cawley & Ruhm, 2011; Higgins et al., 2002). It reinforces or rewards individuals with vouchers exchangeable for retail goods and services or the opportunity to win prizes to promote positive behavioral change (Petry, 2011). A meta-analysis of voucher-based reinforcement therapy found overwhelming evidence of increased abstinence; the vouchers raised compliance by an average of 30%, with larger effect sizes for rewards that were more valuable or were delivered immediately (Lussier et al., 2006). However, there is some evidence that contingency management may be more effective at treating the use of opiates and cocaine than tobacco (Prendergast et al., 2006). A striking feature of these programs is the relatively high success rates obtained for small vouchers – as little as \$2.50 for a single negative test for cocaine (Higgins et al., 2002; Petty & Martin, 2002), suggesting that the immediacy of the reward is enough to overcome the urge to use.

One important caveat regarding the financial incentives described above is the ambiguity concerning their long-term impact. Most of the studies cited here examine the effect of financial incentives on NCD management or the uptake of health care services only in the short term. More importantly, even some of these short-term studies find evidence that the appropriate behavior often stops once the financial incentives ends. This brings into question the potential long-term effects of such incentives and emphasizes that their usefulness may be limited to cases where short-term but “sticky” habit formation is required. This caveat should be taken as a cautionary note, since many governments in low- and middle-income countries still consider financial incentives- whether conditional or unconditional- as a silver bullet for many problems. The studies above highlight that the long-term effects of these tools are not certain and that such approaches might therefore only offer temporary solutions.

B. Commitment contracts – devices

Another tool for curbing unhealthy behaviors is commitment contracts, for example encouraging people to sign contracts to quit smoking and providing rewards for those who do. In the Philippines, Gine et al. (2010) randomly assigned 2,000 regular smokers into two groups - one that was offered the opportunity to join a commitment program and one that was not. The program (CARES) offered individuals a savings account into which they deposited funds for six months, after which they took a urine test for nicotine and cotinine. If these substances were not detected, the money was returned to them; otherwise, their money was confiscated and donated to a pre-chosen charity. The group that received CARES (includes both populations who accepted and did not accept the program) were 3.5 to 5.7 percentage points more likely to pass the 12-month urine test than those in the control group, who were only informed about the consequences of continuing to smoke. This result was (marginally) significant. However, those who used CARES were 31 to 53 percentage points more likely to pass the 12-month urine test than the control group.

Commitment contracts have also been used to encourage other forward-looking behaviors, including weight loss (Volpp, John, et al., 2008). Obese participants from the United States were randomly assigned to one of three treatments: monthly weigh-ins, a lottery, or a “deposit contract incentive system.” In the

deposit contract incentive system, participants committed between \$0 and \$252 per month of their own money towards the goal of losing weight. The money would be returned to them with a 1:1 incentive match upon meeting their goal (losing 16 pounds in 16 weeks), but they would forfeit the money if they failed to meet their weight loss goal. Such a contract incorporates the behavioral economic findings of overconfidence and optimism bias, as people are ex-ante overly optimistic about achieving their weight loss goals and therefore more likely to enter the contract than they otherwise might be. This incentive design also takes advantage of loss aversion because, once the money is committed, the motivation to lose weight is heightened by the motivation to avoid the loss of the funds. Finally, the contract can potentially appeal to those who are sophisticated about their present-biased preferences: their “planner” selves today will sign up their future “doer” selves for the hard work of following through on the binding commitment. Although the study was based on very small sample sizes, it revealed that both incentive systems worked. Average weight loss was 13 to 14 pounds across both types of incentive programs, compared with just four pounds in the control group that underwent monthly weigh-ins. Furthermore, nearly 90 percent of participants chose to participate in the deposit contract. However, in both treatments, participants were found to regain the weight upon withdrawal of the incentives (John et al., 2012).

In South Africa, Schwartz et al. (2014) tested a voluntary self-control commitment device to help grocery shoppers make healthier food purchases. Participants, who were already enrolled in a large-scale incentive program that discounts the price of eligible groceries by 25%, were offered the chance to put their discount on the line. Agreeing households pledged that they would increase their purchases of healthy food by 5 percentage points above their household baseline for each of six months. If they reached that goal, their discount was awarded as usual; otherwise, their discount was forfeited for that month. Thirty-six percent of households that were offered the binding commitment agreed; they subsequently showed an average 3.5-percentage-point increase in healthy grocery items purchased in each of the six months; households that declined the commitment and control-group households that were given a hypothetical option to precommit did not show such an increase (Schwartz et al., 2014).

The basic principle explaining why commitment contracts are hypothesized to work is that committing oneself today to a behavior tomorrow can overcome hyperbolic discounting and present bias (Luoto & Carman, 2014). That is, it is easy to plan to start dieting or exercising tomorrow. If your present self can precommit your future self to follow through on such behaviors, intentions and actions can align where they otherwise might deviate.

C. Saliency and vividness

Saliency and vividness have also been found effective in highlighting the risks of unhealthy behaviors and inflecting those behaviors. For example, the government of Uruguay implemented a major non-price tobacco campaign with measures including programs to treat nicotine dependence at health centers, banning tobacco advertising nationwide, rotating warnings with pictograms on each pack of cigarettes, restricting brands to a single presentation, and increasing the size of pictograms to 80% of the front and back of each pack. Results from the program evaluation indicate that, from 2007 to 2012, the proportion of pregnant women who had quit smoking by their third trimester increased markedly, from 15 to 42 percent. Quitting smoking by the third trimester increased birth weight by an estimated 163 grams (Harris et al., 2015). Although the Uruguayan campaign has elements that operate at both the individual level and

the system level (e.g., access to treatment programs), overall saliency is about the decision-making context and can therefore be considered most closely linked to other community-level interventions.

Another randomized trial tested the role of feedback in the form of mHealth SMS messages in encouraging greater adherence to self-monitoring in a weight loss regimen. The two-year study found that daily SMS feedback messages enhanced adherence to self-monitoring and increased weight loss (Burke et al., 2012). However, the overall effects on weight loss were small, around 2 percent of bodyweight, on average. Barnes et al. (2012) found that using symbols such as stars, rather than presenting numbers, was easier for most people to comprehend. In addition to this, applications or processes that rely on sending SMS can also suffer from user fatigue. This means that such an approach can have a strong effect in the short term, due in part to its novelty, but that the intervention's effectiveness can decrease and even disappear as the novelty wears off, if users unsubscribe or withdraw from the messaging system.

Reminders and saliency applied to health workers can also promote medication adherence. Using a randomized controlled trial format, Doctor et al. (2018) monitored the effect of notifying physicians who had a patient die of opioid overdose within 12 months of a prescription. The physicians received an injunction to prescribe safely from their county's medical examiner. The hypothesis behind this intervention was that, as people rely upon knowledge that is impactful, recent, and easy to retrieve from memory when judging probabilities and making decisions (Tversky & Kahneman, 1973; Bruine de Bruin et al., 2016), decisions to avoid harms could occur more frequently after receipt of the letter, because the effects of opioid harms would be more readily available to memory. Clinicians are also disproportionately exposed to patients who return to their clinics uneventfully for an opioid refill. The letter alerted clinicians to those patients who do not return, owing to death via an overdose. Clinicians would then prescribe with greater care, if they perceived that they are being watched, particularly by figures of authority (Cialdini, 2003). To receive a message communicating a patient's overdose death from the medical examiner would have particular weight. This intervention led to reductions in high-intensity prescribing, reductions in the likelihood that an opioid-naïve patient would receive a prescription, and a reduction in overall cumulative opioid intake (Doctor et al., 2018).

D. Plan-making

Plan-making can also make adherence more salient. Milkman et al. (2011) designed a field experiment to test whether suggesting that individuals write down when they intended to get an influenza vaccine (thus making it more salient) increased rates of vaccination. This approach aligns two behavioral tools frequently used together to promote better behaviors regarding NCD management, namely mental contrasting with implementation intentions (MCII). During mental contrasting, people first are prompted to indicate a wish (what they want to achieve) and then to imagine what fulfilling that wish would feel like. This is followed by an identification of the obstacle(s) to fulfilling the wish in present reality, and by the identification of a plan to address such obstacles (e.g., a wish to be healthier to be able to play with a grandchild, obstructed by a lack of regular exercise today, that would be tackled by a daily walk after lunch). By focusing on the motivation factors -wish and outcome of the wish- and identifying an obstacle and plan to address it that is under the individual's control, effort toward the desired future is strengthened (Oettingen et al., 2001; Oettingen, 2015). The technique has been shown to reduce drinking (Wittleder et al., 2019), improve healthy food consumption (Loy et al., 2016), increase physical activity and weight loss (Marquardt et al., 2017), and

reduce smoking (Mutter et al., 2020). Stadler, Oettingen, and Gollwitzer (2009) found that women who used MCII doubled their amount of weekly moderate-to-vigorous physical exercise (about one hour more per week) and that the effect was sustained for four months.

E. Reminders

To tackle limited memory and forgetfulness, electronic reminders are increasingly being used by the health system to address poor medication adherence and appointment attendance rates. These reminders alert individuals by either providing an auditory or visual reminder or by sending an automatic electronic message such as a text message (Kessler & Zhang, 2014). A randomized evaluation in Cordoba, Argentina, found that sending this kind of reminder significantly improved attendance at appointments (by 29.4%), an increase from 50.6% (control group) to 65.5% (experimental group) ($p < .05$) (Bonino et al., 2020). A study in Australia showed that a scheduled reminder intervention through telephone calls improved attendance by 16.3% (Ritchie et al., 2000). Another investigation evidenced a 17.6% increase in the rate of attendance at scheduled controls among outpatients of an endoscopy clinic who received reminders (Lee & McCormick, 2003).

Alternative reminders such as personal phone calls can increase adherence but often require costly time investment and personal commitment from health care providers. Some studies have compared the effects of different technologies for sending shift reminders. Results indicate that text messages, telephone calls, and even reminders made in person present similar rates of reduction in absenteeism (Perron et al., 2013; Mugo et al., 2016). Vervloet et al. (2012) review 13 randomized control trials that test the effectiveness of different electronic reminders for increasing adherence to various types of chronic medication. They find evidence suggesting that electronic reminders encourage medication adherence in the short run (less than six months) but are less effective over the long run. Furthermore, effectiveness can vary across medications for a given type of electronic reminder. While text messages are an effective tool for increasing adherence among adult patients with HIV (Hardy et al. 2011, Pop-Eleches et al., 2011) or children requiring influenza vaccinations (Stockwell et al., 2012), they have mixed effects on adherence for women taking oral contraceptives (Hou et al., 2010; Castano et al., 2012).

F. Choice architecture

A favorite approach for behavioral economists to mitigate present bias is simply to remove the temptation from one's choice set, or to make the healthy and unhealthy options equally convenient. Choice architecture refers to the practice of influencing choice by "organizing the context in which people make decisions" (Thaler et al., 2013, p. 428). A systematic review by Blaga et al., (2018) found 10 studies that employed choice architecture to improve nutrition by making changes to serving lines, vending machines, or by indicating healthful and unhealthful foods using traffic-light-like labels. Like salience, all these adjustments change the environment in which people make health-relevant choices and should be considered as community-level interventions within the framework presented, in comparison to many of the individual-level ideas described above.

Another study looked at the use of portion control plates for dispensing meals to obese patients in Canada. Anchoring patients on smaller plate sizes resulted in a significantly greater weight loss and less need for

diabetes medications after six months among those assigned to the intervention group versus a control group that was given the usual care, or dietary teaching (Pederson, Kang and Kline, 2007).

Anchoring bias has also been used to encourage healthier shopping at grocery stores. In a study in grocery stores, researchers put a piece of duct tape across the top of shopping carts with a sign indicating that fruits and vegetables should go in front of the tape and behind was reserved for everything else. Fruit and vegetable sales more than doubled without affecting the store's profitability (Bannister, 2010).

Similarly, another study included the design of a menu featuring healthful options on the front page and unhealthy options at the back of the menu (Downs et al., 2009). This treatment harnessed the status quo bias by making the healthy options the implicit default, given that one had to look in the back of the menu to find the unhealthy fare. Those who received the menu highlighting healthy fare were 48 percent more likely to purchase a low-calorie sandwich relative to the standard menu that had a mix of healthy and unhealthy options. A third group was given a menu that highlighted unhealthy fare, and as a result they were 47 percent less likely to purchase a low-calorie sandwich. The results suggest that highlighting the healthy options can improve people's chances of selecting more healthful fare.

In the field of suicide prevention, changes in the choice architecture have been implemented to deter paracetamol overdose. In 1998, the UK changed its laws on paracetamol packaging, making it illegal for pharmacies to sell the drugs in large containers. This change in legislation presented only a small barrier, as people could still buy packs in other outlets. Nonetheless, friction costs led to an estimated 43 % reduction in suicides in the 11 years following the introduction of the legislation (Hallsworth et al., 2016b).

VII. Conclusion

This paper proposes a framework for integrating insights from behavioral science into policies aimed at reducing NCDs and improving healthy longevity. As NCDs become a key focus of global health policy, a framework and toolkit for understanding the role of various behavioral biases and barriers become crucial to designing effective interventions that produce lasting impacts. Despite existing knowledge regarding the magnitude of the link between behavioral habits, NCD risk factors, and disease prevention, it remains the case that a large share of deaths can be attributed to behavioral risks.

The framework presented in this paper has aimed to clarify the relationship between individual behaviors and the achievement of healthy longevity through entry points at the individual, community, and health systems levels for the three main stages of the NCD journey: formation, detection, and management. The paper used this framework to unpack the main behavioral barriers identified for each of these levels and stages. It then documented how behaviorally informed policies—for instance involving framing, timeliness, motivation, or future focus—can support healthy longevity. The central insight from behavioral science lies in identifying the obstacles and barriers that constrain people's ability to realize their aspiration toward healthy aging, whatever the form of the subsequent optimal policy. This paper has outlined a framework and roadmap for diagnosing these underlying issues. The policy toolkit then proposes key areas of intervention that can be used across NCDs to reduce their formation, improve their detection, and ameliorate their management, and that can be adapted to different population groups.

While different groups in different contexts are likely to benefit from different interventions, and in some sense, this is especially true for behaviorally informed policies, it is still the case that the fundamental insights, and many of the corresponding barriers, are universal. All humans care about what others think of them, even if the specific reference class (peers, religious leaders, or other categories) varies by age and culture. One implication is that most of the biases discussed, as well as the impacts of targeted programs, do not differ greatly by gender or income, for example. That said, women may be especially receptive to interventions based on aspirations (for themselves or their children), while men are especially unlikely to seek health care and may need additional support in that domain.

Finally, it is worth facing the fact that all interventions, behavioral or otherwise, involve making tradeoffs and considering opportunity costs; this is particularly true in resource- and capacity-constrained settings across much of the world. Fortunately, many behavioral ‘nudges’ can be implemented essentially for free, making them even more relevant in such contexts. This still requires the capacity to take the initiative and to know what to do, for which there are existing sources of external support (such as the World Bank’s eMBED team) but also a growing number of internal units (see OECD [Interactive BI Unit Map](#)). Behavioral organizations exist at either the national or sub-national level in Brazil, Chile, Colombia, India, Lebanon, Peru, South Africa, Tanzania, Tunisia, and Zambia – among others. It should be reiterated that all these policy approaches can be viewed as complements to, not substitutes for, traditional approaches (Bryan et al. 2017). Behavioral measures are often used to build on or leverage existing frameworks, which can therefore ease their adoption from both a financial and political perspective.

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Annex 1

Table 1. Summary of Behavioral Economics Concepts

Concept	Definition	Example
Present bias	Tendency to value instant gratification more than future benefits	Patient decides to consume an unhealthy but delicious meal now despite knowing that it contributes to poor health outcomes in the future
Time inconsistency	Tendency to be impatient when choosing between receiving benefits today and receiving them in the future, but patient when choosing between benefits at two different moments in the future	
Intention-action gap		Patient understands the importance of symptom monitoring but does not do it

Overconfidence	Overestimation of own performance and overplacement of own performance relative to others.	Patient understands that exercise is beneficial, but that knowledge fails to lead to increased physical activity
Over-optimism	Tendency to underestimate the probability of negative events and overestimate the probability of positive events.	
Availability heuristic	Tendency to judge the probability of a future event occurring based on the ease with which an occurrence of such an event comes to mind	Patient immediately following the death of an overweight friend from a heart attack may be more likely to eat healthier, but over time, as the recency and vividness fades, such habits dissipate.
Cognitive dissonance	Tendency to often hold contradictory opinions	People smoke even though they have read countless times that it is dangerous. This self-contradiction causes dissonance, so people need to develop cognitive tools to justify the contradiction. For example, by overly exaggerating how much pleasure they get out of smoking underestimating the future costs
Loss aversion	Loss causes distress that is greater than the happiness caused by a gain of the same size	
Endowment effect	The overvaluation of a good when we possess it	
Framing effects	Tendency to draw different conclusions depending on how the information is presented	Food options or incentives can be presented in a way that highlights the positive or negative aspects of a decision, leading an option to be perceived as more or less attractive
Anchoring	An initial exposure to a certain number or attribute serves as point of reference and impacts subsequent judgements	When faced with a decision under uncertainty, individuals attribute too much weight to the initial exposure, which, without further awareness, distorts estimates and judgements
Cognitive overload (choice and decision fatigue)	The cognitive load is the amount of mental effort and memory used at a given moment in time. Overload is when the volume of information or choices provided exceeds an individual's capacity to process it.	
Social norms	The unwritten rules governing behavior within a society	
Peer effects	The influence exerted by a peer group on its individual members to fit in with or conform to the group's norms and expectations	
Stigma	The negative social attitude attached to a characteristic of an individual that may be regarded as a	

	mental, physical, or social deficiency and can lead unfairly to discrimination against and exclusion of the individual.	
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Source: Authors with input from Chang, et al., (2017) ; Emanuel et al., (2016).