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The effects of infographics and several quantitative versus qualitative formats for cardiovascular disease risk, including heart age, on people's risk understanding

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ABSTRACT

Objective: To study how comprehension of cardiovascular disease (CVD) risk is influenced by: (1) infographics about qualitative risk information, with/without risk numbers; (2) which qualitative risk dimension is emphasized; (3) heart age vs. traditional risk format.
Methods: For aim 1, a 2 (infographics versus text) x 2 (risk number versus no risk number) between-subjects design was used. For aim 2, three pieces of information were tested within-subjects. Aim 3 used a simple comparison group. Participants (45–65 yrs old) were recruited through an online access panel; low educated people were oversampled. They received hypothetical risk information (20%/61yrs). Primary outcomes: recall, risk appraisals, subjective/objective risk comprehension. Secondary outcomes: behavioral intentions, information evaluations.
Results: Infographics of qualitative risk dimensions negatively affected recall, subjective risk comprehension and information evaluations. No effect of type of risk dimension was found on risk perception. Heart age influenced recall, comprehension, evaluations and affective risk appraisals.
Conclusion: Infographics of hypothetical CVD risk information had detrimental effects on **measures related to** risk **perception**/comprehension, but effects were mainly seen in undereducated participants. Heart age influenced **perceptions/comprehension of hypothetical risk in a way that seemed to support understanding**.
Practice implications: Heart age seems a fruitful risk communication approach in disease risk calculators.

1. Introduction

Cardiovascular disease (CVD) risk calculators have become common in preventive care [1], but end-users are known to have difficulties in interpreting the results. One problem is that since the results are usually communicated via absolute risk percentages, people have difficulty deriving meaning from such numbers [2,3]. Many studies have concentrated on how to convey risk numbers, e.g. through visual icon arrays and bar graphs. Although such representations do help [4,5], difficulties remain, especially for low-literate people who have trouble interpreting bar graphs [6]. Perhaps as a result, risk numbers are sometimes omitted in risk calculators.

To make informed decisions, it is considered important that people are aware of their risk, which means that they understand both quantitative and qualitative risk dimensions [7,8]. Qualitative dimensions structure how laymen think about risks [7,9,10] and might be important in providing intuitive meaning to risk information. Cameron [10] suggested five key dimensions in risk understanding: *identity* (beliefs about certain characteristics and their risk potential), *causes* (beliefs about risk factors), *timeline* (beliefs about how risk increases/decreases when becoming older), *consequences* (beliefs about physical/psychosocial consequences), *control* (beliefs about personal control and treatment). Regarding CVD risk, we know from previous studies that people

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have knowledge gaps and misconceptions concerning timeline and consequences [11].

Although online risk calculators do provide information about qualitative risk dimensions (e.g., risk factors), this is usually done through much text, which may be ignored or misinterpreted by low-literate people. More sophisticated visualizations such as infographics, typically conveying some narrative [12], might be more appropriate. It is only recently that researchers have begun to explore infographics in risk communication (e.g.,'Visualizing health project' of the Robert Wood Johnson Foundation/University of Michigan Center for Health Communication Research), but much of this work focuses on visualizing *numerical* risk, rather than qualitative aspects. The use of infographics in online health communication more generally has expanded, though [13]. Infographics are embraced because they can rapidly grab attention, simplify complex concepts and connect components of complex concepts. [13,14] Infographics may thus be interesting to connect quantitative and qualitative dimensions in risk communication. Furthermore, if accompanied by numbers or other text, risk information may be processed through multiple information processing 'channels' (i.e. verbal/visual), which can improve information processing [13,15,16]. On the other hand, infographics may result in pitfalls such as wrong salience, distraction, ambiguity and over-complexity [17,18]. Especially among under-educated people who lack experience with visual representations, these problems may occur [14].

Another means to tackle abstract risk numbers may be to use a different numerical concept. Concepts like 'real age' or 'heart age' as numerical metaphor have been attracting growing attention [19–21]. Heart age can be calculated by comparing individuals' absolute risk to the age at which they would reach that risk if they had 'ideal' risk factors [22]. Heart age seems to convey more intuitive meaning than risk numbers; because older age is probably quickly recognized an undesirable outcome. Qualitative work suggests that patients prefer heart age over traditional risk formats, but that risks are still questioned and misunderstood [2,23]. Only a few studies directly compared heart age to traditional risk formats. Soureti et al. [24] demonstrated a graded relationship between perceived and actual risk (suggesting better risk understanding) only in participants who received their heart age and not in participants receiving their 10-year absolute risk. Heart age was also found to be more emotionally impactful among younger participants with higher risk. Bonner et al. [22] compared heart age to 5-year absolute risk and found that heart age was better recalled, but also that it inflated risk perceptions in low-risk participants. Behavioral intentions did not improve when using heart age.

The aim of this study was threefold: (1) to evaluate the effects of using infographics about qualitative risk dimensions either with or without risk numbers (traditional risk percentage with natural frequency) on risk comprehension; (2) to investigate what type of qualitative risk dimension can be best emphasized in infographics: causes, timeline or consequences; (3) to test the effects of heart age – compared with a traditional risk number – on risk comprehension. We focused on how effects differed for people with lower cognitive skills versus higher cognitive skills. A broad range of variables related to risk comprehension was investigated, to be able to assess effects on different aspects of information processing, perceptions and beliefs. This was especially important for infographics because we had no a priori hypotheses as to what variables would be particularly influenced. We expected heart age to positively influence both subjective and objective risk comprehension because with heart age, the risk size and its meaning in terms of good/bad is probably clearer.

2. Methods

2.1. Design

Fig. 1 displays the design. For aim 1, an experimental 2 (infographics versus text, both with qualitative risk information) x 2 (risk number versus no risk number) between-subjects design was used, resulting in four conditions: (1) infographics with a risk number; (2) text with a risk number; (3) infographics only; (4) text only. For aim 2, we evaluated the differences between information within-subjects on: (1) causes of the risk; (2); timeline of the risk; and (3) consequences of the risk. A simple comparison group was used to test aim 3, (heart age versus traditional risk number), in which an additional group of participants was included provided with heart age, accompanied by infographics on qualitative risk dimensions. The total sample was randomized to 5 conditions, with additional randomization of the order in which participants saw three pieces of information (aim 2). All experimental materials were hypothetical, meaning that participants had to place themselves in a hypothetical risk profile and answer questions based on this situation.

2.2. Participants

Participants from the target population of CVD risk calculators were recruited through an online access research panel (FlyCatcher Internet Research, ISO 20252- and ISO 26362-certified). We approached people between 45 and 65 years, the target group for Dutch CVD risk tests [25]. The survey was disseminated among 1347 panel members and the final sample consisted of 727 participants.

2.3. Procedure

Participants received an invitation via email, were randomly assigned to one condition and asked to imagine that provided information was their own result from a risk calculator. Each participant saw three pieces of information presented as either infographic or text. Each piece emphasized either causes, consequences, or timeline of CVD risk and was provided in a random order. After each piece of information, participants answered two questions about risk perception and worry (T = 1, T = 2, T = 3). Finally, participants were shown complete information with the three pieces simultaneously; they then filled out an extended survey (T = 4). Before answering each set of questions, participants were again explicitly instructed to keep in mind the hypothetical result. Participants were thanked for participation and were once again told that the presented risk was not their own risk. In order to allow them to assess their own risk, we provided them with an online link to a Dutch national cardiometabolic risk calculator.

2.4. Materials

Appendix 1 shows the three pieces of information. Text versions were developed by the researchers and corresponded to typical information in CVD risk calculators. Information about the consequences was based on the Dutch Heart Foundation's website. All infographics were designed by a professional designer based on iterative sessions with researchers. Participants in conditions 1 and 2 received basic information stating: *"Your risk of developing CVD within now and the next 10 years is 20%. This means that 20 out of every 100 women/men with the same test result as you will develop CVD within 10 years. Your risk is thus increased."* These risk numbers were accompanied by a visual icon array. The 20% risk was based on the following risk profile in the national risk calculator: someone being aged 56

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