Evaluation of a cardiovascular disease risk assessment tool for the promotion of healthier lifestyles.

ABSTRACT

Background While percentage risk formats are commonly used to convey CVD risk, people find it difficult to understand these representations.

Aims To compare the impact of providing a CVD risk message in either a traditional format (% risk) or using an analogy of risk (Heart-Age) on participants’ risk perceptions and intention to make lifestyle changes.

Methods Four hundred and thirteen men and women were randomly allocated to one of two conditions; CVD risk as a percentage or as a Heart-Age score (a cardiovascular risk adjusted age).

Results There was a graded relationship between perceived and actual CVD risk only in those participants receiving a Heart Age message (p<0.05). Heart-Age was more emotionally impactful in younger individuals at higher actual CVD risk (p<0.01). Self-reported emotional reactions further mediated the relationship between risk perception and intention to make lifestyle changes.

Conclusion This study found that the Heart-Age message significantly differed from % CVD risk score in risk perceptions and was more emotionally impactful in those participants at higher actual CVD risk levels.

Keywords: Risk Perceptions, Risk Communication, CVD, Intention
INTRODUCTION

Cardiovascular disease (CVD) continues to be a leading cause of mortality among adults (Pastor et al., 2002) and physicians find explaining risk a difficult task (Steenkiste van et al., 2007) with the commonly used percentage risk formats (Fair et al., 2008; Gigerenzer & Hoffrage, 1995; Hoffrage & Gigerenzer, 1998; Slovic et al., 2000). A number of studies have shown that representing % risk over the next 10 years (absolute risk) can be falsely reassuring (Marteau & Lerman, 2001; Tymstra & Bieleman, 1987). This is particularly problematic for individuals with low to moderate CVD risk with a number of high modifiable risk factors, e.g. smokers, obese, high blood pressure (Lloyd-Jones et al., 2007).

More concrete risk presentation formats are easier to visualise and have a bigger emotional impact on people (Borgida & Nisbett, 1977). For example, frequencies are easier to understand and imagine than percentages (Slovic et al., 2005; Timmermans et al., 2004) and population figures are more concrete than frequencies when they are shown as human figures or faces (Timmermans et al., 2008).

Alternative formats for risk perception information are analogies such as the ‘Heart-Age’ or ‘Vascular Age’. These analogies combine aspects of absolute and relative CVD risk in a way that could simplify communication in clinical and non-clinical settings (D’Agostino et al., 2008). However, there are only a few research studies evaluating the impact of such analogies on patients (Edwards et al., 1999; Goldman et al., 2006; Grover et al., 2007, Lipkus et al., 2007).

This study compared the impact of % CVD risk with that of a ‘Heart-Age’ risk analogy on risk perception and intention to make lifestyle changes. A secondary aim was to assess whether the emotional impact of these CVD risk messages mediated the relationship between risk perception and intention.
METHODS

Participants

Four hundred and thirteen UK participants were recruited online; 204 were randomly allocated to the Heart-Age message and 209 to the % CVD risk message. The self-report eligibility criteria included; age (30 to 60), either smokers and/or obese (Body Mass Index>29), not diagnosed with a heart-condition or cancer.

Design and Procedures

This was a random stratified, between-groups design. Allocation to the % CVD risk or the Heart-Age communication was stratified to balance by age group (30-45 years or 46-60 years), gender and risk group (smoker or obese).

Participants received a link to one of two websites and filled out information on their age, gender, weight and height, prescribed blood pressure medication, family history of heart and vascular disease, smoking status, self-reported prevalent diabetes, self-reported total and HDL cholesterol levels and systolic blood pressure, their physical activity and eating habits. Both groups were subsequently provided with feedback. Following the presentation of one of the two CVD risk messages participants received brief advice on healthy lifestyle changes. At the end of the study, all participants completed a set of questions and received £5 for their participation.

Interventions

In the present study participants were presented with either a) risk as a percentage chance within the next 10 years or b) as a Heart-Age score message (D'Agostino et al., 2008). This is the age corresponding to someone of the same gender with the same CVD risk level but with normal risk factors. The definition of 'normal' is based on the following profile (not smoking, not diabetic, systolic blood pressure=125mmHg (mid point of normal range; 120-130mmHg), total serum cholesterol=180mg/dL (between normal range of 160-200mg) and HDL cholesterol=45mg/dL. For example, a 61 year old man who smokes and has no other risk factors has a 10 year CVD risk of 10% and the Heart-Age of 73 year old man.
Measurements

**CVD risk perceptions.** The risk perception questions measured participants' perceived risk in an absolute sense and comparative to their age group (Fair et al., 2008). The first item (Q1) looked at perceptions of ‘individual’ CVD risk ('I think that my chances of getting heart-disease in the short-term are...'). The second item (Q2) compared participants’ risk perceptions against other people of their age ('I think that my chances of getting heart-disease before other people of my age are...'). The response options were: low, moderate, high, don’t know/not sure.

**Reactions to the CVD risk communication** items were adapted from a previous study (Gigerenzer et al., 1995). They included cognitive evaluation, such as credibility and confidence in the information received and affective reactions, e.g. 'I felt this was a wake-up call', ‘I found the results worrying'.

**Intention** covered a number of health-related behaviors such as stopping smoking, eating healthier, becoming more physically active, reducing saturated fat intake and starting to eat more fruit and vegetables. Overall intention was calculated by adding together the four items (Cronbach alpha, $\alpha = 0.9$) apart from smoking since only half of the participants were smokers. Intention to change lifestyle questions were assessed on a ‘strongly disagree-strongly agree’ 7 point scale.

**Statistical Analysis**

The distribution of discrete responses to the risk perception questions and participants’ cognitive and affective reactions were assessed by Chi-Square and Fisher’s Exact test respectively. A generalised linear model with multinomial distribution and cumulative logistic link function was used to model the probability of giving a higher score on the risk perception and CVD reaction scales as actual percentage CVD risk increased in the two CVD risk messages. Overall effects of the risk communication on intention were assessed by Fisher’s Exact test on the proportion of participants saying they were intending to make a particular change. Analysis of variance was further used to compare the overall intention score across each level of perceived risk.
The mediating effect of affective reactions was tested by adding the affective reaction variables to the model linking perceived risk to intention to change (Baron & Kenny, 1986).

RESULTS

Participants Characteristics

There were 84 smokers and 125 obese who received the % CVD risk message and 81 smokers and 123 obese who received the Heart-Age message. Women and men were equally distributed in each condition. There were no significant differences between the two groups in terms of their age, BMI, or CVD risk. Table 1 shows the means and standard deviations for these variables split by gender and CVD risk message.

Table 1. Means (Standard deviations) for BMI, Age, CVD risk and Heart-Age in the two CVD risk messages

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% CVD Risk</td>
<td>HA</td>
</tr>
<tr>
<td>AGE (years)</td>
<td>45.90 (7.33)</td>
<td>45.12 (8.11)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>31.10 (6.52)</td>
<td>31.46 (7.51)</td>
</tr>
<tr>
<td>Smokers (%)</td>
<td>60</td>
<td>59.8</td>
</tr>
<tr>
<td>10 year CVD risk (%)</td>
<td>6.38 (4.17)</td>
<td>5.87 (3.82)</td>
</tr>
<tr>
<td>Heart-Age (years)</td>
<td>54.32 (11.91)</td>
<td>52.23 (13.03)</td>
</tr>
<tr>
<td>Heart-Age - Age</td>
<td>8.42</td>
<td>7.11</td>
</tr>
</tbody>
</table>
CVD risk perceptions

There were no significant differences between the two experimental groups in terms of their CVD perceptions (low, moderate or high) for the individual (chi-square = 1.482, p=0.477) or comparative (chi-square = 0.014, p=0.993) risk questions. No significant interaction effects were found between CVD risk message and gender (p>0.05) with regards to risk perceptions. Most participants perceived themselves as having moderate levels of CVD risk for both questions.

The probability of giving a higher score on the risk perception scales increased as actual CVD risk increased. For the ‘individual’ risk question, the regression slope with actual risk was 0.161 for those seeing the Heart Age message (SE=0.052, P= 0.002) and 0.022 (SE=0.037, P=0.558) for those seeing the % CVD risk message. The value of the slope for the Heart-Age message was also significantly larger than that for the % CVD risk (difference=0.139, SE=0.064, P = 0.031) for the individual risk question, indicating that participants’ risk response was more related to the actual level of CVD risk for those seeing the Heart-Age message. For the comparative risk question, the regression model showed slopes of 0.167 (SE=0.051, P = 0.001) for those seeing the Heart-Age message and 0.047 (SE=0.047, P = 0.206) for those seeing the % CVD risk message. The difference between the slopes was 0.120 (SE=0.063, P= 0.057). Table 2 shows the mean CVD risk level for participants giving each of the three possible responses to the individual and comparative risk question.
Table 2. Mean CVD for each level of response of perceived risk susceptibility and actual CVD risk

<table>
<thead>
<tr>
<th>Actual CVD Risk, Mean (SD)</th>
<th>Perceived CVD Risk</th>
<th>% CVD risk</th>
<th>Heart-Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td>7.75 (6.75)</td>
<td>6.79 (5.73)</td>
</tr>
<tr>
<td>Risk (Q1)</td>
<td>Moderate</td>
<td>10.51 (7.74)</td>
<td>9.84 (7.73)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>9.65 (6.04)</td>
<td>14.41 (8.02)</td>
</tr>
<tr>
<td>Comparative</td>
<td>Low</td>
<td>8.00 (6.54)</td>
<td>6.94 (6.86)</td>
</tr>
<tr>
<td>Risk (Q2)</td>
<td>Moderate</td>
<td>9.29 (7.78)</td>
<td>8.62 (6.45)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>10.19 (5.83)</td>
<td>12.13 (8.62)</td>
</tr>
</tbody>
</table>

Reactions to the CVD risk communication.

In both the % CVD risk and the Heart-Age communication, 88% of participants reported high levels of perceived confidence (p>0.05). 74% of participants in the % CVD risk and 79% of subjects in the Heart-Age message perceived the message to be credible (p>0.05). There were no differences between the two CVD risk communications in terms of gender, levels of worry and perceiving the information as a 'wake-up call'.

The multinomial cumulative logistic generalised linear model restricted to the younger participants alone revealed that at higher levels of actual CVD risk, expression of risk as a Heart-Age message led to a significantly higher ‘worried’ response ($X^2=7.77$, p=0.005) than expression of CVD risk as a percentage and increased the likelihood of perceiving the message to be a ‘wake-up call’ ($X^2=4.05; p=0.044$).
CVD risk communication type and intention to change

In terms of intention to stop smoking, 62.6% of participants (who smoked), who saw the Heart-Age communication, agreed that they wanted to stop smoking, compared to 52.0% on the % CVD communication ($P=0.097$). For those who saw the Heart-Age communication, 84.3% intended to eat more healthily and 82.4% were motivated to take more physical activity. On the % CVD risk communication the corresponding percentages were 79.9% and 76.6% ($P>0.05$).

Risk perceptions and intention to change.

Intention to change differed significantly with individual risk perceptions ($Q_1; F=7.03, P=0.001$). Follow-up multiple comparisons using a Tukey adjustment to the significance level, showed that those who reported high levels of perceived risk were more motivated than those with low ($t=-3.74, P<0.001$) or moderate ($t=-2.66, P=0.022$) levels. The same relationship was true for comparative risk perceptions ($Q_2$) and intention to change ($F=5.91, P=0.003$), with a significant difference reported between those of high and low perceived risk ($t=-3.25, P=0.004$) and high and moderate perceived risk ($t=-2.75, P=0.017$). However, the relationships between risk perception and intention did not significantly differ between the two types of CVD risk messages ($P>0.05$).

Mediating effects of emotional reactions

Responses to the items measuring worry and identifying the information as a 'wake-up call' were highly correlated ($r=0.736, P<0.001$). These emotional items ('worry' and 'wake-up call') were significantly correlated with overall intention to change ($r=0.377; P<0.001$ and 0.525; $P<0.001$, respectively). Both items were significantly correlated with participants' risk perceptions ($P<0.0001$) following exposure to the CVD risk messages (Table 3). We therefore tested whether these two responses mediated the relationship between perceived risk and intention to change. The other reaction items were not strongly related to the total intention score with correlations of $r<0.2$ and therefore were not included in the mediation analysis.
Table 3. Relationship between perceived risk and emotional reactions.

<table>
<thead>
<tr>
<th>Spearman Correlation Coefficients</th>
<th>Worried</th>
<th>Wake-up Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>0.459*</td>
<td>0.409*</td>
</tr>
<tr>
<td>Q2</td>
<td>0.418 *</td>
<td>0.387*</td>
</tr>
</tbody>
</table>

*(p<0.0001)

If a mediating effect exists then we would expect the significant relationship between risk perceptions and intention to change to disappear when affective reactions are entered as covariates in the analysis of variance model. In support of mediation, the F test became non-significant when the covariates were entered for both the individual (Q1: F=1.58, P= 0.207) and comparative risk items (Q2: F=0.94, P= 0.393).

DISCUSSION

This study evaluated the impact of a Heart-Age risk analogy on perception of CVD risk. Although there was no significant difference in average risk perception between Heart-Age and % risk communications, perceived risk only increased at higher levels of actual CVD risk for those receiving the Heart-Age message. Moreover, the Heart-Age message was more emotionally impactful than traditional % risk, for younger participants at higher levels of CVD, and emotional reactions mediated the relationship between risk perceptions and intention to change.

Similar results have been reported in the CHECK-UP study, in which a risk profile including cardiovascular age had a greater impact on cholesterol levels for those with worse profiles (Grover et al., 2007). Fair and colleagues (2008 also found relative rather than absolute risk formats generated greater emotional reactions in younger participants probably because younger individuals see absolute risk scores that are too low to be emotionally impactful (Gigerenzer et al., 1995).

Recent research has also demonstrated that % risk scores have only a small impact upon risk perceptions (Gigerenzer & Edwards, 2003; Marteau & Lerman, 2001; Lipkus et
al., 2001; Lipkus, 2007; Woloshin et al., 2011). This may be due to two related problems. Firstly, the general population have difficulties in understanding mathematical concepts (Lipkus et al., 2001; Woloshin et al., 2011) and when presented with small probabilities (i.e. an absolute risk of 5% over 10 years) they tend to underestimate their impact leading to false reassurance (Marteau & Lerman, 2001; Tymstra & Bieleman, 1987).

Furthermore, risk is an abstract concept, whereas a 'heart' which appears older than you may be a much more concrete, easier to imagine and impactful concept. Use of a similar concrete risk analogy 'Lung-Age', which communicates to smokers how 'old' their lungs are, was associated with increased likelihood of maintained abstinence (Parkes et al., 2008).

Our finding that emotions may play a role in mediating the relationship between risk perception and intention is in line with emerging evidence that emotional reactions can influence perception of risk through 'gut feeling' processes that are more intuitive and rapid than cognitive evaluations (Timmermans et al., 2008; Crites et al., 1994, Manstead et al., 1995, Van der Pligt et al., 1998; Zanna et al., 1998; Denes-Raj et al., 1994; Slovic et al., 1994). Further research is required to evaluate the impact of emotions and risk analogies in the promotion of lifestyle changes.

Whereas previous research has used fictitious illnesses and hypothetical scenarios to communicate risk (Fair et al., 2008; Goldman et al., 2006), in our study risk corresponded to participants’ personal characteristics making it more relevant. Participants in our study were also good candidates for lifestyle changes, as they had high prevalence of modifiable risk factors and were on average below the high risk threshold (National Institute of Health and Clinical Excellence, 2008; Wood et al., 2005; NCEP, 2001) needed to promote use of lipid-lowering medication.

Based on the present findings, individuals receiving a Heart-Age message had risk perceptions more in line with their actual risk, and younger individuals at high risk found it more emotionally impactful. Further research is required to identify how to convert modified risk perceptions and emotional responses into lifestyle behavior change.