Managing Obesity Using the Health Belief Model – A Chronological Approach, A Narrative Review

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Abstract: *We used a chronological approach to examine the evolution of the Health Belief Model (the HBM) in time for predicting the engagement in specific, health-related, behaviors. Our review was grounded in the assumption that health behavior is activated based on relevant perceptions of threat, barriers and benefits, self-efficacy and cues to action in engaging in protective behavior, variables of the conceptual model that formed the main inclusion criteria for the articles included. We search scientific articles from 3 periods of time (1960-1989, 1990-2014 and 2015-2024) that capture the evolution of the model conceptualization and the refining of the methodological approach that applies the model to inform practical public health concerns. Then, we narrow down our aim and assess problematic beliefs, values and attitudes that influence health-related behavior in obesity prevention that aim to serve as a future framework for tailored interventions.*

Key words*:* Health Belief Model, history, obesity, early warning, health-related behavior, perception, protective behavior

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1. Introduction

In times of war, the main cause of disabilities was the armed conflict itself. When returning back in their villages, veterans were recognized by their sufferance, has it been their profoundly changed facial expressions or their physical loss of multiple limbs and sensory organs such as eyes. Unprecedented in scale, The First World War was marked by the usage of new terrifying weapons such as cannons, machine guns and poison gas (Mutilation and Disfiguration | International Encyclopedia of the First World War (WW1), n.d.) and amputations soon became a daily occurrence (Purcell, 2017) of the first war being fought in three dimensions: on land, at sea and in the air (Imperial War Museums, n.d.). In time, with technological advances leading to improved healthcare systems and health status, an increase in food supply and wellness, it was brought to surface a different dimension of war: the incremental increase in the prevalence of non-communicable diseases (NCDs); today, every 30 seconds a lower limb is being amputated somewhere in the world due to Diabetes complications (Bilal et al., n.d.; Complications, n.d.). Obesity, an important and modifiable risk factor, is known as one of the main causes of the increase in the prevalence and incidence of Type 2 Diabetes Mellitus, recognized as a pandemic of unprecedented magnitude ('Diabetes Is "a Pandemic of Unprecedented Magnitude" Now Affecting One in 10 Adults Worldwide', 2021). It is expected that over 51% of the global population to become overweight or obese in the next 12 years, according to the World Obesity Federation (Chandrasekaran & Weiskirchen, 2024).

It is estimated that in 2022 2.5 billion of people over 18 years old were overweight which represents almost 43% of adults all around the world, while almost 1 billion people were affected by obesity according to the World Health Organization (Obesity and Overweight, n.d.), an increased BMI being recognized as a leading cause of global number of deaths and percentage of disability-adjusted life-years (DALYs) (GBD 2019 Risk Factors Collaborators, 2020). Obesity rates in children raises one of the most important concerns as these children are less likely to perform well in school and later, to complete higher education, according to a report published by OECD in 2019. The same report states that adults affected by obesity encounter difficulties due to lower employment chances and lower performance at the workplace. (The Heavy Burden of Obesity, n.d.). One important issue we are facing nowadays regards also young people becoming unfit to serve their country: 71% of American Youth were not being able to qualify for Military Service in 2018. It is reported also that in 2022 the percentage increased to 77%. The three main reasons were overweight or obesity, educational deficits and criminal or drug abuse records (CDC, 2023)

Worldwide, obesity rate registered an incremental increase: among adults it has more than doubled since 1990, and has quadrupled among children and adolescents (5 to 19 years of age), posing a heavy threat on societies, reducing life expectancy, increasing healthcare costs, decreasing workers' productivity and lowering states' GDP (OECD, 2019).

Tackling obesity requires a multidisciplinary approach as it is a form of social contagion of endemic proportions that does not respect the mode of transmission of infectious diseases and a form of addiction that includes cognitive and emotional components that are difficult to stop by conventional means. The consecutive incremental increase of T2DM prevalence raises healthcare

expenditure, lowering healthcare systems output worldwide. Therefore, a key concept for this emergent problem is addressing modifiable human self-protective – seeking-shelter- behaviors and it requires immediate action (Singer et al., 2021; Wei et al., 2023).

A potential approach to addressing obesity epidemic was born in the 1950s: The Health Belief Model (the HBM), a socio-cognitive conceptual model demonstrating that people tend to adopt a particular behavior when they believe the problem could affect their daily living activities, the intervention will have the expected results, and when there are encountered few obstacles along the path to taking action. (Henshaw & Freedman-Doan, 2009). Based on a socio-cognitive perspective, the HBM's original purpose was to explain why people fail to engage in preventive health-related behaviors for early detection of diseases, patient response to symptoms, and medical compliance (Kirscht, 1972; Rosenstock, 1974, p. 1972; The Health Belief Model: A Decade Later - Nancy K. Janz, Marshall H. Becker, 1984, n.d.) and it evolved towards the potential to serve as a tool in the prevention of infectious and NCDs (Augeraud-Véron & Leandri, 2024; Durham & Casman, 2011; Khaira et al., 2024; Ryan et al., 2024; Subedi et al., 2023; Weston et al., 2018).

Demographic variables (race, age, socio-economic status, etc) are known to contribute to contouring all four core concepts: perceived susceptibility, perceived severity, perceived benefits and perceived barriers, that further on, are thought to be related, in different extents, to a fifth original factor, cues to action, that act as triggers in the decision-making process to accept a recommended health action.

Rosenstock, Strecher, and Becker (1988) further considered a new complementary socio-cognitive component to the HBM (Bauer, 2004; Karl et al., 2022; Rosenstock, 1974; Rosenstock et al., 1988). The sixth core concept, defined as one's perceived ability to achieve a planned goal (self-efficacy), proved to be as valuable as the first four core concepts.

In time, the HBM was used as a tool for influencing behavior change, particularly health-related behavior but it also proved effective in numerous different fields of research: for promoting bicycle safety helmets (WITTE et al., 1993), for the adoption of agricultural specific techniques by farmers for water conservation (Tajeri moghadam et al., 2020), in searching for a useful tool for identifying gaps in cybersecurity behavior (Almansoori et al., 2023) or explaining safety behaviors of terrorism victims (Tade & Nwanosike, 2016).

The aim of this research is to explore how the HBM conceptual model evolved over time in terms of the construct's' evolution as well as in terms of the process of shaping the research methodology. The increased expenditure for public healthcare systems overwhelmed also by the number of patients that access it daily as well as the social contagion dimension of obesity, makes the HBM a necessary tool for tackling this important cardiovascular risk factor.

The articles included are part of 3 main timeframes, marked by different crisis, a progressive increase in global population as well as a change in morbidity and mortality characteristics to gain a better understanding of the future of tailored preventive interventions.

2. Research methodology

For this review we included articles indexed in Google Scholar between 1960 and 2024. The comprehensive electronic literature search included specific keywords and a manual search of the reference lists of eligible studies identified: health belief model, the HBM in time, the HBM history, the HBM origins, obesity, diabetes, cardiovascular, NCDs, preventive behavior, history, path analysis, performance, intervention effectiveness, obesity epidemic, prevention, behavior change, health-related behavior, perception, behavioral, healthcare, health education, early warning, compliance. We used Boolean operators to narrow the list of articles selected. More than 31.700 related articles were identified. From all potentially relevant articles to supplementary contract the vast number of approaches, we manually selected articles that distinctively emphasized the usage of the HBM constructs. The main focus in the selection process was to underline the evolution of the methodological approach. The 29 articles selected were clustered into 3 main timeframes: 1960-1989, 1990-2014, 2015-2024, with references to the theoretical and practical validation of the HBM core concepts in time, descriptive for any of the core concepts, tracing the historical development of the HBM, retrospective or prospective research, observational as well as experimental in design, including references of theoretical and practical implications for obesity and diabetes mellitus prevention.

We excluded articles not using or focusing on the HBM, duplicate in design or methodological approach.

We analyzed the included articles in a comparative manner using a standardized Excel spreadsheet developed for this project by country, sample characteristics, methods used, the definition of the main core concepts of the HBM, the main findings, as well as the theoretical and practical implications.

3. Results and discussions

3.1 Results. In terms of theoretical background, the articles published between 1960-1989 have in common the focus of the HBM on individuals' perceptions and the practical aim of adopting of a preventive behavior, emphasizing the need for a theoretical framework to predict and explain health behaviors (Janz & Becker, 1984; Rosenstock, 1974). All studies selected for this period originated in the USA, had a common purpose related to preventive behavior even if with a heterogenic approach and variation in taxonomy. From all 9 articles selected, 8 were observational research, qualitative as well as quantitative in design (Becker et al., 1974), one was a multitrait-multimethod design (Cummings et al., 1978) and one consisted of a revised explanatory model (Rosenstock et al., 1988). Common variables analyzed were perceived susceptibility, severity, benefits and barriers; cues to action were considered to play a critical role since 1974; self-efficacy was later included aiming for an enhanced approach in understanding and influencing health-related behavior (Rosenstock et al., 1988).

Since the beginning, there was important empirical evidence supporting the HBM dimensions as important contributors in explaining, predicting but also in influencing individuals' health-related behavior (Berkanovic, 1976; Janz & Becker, 1984; Rosenstock, 1974; Rosenstock et

al., 1988). There was also provided a basis for developing brief health belief scales, being found that HBM variables can be measured with a substantial amount of convergent validity using Likert or multiple choice questionnaire items (Cummings et al., 1978). The introduction of the self-efficacy concept opened the door for an optimized approach to understanding and influencing health behavior (Rosenstock et al., 1988). Even with advanced treatment methods, back in the era, an effective control of diabetes was considered primarily dependent upon patient adherence to the recommended treatment (Becker & Janz, 1985). Establishing the framework of the first definitions of the model and of the core concepts, the HBM model is a member of the value-expectancy family, with growing potential in supporting decision-making under uncertainty with education being underlined as bringing a greater ability to cope in the face of a threat (Kirscht, 1974).

The articles between 1990-2014 have in common the research of an operational (Ali, 2002a) HBM model to predict and prevent specific health-related behaviors. All of the 10 articles selected for this timeframe originated in heterogenous countries and cultures (Nigeria, UK, Taiwan, Iran, Arizona, Indiana, Australia) and included an observational research, with a qualitative as well as a quantitative component, one article including a cross-sectional approach (Chao et al., 2012) and two case-control studies (Bayat et al., 2013; Sharifirad et al., 2009). One study was a mixed methods sequential explanatory design (Sui et al., 2013) and one with an ex post facto comparative design (Koch, 2002). Path analysis (Gillibrand & Stevenson, 2006) and hierarchical multiple regression (Bond et al., 1992) were used as analytic methods in the examination of the theoretical model. The variables analyzed included the core concepts (perceived susceptibility, severity, benefits, barriers, cues to action and self-efficacy) as well as perceived intensity (Bayat et al., 2013), threat (Sharifirad et al., 2009), locus of control (S. Cohen, 1997; Gillibrand & Stevenson, 2006), health motivation, social support and knowledge (Ali, 2002b), costs (Bond et al., 1992). As main findings, articles selected for the second period of time, bring to light more evidence that knowledge is not sufficient in influencing behavior and that the HBM core concepts should not be considered in isolation (Adejoh, 2014; Ali, 2002a; Sharifirad et al., 2009). One important aspect highlighted was the limited influence of health professionals in effecting behavior change (Sui et al., 2013), suggesting the cues to action core concept as holding a major impact in the model.

As theoretical background, all 10 studies selected for the 3rd timeframe, 2015-2024, have in common the assessment of the predictive power of the HBM, considered now a pivot tool for tailored educational interventions for influencing preventive behavior.

With roots in different countries and cultures (UK, Iran, USA - North Carolina, Ethiopia, Malaysia, China, Turkey), 4 of the articles included in this timeframe had an observational design (McArthur et al., 2018; Melkamu et al., 2021; Saghafi-Asl et al., 2020; Wills et al., 2015), 3 included a cross-sectional approach (McArthur et al., 2018; Melkamu et al., 2021; Saghafi-Asl et al., 2020), one pretest-posttest quasi-experimental design (Azadi et al., 2021), one study protocol for a randomized controlled trial (Al-Haroni et al., 2024). Also, 4 had an experimental design (Faghih et al., 2024; Komaç & Duru, 2024; Shao et al., 2018; Tamadonpoor et al., 2024) out of which 2 were randomized controlled trials (Faghih et al., 2024; Komaç & Duru, 2024).

One of the studies included a thematic analysis and a psychographic segmentation (Wills

et al., 2015), one article included references for structural equation modeling (Saghafi-Asl et al., 2020). Regression, one-way, two way ANOVA, robust ANCOVA and Bonferroni correction were used to approach multiple comparisons (Azadi et al., 2021; Komaç & Duru, 2024, 2024; McArthur et al., 2018); bivariate and multivariate logistic regression models were used in one cross-sectional article (Melkamu et al., 2021); Friedman analysis of variance and a post hoc Wilcoxon signed-rank test with Bonferroni correction as well as Mauchly's test of sphericity were spotted in one of the articles selected (Komaç & Duru, 2024); Lawshe table was used for content validity analysis and intraclass correlation coefficient was used to assess the stability over time in one article (Saghafi-Asl et al., 2020). Al-Haroni et al. proposed the generalized estimated equation (GEE) to be used to test the effect of the intervention program between and within group at baseline as well as 6 weeks and 2 months following intervention, after adjusting for clustering. Likert scale items and assessing internal consistency with Cronbach's alpha coefficient became widely used.

The variables analyzed in the selected studies included the main core concepts of the HBM (perceived susceptibility and severity – both regarded as perceived threat, benefits, barriers, cues to action, self-efficacy) as well as knowledge, social support, physical activity, BMI, waist-hip ratio, seric uric acid, carbohydrates intake, hepatic enzymes, variables regarding 10 year Framingham CVD risk score.

Hence, the third period is relevant for the increased stability in design and approach and the regular usage of quantifiable research methods for increasing the validity and the predictive power of the conceptual model, with numerous articles highlighting the effectiveness of tailored educational programs based on the HBM in promoting prevention behaviors (Azadi et al., 2021; Melkamu et al., 2021; Shao et al., 2018; Tamadonpoor et al., 2024)

3.2 Discussions. Obesity is reported as a main cause of Type 2 Diabetes Mellitus and a central role is played by the adipose tissue, the liver and skeletal muscle dysfunction (Chandrasekaran & Weiskirchen, 2024) but it is also reported as following a model of social contagion (Datar & Nicosia, 2018), hard to tackle by conventional means. Almost 90% of patients with Type 2 Diabetes Mellitus are classified as overweight or obese (Grant et al., 2021). Nowadays, Diabetes is considered the leading cause of non-traumatic lower limb amputations (Amputation Prevention Alliance | ADA, n.d.), blindness (CDC, 2024) and end-stage kidney disease (Eldehni et al., 2022).

The concern regarding a multidimensional approach to nutrition was underlined earlier through the lens of Kurt Lewin (1890-1947, USA) who described the concept of nutritional gate-keepers (Standford.edu), Jean Tremoliers (1913-1976, France) who's name is related to the institutionalization of French nutrition, the founder of Cahiers de nutrition et de diététique (CND) along with his co-worker, Ioan Claudian (1900-1987, Romania) which was assigned by Dimitrie Gusti back in the era with the mission to establish an open conceptual framework for medicine and sociology (Lepiller & Poulain, 2015). Lepiller and Poulain also bring their contribuition in CND, signaling an increasing gap between nutritional norms and practices as a sign of a loss of legitimacy of the traditional normative apparatus.

Derived from theories in Cognitive Psychology, the HBM was developed in 1950s by social psychologists Irwin M. Rosenstock, Godfrey M. Hochbaum, S. Stephen Kegeles, and Howard

Leventhal at the U.S. Public Health Service and it has been used to design effective interventions for health-related behaviors (Berkanovic, 1976; Kirscht, 1974; Rosenstock, 1974; Rosenstock et al., 1988). Fundamental for this theory are people's beliefs and perceptions regarding health-related behaviors (Rosenstock, 1974; Yoshitake et al., 2019) and one of the key concepts in using the HBM has to deal with intrinsic and extrinsic motivation compiled in cues to action.

Since 1960s, we virtually witnessed the evolution of a paradigm. Since 1984 it was noted the necessity to refine and standardize the tools used to measure the model's components (Becker & Janz, 1985; Janz & Becker, 1984). One common aspect of the main 3 time frames noted was that previous studies showed that perceived susceptibility, benefits, and barriers were consistently associated with the desired health behavior while perceived severity was regarded as less often associated with the desired health behavior (Karl et al., 2022). Also, one noticeble aspect can be considered that , in time, the HBM concept grew in parallel with the performance of quantitative statistical methods.

With the emergence of a new form of threat represented by the heavy impact of the NCDs worldwide (Beaglehole & Yach, 2003), no matter the framework of the healthcare system, because of the change in the morbidity-mortality profile worldwide we can expect a lower output in time (Connolly et al., 2004; Roberts et al., 2013).

In 2021, McGaughey et al. reported that the implementation of Early Warning Systems (EWS) or Rapid Response Systems (RRS) for the prevention of patient deterioration on acute adult hospital wards across ICUs worldwide brought little or no difference in hospital mortality, unplanned ICU admissions, unexpected cardiac or respiratory arrest or length of hospital stay (McGaughey et al., 2021). Also, a systematic review and meta-analysis from 2024 bring to light that neither the EWS, SIRS, nor qSOFA are ideal standalone screening tools for sepsis or prognosticating patients with sepsis (Chua et al., 2024). In agreement with Taleb et al (Taleb et al., 2022), we suggest these results argue in favor of enhancing the usage of age-tested heuristics and low cost operational tools such as the HBM – with potential large pay-offs in terms of the reduction of the multiplicative effects, at the expense of over-optimization, particularly in an environment marked by uncertainty.

From a different perspective, considering a burdened healthcare system as a patient in acute distress, we require further research for tools assisting the prevention of a further rapid deterioration of overcrowded healthcare departments (Burgos-Esteban et al., 2022), tools enhancing a system's capability for an early response, particularly in prevention, functioning as early warning tools that could address the vulnerability posed by NCDs. Obesity is nowadays considered to have devastating consequences and it is expected, as all NCDs, to become a threat to overwhelm healthcare systems with the emerging possibility of people not being able to access treatment or/and immediate care. Over time, perceived benefits and barriers proved to be the strongest predictors in adopting a specific health-related behavior, with proved augmented efficacy in prevention behaviors in comparison with acute disease (Carpenter, 2010; Karl et al., 2022; Sulat et al., 2018), underlining the HBMs pivotal role as a potential early warning tool in prevention. Therefore, we believe the conceptual model has the potential to further be operationalized as a tool used in prediction of treatment adherence long before the first access of the healthcare system and so, used further as a frontline, preparing the system for facing overcrowding.

Concomitantly, studies reported major gaps in the extensive literature regarding also the relationship between educational attainment and obesity (A. K. Cohen et al., 2013) to which the implementation of tools such as the HBM in public policy can contribute.

In Romania, there is an important gap in socio-epidemiological data regarding diabetes and obesity and associated pathology, the latest consistent data being attributed to PREDATORR, an epidemiological study with a stratified, cross-sectional, cluster random sampling design developed by The Romanian Society of Diabetes, Nutrition and Metabolic Diseases (Mota et al., 2016). Nowadays steps towards an electronic platform that could help patients' management are being made. (ORDONANTA 39 31/08/2023 - Portal Legislativ, n.d.). In Romania, Diabetes Mellitus patients requiring subcutaneous insulin regimens, benefit from a 100% compensation of their insulin prescription and there is a fear among healthcare providers that, in the context of the state not being able to cover integrally the costs and, subsequently, as result, the introduction of a co-payment regulation as well as the case of a severe disruption in insulin supply might lead to an increased addressability in Emergency Departments. Recent articles are also upholding these concerns, with a report from Finland where a co-payment system lead to a decreased consumption of necessary medicines (Rättö et al., 2021) as the consequences of rationing insulin are being considered deadly (Lin et al., 2023).

The HBM also has significant limitations despite the growth in complexity: the low predictive capability of the determinants; their small effect size; and the lack of clear rules for combination of the variables and the relationships between them (Orji et al., 2012), with a systematic unidirectional causality between risk perception and individual prevention, disregarding heterogeneity in risk preferences (Augeraud-Véron & Leandri, 2024). Even if the HBM is mostly descriptive rather than explanatory (Jones et al., 2015), used with a proper validated methodology it can be an important tool for the development of tailored interventions with potential focus on the prevention of NCDs (Ali, 2002b; Becker & Janz, 1985; Becker & Maiman, 1980; Cummings et al., 1978; Kirscht, 1974; Koch, 2002; Melkamu et al., 2021; Rosenstock et al., 1988; Wang et al., 2022; Wills et al., 2015)

This review is limited as approach, not aiming to present an exhaustive historical development, but to rather highlight the refinement in the methodological approach of the HBM in time.

It is expected for future technology to further incorporate digital behavior change interventions (Tarricone et al., 2024) or facilitators for enhancing behavior change (such as attention to opportunities for skill development, individualized goal setting, receiving feedback, and enhancing social support) as well as to contribute to precision tailored behavioral medicine (Wong & Monaghan, 2020). Today, patients suffering from Diabetes can choose to manage their glycemic control using continuous or intermittent glucose monitoring systems but in the context of a frail regulatory framework regarding CGM, patients' information might be implied with consequences that are not fully understood (Britton & Britton-Colonnese, 2017). In this context, the HBM proved over time to be a valuable tool also for tackling behavioral cybersecurity risk (Britton & Britton-Colonnese, 2017)

It is mentioned previously in literature that there is a consensus that health promotion programs should be culturally sensitive (Adejoh, 2014; Resnicow et al., 1999). A quasi-experimental

setup from Indonesia, published in 2024, that aimed to evaluate the impact of the mother's role achievement module on breastfeeding, brings as novelty the focus on culturally sensitive tailored interventions based on the HBM, reporting remarkable results, among which we mention a 25% increase in breastfeeding frequency, a 30% enhancement in proper breastfeeding technique (Safaah et al., 2024).

With education and inequality as additional dimensions to social capital (Vâlsan et al., 2023), we raise a different concern regarding the lower expectancy of educational outcomes of obesity children. NCDs are reported to reduce productivity and human capital (Financing NCDs, 2015) and Doh et al described three pathways for how NCDs can emerge as a threat: low productivity and poor economic growth; pressure on public resources and public expenditure; familial burden (Doh et al., 2024). Even if digital communication tools are widely developed and used, it was previously shown that, despite convenience, switching to digital models registered a decrease in students' performance (Vaduva et al., 2022), suggesting the importance of human interaction in the learning process (De Felice et al., 2022) and particularly person-to-person delivery of knowledge. Nowadays, the design of most of the studies using the HBM includes a form of delivery of education, most of the time as face-to-face focus groups and the results are analyzed before and after the intervention. One meta-analysis in 2021 and one randomized controlled trial in 2019 show still inconclusive data for improved results or ineffective mHealth interventions (Boels et al., 2019; El-Gayar et al., 2021).

From our knowledge, this is the first report of the HBM construct's potential as an early warning tool assisting processes addressing NCDs. An earlier study established an early warning model based on Bayesian Belief Network (BBN) to predict the outbreak risk of severe Hand-Foot-Mouth-Disease and death in Hunan province, China (Liao et al., 2018). We also found a different reference regarding early prediction: constructs of benefits and barriers were found to be better predictors of CPAP adherence than the objective severity measures of RDI, BMI and CPAP, with the model being of use in the early prediction (after 1 night) of CPAP acceptance and adherence. (Olsen et al., 2008)

3. Conclusions

Our article, without having an exhaustive approach, aimed at underlining important aspects in the evolution of the HBM model conceptualization and the refining of the methodological approach over time in order to assess the potential addressability of practical public health concerns, focusing on obesity prevention.

The HBM conceptual model is considered an important tool to assist future tailored interventions for obesity prevention and also a potential early warning tool for assisting the enforcing of the preventive capacity of the healthcare system, helping in identifying, quantify, addressing and discouraging health-related risk behavior, from primordial prevention to bedside medical practice and public health concerns

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