The Influence of Messaging Strategies and Informed Decision Making on the Intention to Screen for Cervical Cancer

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Abstract

Cervical cancer is the fourth most common type of cancer. Despite the existence of highly effective preventative methods such as cervical cancer screening, research shows a decline in participation in these screenings. This study investigated the effectiveness of loss-gain framing and the messenger effect on increasing the intention to participate in cervical cancer screening, while also investigating the role of perceived ability to make an informed decision. Loss-gain framing refers to influencing decisions by presenting outcomes as positive or negative, and the messenger effect refers to the influence different messenger types have on accepting information. A survey study was conducted ($N = 370$), in which framing (loss- and gain-framed) and messenger (family doctor, public health organization and female role model) were manipulated. Participants received information about HPV and cervical cancer, and screening intention was measured before and after the manipulation. Results show that screening intention increased after seeing the information messages. Neither framing nor messenger type had a significant effect on intention, but there is a significant positive relation between informed decision making and screening intention. Higher perceived ability to make an informed decision is related to higher screening intention. Despite finding mostly nonsignificant results, this study offers important suggestions for future research to improve health communication and increase participation in cervical cancer screening. Implications and limitations are discussed.

Keywords: cervical cancer screening, loss-gain framing, messenger effect, informed decision making

The Influence of Messaging Strategies and Informed Decision Making on the Intention to Screen for Cervical Cancer

Every two minutes, a woman dies of cervical cancer (UNICEF, n.d.). Cervical cancer is often caused by the human papillomavirus (HPV), a sexually transmittable virus that nearly everyone gets at some point in their lives (Rijksinstituut voor Volksgezondheid en Milieu [RIVM], 2026a). Usually, the body clears the virus on its own, but when that fails, it can develop into cervical cancer. The Dutch government offers preventative measures for cervical cancer: a vaccine against HPV that decreases the chances of getting cervical cancer, and routine cervical cancer screening. Screening can detect signs of cervical cancer in early stages, making it easier to treat. Dutch women are invited for a cervical screening every five to ten years from the ages of 30 to 60 (RIVM, 2026a). Cervical cancer is most common in women aged 30 to 45, but research shows that 30 year old women are least likely to get cervical cancer screenings in the Netherlands (RIVM, 2026b). Since 2018, the Netherlands has seen a decline in participation in cervical cancer screening for all ages (RIVM, 2023; Van Stigt et al., 2025; RIVM, 2025b). World Health Organization (WHO) has an elimination initiative for cervical cancer, striving to have 70% of 35 year old women screened by the year 2030 (World Health Organization [WHO], n.d.). The most recent report shows that in 2024, 53.3% of women aged 35-40 years have been screened (RIVM; 2025b), highlighting the need to increase participation in cervical cancer screening.

Given that most cervical cancer cases can be prevented through screening, this study aims to identify how messaging strategies can increase the intention to participate in cervical cancer screenings among Dutch women, while also looking at the role of the perceived ability to make an informed decision.

Message Framing

The term *framing* refers to the way a message is presented to an audience (Steffen & Cheng, 2021). One type of framing is loss-gain framing: framing information as positive (gain) or negative (loss) can influence the likelihood people will accept the information (Hameleers, 2021). Loss-gain framing is based on prospect theory (Kahneman & Tversky, 1979), which states that people's tendency for risk-seeking behaviour can be influenced by how the outcome is framed (Kahneman & Tversky, 1979; Rothman et al., 2006; O'Keefe & Jensen, 2009; Hameleers, 2021). The extent to which a behaviour is considered high or low risk depends on how unpleasant people expect the outcome to be (Rothman et al., 2006). When the outcome of a decision is framed as a possible loss ('by doing x, you risk getting unpleasant outcome y'), people tend to behave more risk-seeking than when it is framed as a possible gain ('by doing x, you have a chance at pleasant outcome y').

Part of the research on loss-gain framing has focused on its use for promoting health behaviour. Health behaviour can be distinguished into illness detection behaviour, such as screening, and prevention behaviour, such as vaccinations (Kim, 2024). Illness detection behaviour is often perceived as risky, as the outcome may reveal serious health issues. Cancer screening is one type of illness detection behaviour that is often perceived as high-risk behaviour (Rothman et al., 2006; O'Keefe & Jensen, 2009; Gallagher et al., 2011; Kim, 2024). Following prospect theory, loss-framed messages are likely to be more effective in promoting illness detection behaviours than gain-framed messages (Rothman & Salovey, 1997; Edwards et al., 2001; Rothman et al., 2006; Bartels et al., 2009; Ainiwaer et al., 2021; Steffen & Cheng, 2021). Several studies support this hypothesis.

Other studies contradict these findings and report no significant differences between the effectiveness of loss- and gain-framed messages on health behaviour (Hastall and Wagner, 2017; Ogden et al., 2021). Despite reporting a small, statistically significant advantage for loss-framed messages in promoting breast cancer screening, O'Keefe and Jensen (2009)

concluded loss-framed messages are unlikely to significantly increase health behaviour. However, cervical cancer screenings were not included in their study, and therefore this meta-analysis cannot draw conclusions on the effect of loss-framed messages on cervical cancer screening. These inconsistent results highlight the importance of testing the effectiveness of loss-gain framing on cervical cancer screening specifically.

Messenger Effect

Another strategy to increase effectiveness in communication is messenger type, which will be referred to as the *messenger effect*. The general goal of an argument is changing one's attitude on a topic, for example about health behaviour. An attitude is described as a general evaluation of a person, object or issue (Petty & Cacioppo, 1986). Whether an attitude changes depends on the argument and to what extent the receiver elaborates on the information. The term 'elaboration' describes the way a person thinks about arguments. The elaboration likelihood model (ELM; Petty & Cacioppo, 1986) offers an explanation on the messenger effect through elaboration, by distinguishing two routes of information processing. In the central processing route, when elaboration likelihood is high, people critically evaluate information. When elaboration likelihood is lower, the peripheral route is often used, and people rely more on peripheral cues than the content of the message. Examples of peripheral cues include positive or negative affect, attractiveness of the source, source credibility and the number of arguments. These factors can influence the likeliness that information is accepted when the receiver does not elaborate on the information. According to Issaka et al. (2025), credibility, attractiveness and perceived knowledge of the source are also associated with higher likelihood of engagement in the behaviour. Another explanation for the messenger effect is given by the source credibility model (SCM; Hovland & Weiss, 1951), which states that the perceived credibility of the source influences how a message is interpretated.

Information by sources with high credibility is more often accepted than information by sources with low credibility.

To maximize the advantages of the messenger effect, it is important to determine which messenger is most effective in increasing participation in cancer screening. Literature on the messenger effect and participation in cervical cancer screening in particular is sparse, and no type of messenger has been identified as most effective. On one hand, doctors are argued to be effective messengers to share health information, since doctors are often perceived as credible sources for health information (Tacken et al., 2006; Yang & Beatty, 2016; Fishman et al., 2017; Lee et al., 2024). According to the SCM, messages by doctors should therefore be more effective in increasing screening participation. Public health organizations are also perceived as credible, and more trustworthy than individual laypeople (Trivedi et al., 2020; Favero et al., 2021). However, other research suggests role models can be effective in sharing health information (Aldoory, 2001; Fishman et al., 2017). Women reported that a topic should be personally relevant to them to be able to retain the information and reported feeling more involved when the source was credible, attractive or similar to themselves (Aldoory, 2001). Furthermore, invitations for cervical cancer screening that were personalised, for example invitation letters from a general practitioner, were more successful in increasing participation in cervical cancer screening than standardized invitations (Staley et al., 2021). These findings are in accordance with the similarity-attraction hypothesis (Byrne, 1971), which states that individuals prefer to compare themselves with people that are like them. To summarize, a family doctor, a female role model and a public health organization can be effective messengers in health communication, but as of yet, no messenger has been identified as most effective in promoting cervical cancer screening.

Informed Decision Making

Several studies mentioned lack of awareness or knowledge as a barrier to cervical cancer screening (Brook-Rowland & Finlay, 2022; Verberckmoes et al., 2024; Rezapour et al., 2025; Shpendi et al., 2025), suggesting that increasing knowledge about screening could improve participation. In a study by Tacken et al. (2006), most women who did not participate in cervical cancer screening believed cervical cancer could not be cured. Another study on increasing HPV testing showed that receiving a message with general information on HPV testing increased the intention to participate (Ogden et al., 2021). This supports the statement that having more knowledge could increase participation intention. A systematic review by Zhang et al. (2022) showed that educational programs about cervical cancer screening could increase participation. Hubert et al. (2025) argue that informed decision making in the context of cancer screening consists of having sufficient knowledge about the procedure, and consistency between the intention and actual participation. They found that personalizing messages significantly increased knowledge, implying that personalised messages could be more effective in increasing participation in cancer screening than standardized messages. There is a gap in the literature on the relationship between loss-gain framing and informed decision making, highlighting the need to investigate this relationship.

Research Goal and Hypotheses

The research question for this study is: how can messaging strategies influence the intention to participate in cervical cancer screenings, and what is the role of the perceived ability to make an informed decision? This study will look at loss-gain framing, and three types of messengers: a family doctor, the Dutch national health institute (RIVM) and a female role model who is vaccinated against HPV and intends to participate in cervical cancer screening when she is invited. The goal is identifying how health messages can be formatted to maximize their effectiveness and thereby increase screening intention. A secondary aim is

increasing understanding of the role of perceived ability to make an informed decision on cervical cancer screening participation.

Given that the primary goal of cervical cancer screening is detecting abnormalities that can indicate cervical cancer, the screening is likely to be perceived as high-risk behaviour (Rothman et al., 2006). Based on prospect theory, people will take more risks when facing possible losses, such as not detecting cervical cancer (Kahneman & Tversky, 1979). Therefore, the first hypothesis is that loss-framed messages will have a stronger effect on screening intention than gain-framed messages.

Literature shows that a family doctor, public health organization and female role model can all be effective messengers in health communication (Yang & Beatty, 2016; Trivedi et al., 2020; Aldoory, 2001). Because the study by Issaka et al. (2025) showed that credibility, attractiveness and knowledge on the topic is important for cancer preventative behaviour, the second hypothesis is that a family doctor has a stronger effect on screening intention for cervical cancer than a female role model and the RIVM. Additionally, the female role model is expected to have a stronger effect than the RIVM, since women reported feeling more involved when the messenger is similar to them (Aldoory, 2001) and messages are personalized (Staley et al., 2021).

For the second part of the research question, an explorative hypothesis was formulated based on the literature about informed decision making and its effect on screening intention. The third hypothesis is that informed decision making mediates the relationship between messaging strategies and screening intention. Informed decision making is found to be associated with screening intention, but no studies have investigated the effect of loss-gain framing on informed decision making. This study explores a possible mediating relationship between loss-gain framing, informed decision making and screening intention. As personalized communication can increase knowledge about cancer screening (Hubert et al.,

2025), the expectation is that the effect of a doctor and female role model will be mediated by informed decision making, since these are personal messengers. No mediating effect for the RIVM is expected.

Methods

Participants

A total of 435 participants took part in this study. All participants had to be between 18 and 29 years old and be biologically female. After receiving the data, 65 participants were removed due to one of the following reasons: not meeting the screening criteria ($N = 3$), no consent for using their data ($N = 4$), not answering the main question about intention ($N = 40$) and participating multiple times ($N = 18$). When participants took part multiple times, only the first try was used if the data was valid. One participant gave nonsensical answers on the first attempt (all 1), and 'normal' answers on the second attempt. Since this participant might have seen two different manipulation conditions, all data of this participant was removed. After the data cleaning procedure, 370 participants remained (see Appendix A), of which 292 were first-year students at the University of Groningen, and 78 were non-first year students who were recruited through a paid recruitment platform set up by the University of Groningen. Of all participants, 265 were vaccinated, 58 were unvaccinated and 47 participants were unsure. There were 209 participants who completed the questionnaire in Dutch, and 161 participants who completed it in English.

Research Design and Procedure

This study was part of a combined bachelor thesis project, which used a randomized 2(framing: loss vs gain) x 3(messenger: doctor, RIVM, female role model) design to test the effects of loss-gain framing and different messengers on the intention to participate in cervical cancer screening, and the willingness to recommend the HPV vaccination to others. This particular study only focused on screening intention. Every respondent was individually

randomized and assigned to one framing condition and one messenger condition. The survey could only be completed online, using the survey tool Qualtrics, and could be completed in both Dutch and English. The survey started with an informed consent page, which included a description of the study, its purpose, and a consent form. Two screening questions followed. If participants did not meet the criteria, the survey automatically ended. If participants met the criteria, they continued to the primary questions. They then were shown the manipulation messages, followed by general information on cervical cancer and HPV. After this, the same primary questions were asked as a post-measure, and the survey continued with secondary questions. At the end of the survey, participants were debriefed, in which they received information on the study and manipulations. All secondary questions were asked after the manipulations and primary questions to ensure the secondary questions could not influence the primary outcomes. The complete survey contained 44 questions, of which six were used in this study. All parts of the survey that are relevant to this study are shown in Appendix B, in the same order it was presented to participants.

Data collection went semi-anonymously. First-year students had to provide an ID-number to collect their course credits, and paid participants had to provide an email address to collect their payment of €2.00. All IDs and email addresses were only accessible for the supervisor, not for students analysing the data. This study was approved by the Ethics Committee of the Faculty of Behavioural and Social Sciences of the University of Groningen (PSY-2526-S-0018).

Measures

Loss- and Gain-Framed Messages

To evaluate the effect of message framing, participants read either a loss- or gain-framed message, as shown in Table 1. The messages were designed for this study, based on publicly available health information (RIVM, 2025a; RIVM, 2025c). The loss-framed

message emphasizes the risks of not vaccinating and not participating in cervical cancer screening, while the gain-framed message emphasizes the protection an individual receives from participating in these preventative behaviours. According to the hypothesis, confronting participants with the risks of not participating would lead to more risk-seeking behaviour and thus increase screening intention, compared to the gain-frame condition.

Table 1

Framing Messages

Loss-framed:	"By not being vaccinated you may put yourself at risk for contracting HPV and increase your risk of developing cervical cancer. Even if you are vaccinated, by not participating in screening you risk detecting cervical cancer at a larger stage, when it is harder to treat."
Gain-framed:	"By being vaccinated you may protect yourself against contracting HPV and decrease your chance of developing cervical cancer. Even if vaccinated, by participating in cervical cancer screening you can detect cervical cancer as early as possible, when it is easier to treat."

Messengers

The second manipulation was the use of different messengers: a family doctor, the RIVM or a 20-year-old woman who is vaccinated and plans to participate in cervical cancer screening. These messengers were used to represent an expert who is either more personally involved (the family doctor) or who works on a national level (the RIVM), or a messenger who is similar to the participants (female role model). These messages were similar in content (Table 2).

Table 2

Messenger Texts

Family doctor:	"Family doctors encourage all women to get the HPV vaccine and participate in cervical cancer screening when invited."
RIVM:	"The RIVM (Dutch National Institute for Public Health and the Environment) encourages all women to get the HPV vaccine and participate in cervical cancer screening when invited."
Female role model:	"Sarah, a 20-year-old woman who is vaccinated against HPV and intends to participate in cervical cancer screening, encourages all women to get the HPV vaccine and participate in cervical cancer screening when invited."

Manipulation and Attention Checks

The survey included two questions to measure the effectiveness of the manipulation: (1) "Who gave the recommendation you just saw?" (1 = *Doctor*, 2 = *RIVM*, 3 = *Another woman*, 4 = *I don't know*) and (2) "What was the message about?" (1 = *HPV*, 2 = *Cervical cancer*, 3 = *Cervical cancer and HPV*, 4 = *I don't know*). The general information was about cervical cancer and HPV, so the third option was correct. Another item served as an attention check to test the reliability of the data: "If you are still paying attention, select 'might or might not' for this question" (1 = *Definitely not*, 2 = *Probably not*, 3 = *Might or might not*, 4 = *Probably yes*, 5 = *Definitely yes*). This question was added in a question matrix near the end of the survey. There was no manipulation check for the framing effect, since this effect works subconsciously. A manipulation check could interfere with this subconscious effect.

Intention

To evaluate screening intention, this study used one item from a study by Tacken et al. (2006). Participants were asked to what extent they agreed or disagreed with a statement on a 5-point Likert scale (1 = *Strongly disagree*, 5 = *Strongly agree*). The statement was: "If I get an invitation for cervical cancer screening in the future, I will certainly attend." The item was administered twice.

Informed Decision Making

To assess the perceived ability to make an informed decision, a new item was created, in which participants were asked to what extent they agreed or disagreed with the following statement: "I feel I have enough information to make an informed decision about participating in cervical cancer screening." The item was assessed with a 5-point Likert scale (1 = *Strongly disagree*, 5 = *Strongly agree*).

Statistical Analysis

To analyse the effects of framing and the messenger, a mixed Analysis of Variance (ANOVA) was performed using IBM SPSS Statistics 29.0.1. This model allows testing both the within-subjects effect of time, which compares the pre- and post-measure of screening intention, and the between-subjects effects of framing and messengers, which compares between conditions. It also tests the interaction between both framing and messenger type and the change in intention over time. Before starting the analysis, the assumptions of the model were checked.

To test the third hypothesis, looking at the perceived ability to make an informed decision, a mediation analysis was performed using PROCESS Macro for SPSS (Model 4; Hayes, 2022). Two mediation models were analysed, first using framing as independent variable, then using messenger type as independent variable. The dependent variable was the post-measure of intention, and informed decision making was the mediation variable. A one-way ANOVA revealed no significant differences between conditions on the pre-measure of

intention, leading to the decision not to include it as a covariate. To interpret the results, 95% confidence intervals were generated using bootstrapping with a sample of 5.000.

Results

Assumptions

First, the assumptions of the mixed ANOVA model were checked (see Appendices C and D for a full overview). Most assumptions for the mixed ANOVA were met: the dependent variable is measured at a continuous level, the within-subjects factor has two related groups, the between-subjects factors have two and three independent groups, there are no significant outliers, there is homogeneity of variances and the assumption of sphericity is met. Only the assumption of normality of data was violated: the Shapiro-Wilk test is significant ($p < .001$) and a Q-Q plot shows a non-normal distribution (Figure D2). The data was left-skewed for both the pre- and post-measure of intention (Figures D3 and D4), meaning the average intention was relatively high. ANOVA is quite robust to violations of normality in cases of large sample sizes, so the decision was made to use ANOVA ($N = 370$). It is important to keep the violation in mind while interpreting the results.

The assumptions for a mediation analysis include a linear relationship between variables, a normal distribution, homoscedasticity, no autocorrelation, no multicollinearity and no significant outliers. Again, all assumptions except normality are met (see also Appendices C and D). The violation of normality should be kept in mind, but as this study has a large sample size ($N = 370$) and bootstrapping is used, it is unlikely the violation will strongly influence the results.

Manipulation and Attention Checks

Analysis showed that 114 participants (30.8%) failed the manipulation check about the messenger, 83 participants (22.4%) failed the manipulation check about the topic, and 12 participants (3.2%) failed the attention check. A Mann Whitney U test was conducted three

times to compare the groups that failed the checks with the groups that passed. There are no significant differences in intention scores for all checks on both the pre- and post-measure (Table 3). Based on these results it was concluded the whole sample could be used in further analysis.

Another Mann-Whitney U test was used to compare the perceived ability to make an informed decision between those who passed and those who failed the attention check. No significant differences were found, providing no evidence that whether participants passed the attention check is related to their perceived ability to make an informed decision in this study (Z = -0.625, p = .532).

Table 3

Mann Whitney U Test Results

	Intention pre-measure Z (p)	Intention post-measure Z(p)
Messenger check	-0.09 (.928)	-0.47 (.458)
Topic check	-1.57 (.117)	-0.79 (.431)
Attention check	-0.72 (.471)	-0.66 (.508)

Descriptive Statistics

Table 4 shows the descriptive statistics of screening intention for all experimental conditions, as well as descriptives for the perceived ability to make an informed decision. Considering screening intention was measured on a 5-point Likert scale, the overall means are relatively high. The distribution of scores on perceived ability to make an informed decision is shown in Figure 1.

Table 4

Descriptives for Screening Intention per Condition and Informed Decision Making

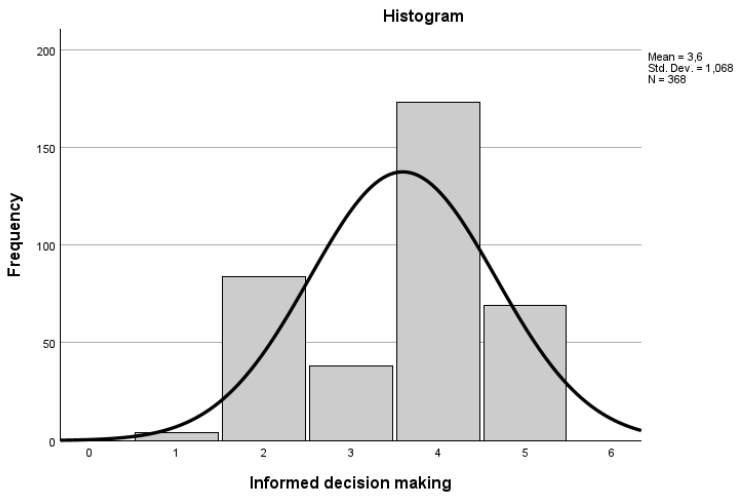
	N	Pre-measure *M (SD)*	Post-measure *M (SD)*
Loss-frame	185	4.04 (1.15)	4.52 (0.84)
Gain-frame	185	4.10 (1.17)	4.45 (0.98)
Doctor	129	4.09 (1.16)	4.53 (0.87)
RIVM	124	4.07 (1.16)	4.52 (0.90)
Female role model	117	4.03 (1.17)	4.39 (1.00)
Informed decision making	368	3.60 (1.07)[a]	

Note. N = Total number of participants, *M* = Mean, *SD* = Standard deviation.

[a] This variable was measured only once.

Figure 1

Distribution of Scores for Informed Decision Making



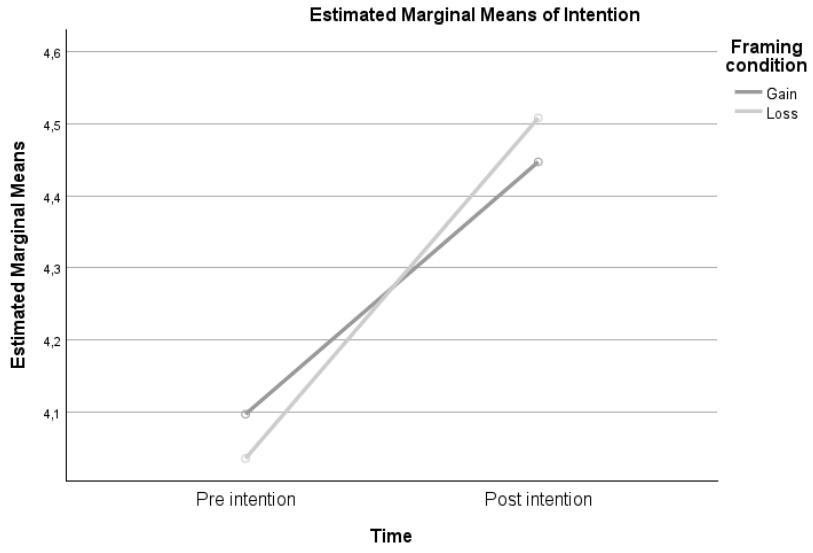
Mixed ANOVA Results

The mixed ANOVA revealed a statistically significant effect of the within-subjects factor time ($F(1, 364) = 68.36$, $p < .001$, $\eta_p^2 = .16$), with a mean difference of .41. Screening intention was nearly half a point higher after reading the manipulated messages and general information.

On the effect of loss-gain framing, this study found no statistically significant between-subjects effect ($F(1, 364) = .00$, $p = .997$, $\eta_p^2 = .00$), meaning there is no difference in average intention scores of both framing groups. No statistically significant interaction-effect between framing and time is found either ($F(1,364) = .69$, $p = .219$, $\eta_p^2 = .004$), meaning the change in intention does not differ significantly between conditions. The estimated marginal means for both conditions over time are shown in Figure 2. These results reject the first hypothesis.

Figure 2

Marginal Means of Framing Conditions



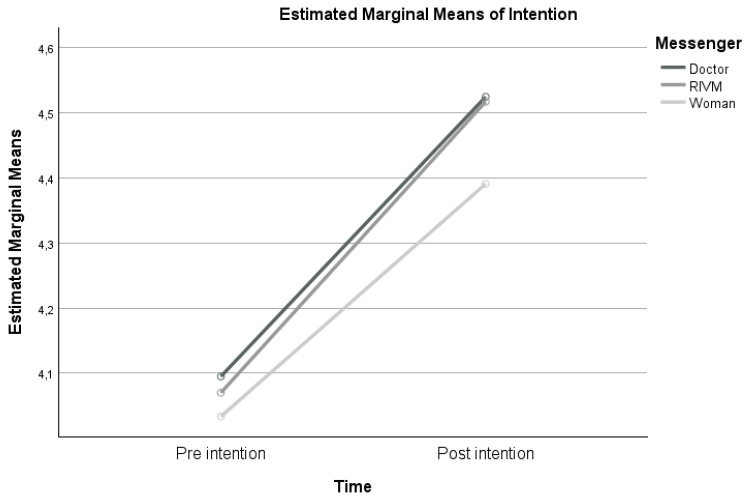
Note. The y-axis does not start at zero.

The mixed ANOVA also revealed no statistically significant between-subjects effect of messenger type on intention ($F(2, 364) = .38$, $p = .688$, $\eta_p^2 = .002$), indicating the average

scores on intention do not differ between the messenger conditions. There is no statistically significant interaction effect between messenger and time either ($F(2, 364) = .30$, $p = .743$, $\eta_p^2 = .002$). These findings reject the second hypothesis. The estimated marginal means of intention for the messenger conditions are shown in Figure 3.

Figure 3

Marginal Means of Messenger Conditions



Note. The y-axis does not start at zero.

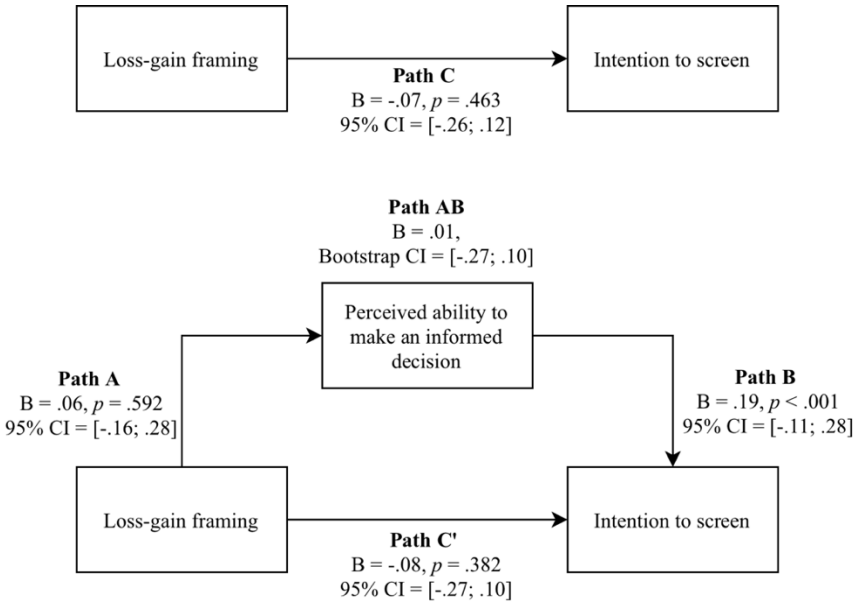
Mediation Analysis

A one-way ANOVA was performed with the pre-measure as independent variable, revealing no statistically significant differences between the framing groups ($F(1, 364) = .26$, $p = .614$) or messenger groups ($F(2, 364) = .09$, $p = .918$). The decision was made not to add the pre-measure as covariate, as there were no baseline differences to be controlled for and adding a covariate could influence the interpretation of effects (Miller & Chapman, 2001). To test the hypothesis that informed decision making has a mediating effect on the relationship between the messaging strategies and intention to screen, a mediation analysis was performed using PROCESS twice, first for loss-gain framing, then for messenger type.

The mediation model for framing is shown in Figure 4. The analysis revealed there is no significant association between framing and informed decision making (Path A: $B = 0.06$, $CI = [-0.16; 0.28]$, $p = .592$), but there is a significant association between informed decision making and screening intention (Path B: $B = 0.19$, $CI = [0.11; 0.28]$, $p < .001$). This association is positive, meaning that higher perceived ability to make an informed decision is related to higher intention to screen. The direct effect of framing on screening intention while controlling for informed decision making is not significant (Path C': $B = -0.08$, $CI = [-0.27; 0.10]$, $p = .382$), neither is the indirect effect of framing on intention through informed decision making (Path AB: $B = 0.01$, Bootstrap $CI = [-0.03; 0.06]$). These results imply there is no mediating effect of informed decision making on the relationship between loss-gain framing and screening intention. An overview of the results can be found in appendix D.

Figure 4

Mediation Model for Framing



For the messenger condition, the mediation analysis used dummy variables. The reference group was family doctor, meaning this condition was first compared to the RIVM,

and then to the female role model. Given that the mixed ANOVA already showed no significant differences between the messenger conditions, no additional analysis was performed to compare the RIVM condition and female role model condition. The mediation for the messenger conditions is pictured in two separate figures (Figures 5 and Figure 6).

There is no statistically significant association between the messenger conditions and informed decision making for both comparisons (path A: $B = 0.15$, $CI = [-0.11; 0.42]$, $p = .253$ for comparison with RIVM, $B = -0.13$, $CI = [-0.40; 0.14]$, $p = .330$ for comparison with female role model). The effect of informed decision making on screening intention remains statistically significant, just as in the model with framing (path B: $B = 0.19$, $CI = [0.10; 0.28]$, $p < .001$). The direct effect of both messengers on screening intention is not significant (path C': $B = -0.05$, $CI = [-0.27; 0.18]$, $p = .674$ for comparison with RIVM, $B = 0.11$, $CI = [-0.34; 0.11]$, $p = .328$ for comparison with female role model), neither is the indirect effect (path AB: $B = 0.03$, Bootstrap $CI = [-0.02; 0.09]$ for comparison with RIVM, $B = -0.03$, Bootstrap $CI = [-0.08; 0.03]$ for comparison with female role model). Based on these results, it is concluded there is no statistically significant mediating effect of informed decision making on the relationship between messenger type and screening intention.

Summarizing the results of the mediation analysis, the findings suggest there is no statistically significant mediating effect of informed decision making on the relationship between both messaging strategies on screening intention. This is in line with the findings from the mixed ANOVA, stating there are no significant effects of both messaging strategies on the intention to screen. However, there is a statistically significant, positive association between informed decision making and intention to screen, suggesting that higher perceived ability to make an informed decision is associated with higher intention to screen.

Figure 5

Mediation Model for Messenger: RIVM vs. Family Doctor

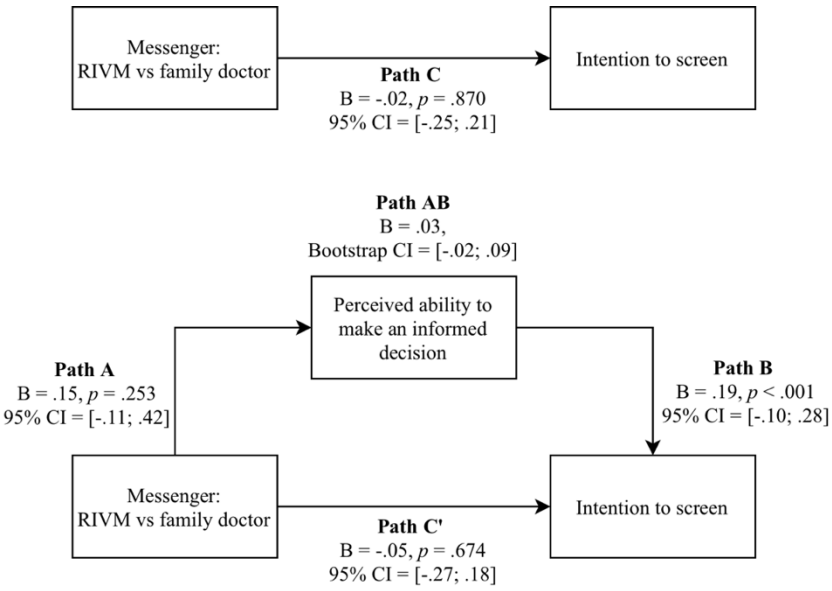
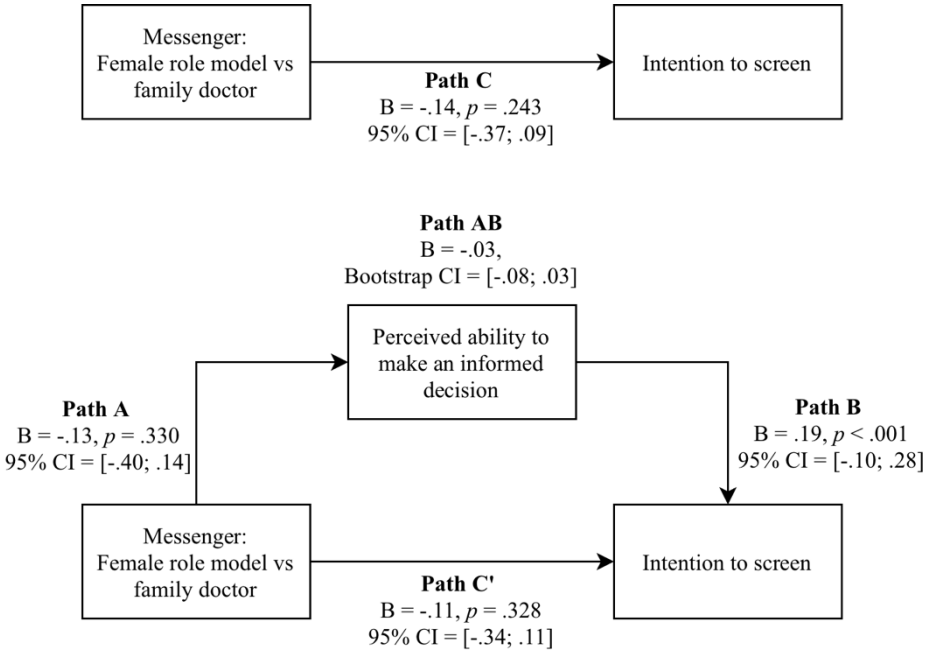


Figure 6

Mediation Model for Messenger: Female Role Model vs. Family Doctor



Discussion

This study investigated the effects of loss-gain framing and messenger type on intention to participate in cervical cancer screening among women in the Netherlands aged 18 to 29. Results show a statistically significant increase in screening intention after reading the manipulated messages and information about cervical cancer screening. No differences were found between the experimental conditions, indicating that in this study, no framing type and no messenger type was more effective than the others. A secondary aim was investigating the role of perceived ability to make an informed decision, by means of a mediation analysis. No mediating effect was found on both messaging strategies and screening intention, but a significant association between informed decision making and screening intention was found. Higher perceived ability to make an informed decision is associated with higher screening intention.

Prospect theory (Kahneman & Tversky, 1979) states that the amount of risk people are willing to take can be influenced by how the outcome is framed. Previous research suggested that loss-framed messages are more effective in promoting illness detection behaviours, including cancer screenings (Rothman & Salovey, 1997; Bartels et al., 2009; Ainiwaer et al., 2021). This study did not provide evidence to support this claim. Possible explanations are discussed in the limitations.

Family doctors, female role models and public health institutions are all shown to be effective messengers (Yang & Beatty, 2016; Trivedi et al., 2020; Aldoory, 2001). Based on the elaboration likelihood model (Petty & Cacioppo, 1986) and the source credibility theory (Hovland & Weiss, 1951), it was expected that the family doctor would be the most effective messenger, and the female role model would be more effective than the RIVM. The results rejected this hypothesis. Interestingly, there was a significant difference in intention after seeing the manipulated messages and general information. Because this study used no control

group, it is not clear what caused this increase. Future research including a design with control conditions is needed to clarify this finding.

Given that lack of knowledge is considered an important barrier to cervical cancer screening (Shpendi et al., 2025), informed decision making was expected to have a mediating effect on the relation between both messaging strategies and the intention to screen. The results do not support this hypothesis, but a significant relationship between informed decision making and screening intention was found. This is in accordance with the literature, which suggested that increasing knowledge was related to participation in cancer screening (Zhang et al., 2022; Hubert et al., 2025). However, more research is needed to get a clearer understanding of this relationship. Investigating how informed decision making can be improved in the context of cervical cancer screening might provide important suggestions for increasing screening intention.

Although not significant, analysis showed a slightly smaller improvement in the female role model condition than in the other conditions. This suggests that female role models may be less effective than doctors or the RIVM, but further research is needed to confirm this. A possible explanation for this contradiction to the hypothesis, is that credibility may be more important than similarity in these participants. However, as this study did not look at perceived credibility or similarity of the source, no conclusions can be drawn. Furthermore, it is possible the manipulation was too weak to show an effect. The manipulation of the messenger was quite subtle, and analysis showed that nearly a third of participants failed the manipulation check and could not remember which messenger they had just seen. Even though no significant differences were found in intention between those who passed and failed this check, it is possible that the manipulation was weakened. Future research should investigate ways to make the manipulation stronger, to properly assess possible effects of messengers.

Despite the nonsignificant results of the messaging strategies, this study suggested that receiving information in general could influence the intention to screen. This is an important implication for both further research and improving communication strategies. Further research should focus on what kind of information is most useful, for example information about the procedure, risks, or benefits.

Limitations and Future Directions

This study has several limitations which need to be considered. First off, and perhaps most importantly, this study looked at the intention to screen, and not participation in screening itself. Since participants would be recruited through platforms for students of the University of Groningen, it was plausible most participants would be under 30 years old and not have been invited for cervical cancer screening yet. Therefore, the decision was made to investigate the intention to screen, and the age limit of participants was set to 18 to 29 years old. However, most of the literature has focused on actual participation instead of intention, and it is possible that the effects found in the literature are weaker for intention, rather than actual behaviour.

Secondly, there was a ceiling effect in this study, meaning that most of the scores were already high on the first measurement (American Psychological Association [APA], 2018). This was also seen in the non-normality of data. Since most participants already had high intentions beforehand, the differences between the framing and messenger conditions may have been harder to detect. It is also possible that certain messaging strategies would be more effective on individuals who show low intention to participate in preventative behaviours. Besides the influence of the ceiling effect on the manipulations, high intention could also indicate that the sample was not representative for the population. It is likely that most participants have a high level of education, as they were recruited through a university. As the Netherlands has seen a decline in participation (RIVM, 2025b), and research shows that

education level is associated with participation in cervical cancer screening (Damiani, 2015), it is plausible that this sample of university students provided a skewed representation of the population. Investigating the effects of loss-gain framing and messenger effect in a sample that is representative for the population might lead to clearer insights.

Another important limitation was the absence of control groups, as mentioned before. This makes it impossible to draw conclusions about whether a general framing or messenger effect exists. It is not possible to eliminate a general framing effect, in which both loss- and gain-framed messages would be more effective than neutral messages, or a general messenger effect, in which a message signed by a messenger would be more effective than an anonymous message. The decision not to include a control group was made because, when developing the survey, it was uncertain how many people would participate. In order to ensure there were enough people in each condition to maintain sufficient power, the decision was made to not use any control group. Further research using control groups is necessary to increase understanding of these effect. Ideally, there would be three conditions for framing (loss-framed, gain-framed, and neutrally framed) and four conditions for the messenger (doctor, female role model, RIVM, and anonymous messenger). Given that previous research (Ogden et al., 2021) shows no significant differences between loss- and gain framed messages, but does see an effect of receiving general information, using a control group to receive no information at all could be considered as well.

A final limitation is that, as mentioned in the methods section, no manipulation check was conducted for loss-gain framing. This makes it impossible to determine if the manipulation was successful, and whether these results are found because no effect exists, or because the manipulation was unsuccessful. Further research including a manipulation check, is necessary to draw conclusions on the effect of loss-gain framing.

Conclusions

To summarize, this study showed that while no effects of framing or messenger were found, the intention to participate in cervical cancer screening increased after seeing messages containing information about HPV and cervical cancer. A relation between the perceived ability to make an informed decision and the intention to screen was found as well, indicating that knowledge about the topic could be important in screening participation. This study addressed a gap in the literature about informed decision making and messaging strategies, and its focus on cervical cancer screening in particular is considered a strength. The most important conclusion is that receiving information about cervical cancer could help increase the intention to screen for cervical cancer.

References

Ainiwaer, A., Zhang, S., Ainiwaer, X., & Ma, F. (2021). Effects of Message Framing on Cancer Prevention and Detection Behaviors, Intentions, and Attitudes: Systematic Review and Meta-analysis. *Journal of Medical Internet Research*, *23*(9). https://doi.org/10.2196/27634

Aldoory, L. (2001). Making health communications meaningful for women: Factors that influence involvement. *Journal of Public Relations Research*, *13*(2), 163–185. https://doi.org/10.1207/s1532754xjprr1302_3

American Psychological Association [APA]. (2018, April 19). *Ceiling effect*. APA Dictionary of Psychology. https://dictionary.apa.org/ceiling-effect

Bartels, R. D., Kelly, K. M., & Rothman, A. J. (2009). Moving beyond the function of the health behaviour: The effect of message frame on behavioural decision-making. *Psychology and Health*, *25*(7), 821–838. https://doi.org/10.1080/08870440902893708

Brook-Rowland, P., & Finlay, K. A. (2022). Lack of awareness, body confidence and connotations of sex: An interpretative phenomenological analysis of barriers affecting the decision to attend initial cervical cancer screening. *The Journal of Behavioral Health Services & Research*, *50*(3), 381–399. https://doi.org/10.1007/s11414-022-09819-y

Byrne, D. E. (1971). *The attraction paradigm*. Academic Press.

Damiani, G., Basso, D., Acampora, A., Bianchi, C. B., Silvestrini, G., Frisicale, E. M., Sassi, F., & Ricciardi, W. (2015). The impact of level of education on adherence to breast and cervical cancer screening: Evidence from a systematic review and meta-analysis. *Preventive Medicine*, *81*, 281–289. https://doi.org/10.1016/j.ypmed.2015.09.011

Edwards, A., Elwyn, G., Covey, J., Matthews, E., & Pill, R. (2001). Presenting Risk Information A Review of the Effects of "Framing" and other Manipulations on Patient Outcomes. *Journal of Health Communication*, *6*, 61–82. https://doi.org/10.1080/10810730150501413

Favero, N., Jilke, S., Wolfson, J. A., Xu, C., & Young, M. M. (2021). Messenger effects in COVID-19 communication: Does the level of government matter? *Health Policy OPEN*, *2*, 100027. https://doi.org/10.1016/j.hpopen.2020.100027

Fishman, J., Greenberg, P., Bagga, M. B., Casarett, D., & Propert, K. (2017). Comparing Strategies for health information Dissemination: Messengers that can help or hinder. *American Journal of Health Promotion*, *32*(4), 932–938. https://doi.org/10.1177/0890117117733780

Gallagher, K. M., Updegraff, J. A., Rothman, A. J., & Sims, L. (2011). Perceived susceptibility to breast cancer moderates the effect of gain- and loss-framed messages on use of screening mammography. *Health Psychology*, *30*(2), 145–152. https://doi.org/10.1037/a0022264

Hameleers, M. (2021). Prospect Theory in Times of a Pandemic: The Effects of Gain versus Loss Framing on Risky Choices and Emotional Responses during the 2020 Coronavirus Outbreak – Evidence from the US and the Netherlands. *Mass Communication & Society*, *24*(4), 479–499. https://doi.org/10.1080/15205436.2020.1870144

Hastall, M. R., & Wagner, A. J. M. (2017). Enhancing selective exposure to health messages and health intentions. *Journal of Media Psychology Theories Methods and Applications*, *30*(4), 217–231. https://doi.org/10.1027/1864-1105/a000197

Hayes, A. F. (2022). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*(3rd ed.). Guilford Press.

Hovland, C. I., & Weiss, W. (1951). The influence of source credibility on communication effectiveness. *Public Opinion Quarterly*, *15*(4), 635. https://doi.org/10.1086/266350

Hubert, J., Moldovanu, D., Van Den Bosch, I., De Nijs, K., Haaf, K. T., Oudkerk, M., De Koning, H. J., & Van Der Aalst, C. M. (2025). Impact of recruitment method on informed decision-making in lung cancer screening in the 4-IN-THE-LUNG-RUN trial. *Lung Cancer*, *207*, 108686. https://doi.org/10.1016/j.lungcan.2025.108686

Issaka, B., Allor, P., Aidoo, E. a. K., Wood, S. F., Amissah, A. A., & Muturi, N. (2025). Enhancing cancer prevention behaviors through social media: the role of source credibility and message characteristics in Ghana. *BMC Public Health*, *25*(1), 2471. https://doi.org/10.1186/s12889-025-23693-1

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, *47*(2), 263. https://doi.org/10.2307/1914185

Kim, J. (2024). When Gain/Loss Framing exerts its effects and how: Examining the roles of risk perceptions, anticipated regret, and anxiety. *Journal of Consumer Behaviour*, *24*(1), 499–511. https://doi.org/10.1002/cb.2432

Lee, D. N., Liu, J., Stevens, H., Oduguwa, K., & Stevens, E. M. (2024). Does source matter? Examining the effects of health experts, friends, and social media influencers on young adult perceptions of Instagram e-cigarette education messages. *Drug and Alcohol Dependence*, *258*, 111270. https://doi.org/10.1016/j.drugalcdep.2024.111270

Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology*, *110*(1), 40–48. https://doi.org/10.1037/0021-843x.110.1.40

Ogden, S. N., Leskinen, E. A., Sarma, E. A., Wainwright, J. V., & Rendle, K. A. (2021). Effects of message framing on cervical cancer screening knowledge and intentions related to primary HPV testing. *Cancer Prevention Research*, *14*(9), 839–844. https://doi.org/10.1158/1940-6207.capr-20-0622

O'Keefe, D. J., & Jensen, J. D. (2009). The Relative Persuasiveness of Gain-Framed and Loss-Framed Messages for Encouraging Disease Detection Behaviors: A Meta-Analytic Review. In *Journal of Communication*. https://doi.org/10.1080/10810730701615198

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In *Advances in experimental social psychology* (pp. 123–205). https://doi.org/10.1016/s0065-2601(08)60214-2

Rezapour, R., Saadati, M., Sarsour, H., Mahmoud, L., Zareipour, M., & Khezri, S. (2025). Barriers and facilitators to cervical cancer screening in the Eastern Mediterranean Region: a systematic review. *BMC Public Health*, *25*(1), 2370. https://doi.org/10.1186/s12889-025-23532-3

Rijksinstituut voor Volksgezondheid en Milieu [RIVM]. (2026a, January 6). *Baarmoederhalskanker en HPV*. https://www.rivm.nl/bevolkingsonderzoek-baarmoederhalskanker/baarmoederhalskanker-hpv

RIVM. (2021, September 16). *Deelname aan bevolkingsonderzoek baarmoederhalskanker was 50% in 2020*. https://www.rivm.nl/nieuws/deelname-aan-bevolkingsonderzoek-baarmoederhalskanker-was-50-in-2020

RIVM. (2023, October 10). *Participation rates in cancer population screening programmes continue to decline*. https://www.rivm.nl/en/news/participation-rates-in-cancer-population-screening-programmes-continue-to-decline

RIVM. (2025a). *HPV*. https://www.rivm.nl/en/hpv

RIVM. (2025b). Monitor bevolkingsonderzoek baarmoederhalskanker 2024. In *RIVM*. https://www.rivm.nl/sites/default/files/2026-01/monitor-bevolkingsonderzoek-baarmoederhalskanker-2024.pdf

RIVM. (2025c, September 16). *Information about cervical cancer screening*. https://www.rivm.nl/en/cervical-cancer-screening-programme/information-materials

RIVM. (2026b, January 6). *HPV-vaccinatie en het bevolkingsonderzoek baarmoederhalskanker*. https://www.rivm.nl/bevolkingsonderzoek-baarmoederhalskanker/hpv-vaccinatie

Rothman, A. J., Bartels, R. D., Wlaschin, J., & Salovey, P. (2006). The Strategic Use of Gain- and Loss-Framed Messages to Promote Healthy Behavior: How Theory Can Inform Practice. *Journal of Communication*, *56*(suppl_1), S202–S220. https://doi.org/10.1111/j.1460-2466.2006.00290.x

Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin*, *121*(1), 3–19. https://doi.org/10.1037/0033-2909.121.1.3

Shpendi, S., Norman, P., Gibson-Miller, J., & Webster, R. (2025). Identifying the key barriers, facilitators and factors associated with cervical cancer screening attendance in young women: A systematic review. *Women S Health*, *21*, 17455057251324309. https://doi.org/10.1177/17455057251324309

Staley, H., Shiraz, A., Shreeve, N., Bryant, A., Martin-Hirsch, P. P., & Gajjar, K. (2021). Interventions targeted at women to encourage the uptake of cervical screening. *Cochrane Database of Systematic Reviews*, *2021*(9). https://doi.org/10.1002/14651858.cd002834.pub3

Statistics Solutions. (n.d.). *Can an Ordinal Likert Scale be a Continuous Variable?* https://www.statisticssolutions.com/can-an-ordinal-likert-scale-be-a-continuous-variable/

Steffen, J., & Cheng, J. (2021). The influence of gain-loss framing and its interaction with political ideology on social distancing and mask wearing compliance during the

COVID-19 pandemic. *Current Psychology*, *42*(10), 8028–8038. https://doi.org/10.1007/s12144-021-02148-x

Tacken, M. a. J. B., Braspenning, J. C. C., Hermens, R. P. M. G., Spreeuwenberg, P. M. M., Van Den Hoogen, H. J. M., De Bakker, D. H., Groenewegen, P. P., & Grol, R. P. T. M. (2006). Uptake of cervical cancer screening in The Netherlands is mainly influenced by women's beliefs about the screening and by the inviting organization. *European Journal of Public Health*, *17*(2), 178–185. https://doi.org/10.1093/eurpub/ckl082

Trivedi, N., Krakow, M., Hawkins, K. H., Peterson, E. B., & Chou, W. S. (2020). "Well, the message is from the institute of something": exploring source trust of Cancer-Related messages on simulated Facebook posts. *Frontiers in Communication*, *5*. https://doi.org/10.3389/fcomm.2020.00012

UNICEF. (n.d.). *5 fast facts about HPV and cervical cancer*. https://www.unicef.org/stories/fast-facts-hpv-cervical-cancer

Van Stigt, B. J., Olthof, E. M. G., De Kok, I. M. C. M., Heijnsdijk, E. a. M., Lansdorp-Vogelaar, I., Van Ravesteyn, N. T., & Toes-Zoutendijk, E. (2025). Decreasing participation in Dutch population-based cancer screening programs: Trends from 2018 to 2022. *Preventive Medicine*, 108257. https://doi.org/10.1016/j.ypmed.2025.108257

Verberckmoes, B., De Paepe, E., De Vestele, J., Gama, A., Keygnaert, I., Vermandere, H., & Degomme, O. (2024). Barriers and facilitators to cervical cancer screening among under- and neverscreened women in Flanders, Belgium – a qualitative study on community and healthcare providers' perspectives. *BMC Public Health*, *24*(1), 2870. https://doi.org/10.1186/s12889-024-20166-9

WHO. (2025, December 2). *Cervical cancer*. https://www.who.int/news-room/fact-sheets/detail/cervical-cancer

World Health Organization [WHO]. (n.d.). *Cervical Cancer Elimination Initiative*. https://www.who.int/initiatives/cervical-cancer-elimination-initiative

Yang, Q., & Beatty, M. (2016). A meta-analytic review of health information credibility. *Health Information Management Journal*, *45*(2), 80–89. https://doi.org/10.1177/1833358316639432

Zhang, M., Sit, J. W. H., Chan, D. N. S., Akingbade, O., & Chan, C. W. H. (2022). Educational Interventions to Promote Cervical Cancer Screening among Rural Populations: A Systematic Review. *International Journal of Environmental Research and Public Health*, *19*(11), 6874. https://doi.org/10.3390/ijerph19116874

Appendix A

Data cleaning

Paid recruitment tool: 78 participants remaining

- First removed ourselves (testing, problem solving etc.) - identified by date (prior to it going live) and email address - 3 removed
- Missing data - 10 removed:
    - Removed participants who had zero data: 0 participants
    - Removed participants who had not consented: 1 participant
    - Removed participants who were screened out: 1 participant
    - Removed participants who did not provide any answers, including primary outcomes: 8 participants (primarily duplicates)
- Duplicates by Sona Code (6 removed)
    - 4 participant took part twice - only first (by end date) was kept
        - One seemed to have clicked away right at the end (survey not completed) and participated again to enter email address for payment.
    - 1 participant took part three times - only first was kept

Recruitment tool for first year students of University of Groningen: 292 participants remaining

- Removed ourselves - based on SONA ID and blank Sona ID columns - 5 participants
- Missing data: 37 removed
    - Zero data: 0 participants
    - Not consented: 3 participants
    - Screened out: 2 participants (too young)
    - Did not provide any answers: 32 participants (all but 1 were duplicates)
- Duplicates by SONA code: 12 removed

- 11 participants took part twice:
- For the majority of these, the first participation was coded as not completed. They likely participated twice to get assigned SONA points. However, their first case was taken, even if missing most answers, to avoid impact of seeing different manipulations during their second participation.
- One participant (105079) gave nonsense answers (all 1) in first attempt, and "normal" answers in the second attempt - in this case both were removed.

Appendix B

Survey content

Informed consent page

"Cervical cancer screening and HPV vaccinations"

This online survey experiment tests the appropriateness and effectiveness of potential campaign messages to promote the uptake of cervical cancer screening and HPV vaccinations among women aged 18-29.

The survey includes questions about your awareness, intentions, recommendations, and previous behaviours related to cervical cancer screening and HPV vaccinations. It also includes questions about potential factors which may influence people's interest and intention.

By selecting 'yes' to the following questions, you consent to the following

- I have read the information about the research.
- I understand what the research is about, what is being asked of me, which consequences participation can have, how my data will be handled, and what my rights as a participant are.
- I understand that participation in the research is voluntary. I myself choose to participate. I can stop participating at any moment. If I stop, I do not need to explain why. Stopping will have no negative consequences for me.

Below I indicate what I am consenting to.

"Do you consent to participate in this study?"

- Yes, I consent to participate.
- No, I do not consent to participate.

"Do you consent to processing your personal data?"

- Yes, I consent to the processing of my personal data as mentioned in the research information. I know that until 31-01-2026 I can ask to have my data withdrawn and erased. I can also ask for this if I decide to stop participating in the research.
- No, I do not consent to the processing of my personal data.

Screening questions

"What is your biological sex?"

- Female
- Male
- Other
- Prefer not to answer

"To which age group do you belong?"

- Under 18
- Between 18-29 (inclusive)
- 30 and older

Primary questions

"To what extent do you agree or disagree with the following statement: "If I get an invitation for cervical cancer screening in the future, I will certainly attend."

- Strongly disagree
- Somewhat disagree
- Neither agree, nor disagree
- Somewhat agree
- Strongly agree

Framing messages

Loss: “By not being vaccinated you may put yourself at risk for contracting HPV and increase your risk of developing cervical cancer. Even if you are vaccinated, by not participating in screening you risk detecting cervical cancer at a larger stage, when it is harder to treat.”

Gain-framed: “By being vaccinated you may protect yourself against contracting HPV and decrease your chance of developing cervical cancer. Even if vaccinated, by participating in cervical cancer screening you can detect cervical cancer as early as possible, when it is easier to treat.”

Messenger texts

Doctor: “Family doctors encourage all women to get the HPV vaccine and participate in cervical cancer screening when invited.”

Woman: “Sarah, a 20-year old woman who is vaccinated against HPV and intends to participate in cervical cancer screening, encourages all women to get the HPV vaccine and participate in cervical cancer screening when invited.”

RIVM: “The RIVM (Dutch National Institute for Public Health and the Environment) encourages all women to get the HPV vaccine and participate in cervical cancer screening when invited.”

Manipulation checks

“Who gave the recommendation you just saw?”

- Doctor
- RIVM
- Another woman
- I don’t know

“What was the message about?”

- HPV
- Cervical cancer

- Cervical cancer AND HPV
- I don't know

Additional information

"Cervical cancer is one of the most common cancers among women. In the Netherlands, around 900 people per year get cervical cancer. Cervical cancer is most common among women between 30 and 60 years old. The human papillomavirus (HPV) is the most common cause of cervical cancer. HPV is a sexually transmittable virus, infecting 80-90% of people at some point in their life. Most people do not develop symptoms. The HPV vaccine provides a 95% protection rate against the high-risk types that can lead to cervical cancer. Women who were not vaccinated before 18, can choose to get a catch up vaccine at their family doctors, but are required to cover the costs. Cervical cancer screening can detect if someone is at risk of cervical cancer. If you are between 30 and 60 years old, you will receive regular invitations for the cervical cancer screening programme. It is important to take part even if you are vaccinated against HPV. You can take part by using a self-sampling test at home or by going to your family doctor for a smear test - both options are free."

Primary outcomes

"To what extent do you agree or disagree with the following statement: "If I get an invitation for cervical cancer screening in the future, I will certainly attend."

- Strongly disagree
- Somewhat disagree
- Neither agree, nor disagree
- Somewhat agree
- Strongly agree

Informed decision making

"To what extent do you agree or disagree with the following statement: "I feel I have enough information to make an informed decision about participating in cervical cancer screening."

- Strongly disagree
- Somewhat disagree
- Neither agree, nor disagree
- Somewhat agree
- Strongly agree

Attention check

"If you are still paying attention, select might or might not for this question."

- Definitely not
- Probably not
- Might or might not
- Probably yes
- Definitely yes

Debrief

"Thank you again for participating in this online survey experiment on the appropriateness and effectiveness of potential campaign messages to promote the uptake of cervical cancer screening and HPV vaccinations among young women.

The campaign messages and information were designed for the study, based on publicly available health information. To give a bit more background, the study included:

- Two types of message frames: gain-framed messages about the protection offered by screening and vaccination, and loss-framed messages about the risks of not participating in screening and vaccination.
- Three types of messengers: A young woman similar to our study population, a doctor, and the RIVM (Dutch Institute of Public Health and Environment).

We randomized which version each participant saw, so you will only have seen one message frame and one messenger. In our study we are hoping to discover which of these message frames and messengers are most effective in promotion of cervical cancer screening and HPV vaccination.

If you would like further information about:

- Cervical cancer screening: https://www.rivm.nl/en/cervical-cancer-screening-programme/information-materials,
- HPV vaccination: https://www.rivm.nl/en/hpv/hpv-vaccination.

If you have questions or concerns about the study, you can contact Veerle Snijders via v.snijders@rug.nl."

Appendix C

Assumptions of Mixed ANOVA

- Dependent variable should be measured at a continuous level
    - Assumption is met. Dependent variables that are measured on Likert scales are technically ordinal, but can often be used as continuous (Statistics Solutions, n.d.). Since the Likert scale used in our study has five response options, this can be treated as approximately continuous.
- Within-subjects factor has at least two related groups
    - Assumption is met. The within-subjects factor is time, with a pre- and post-measure of the variables.
- Between-subjects factor has at least two independent groups
    - Assumption is met. Participants are assigned to different groups, and no participants are assigned to multiple groups. Framing has two groups (loss, gain) and messenger has three groups (RIVM, doctor, woman).
- No significant outliers
    - Assumption is met. All Cook's distances are < 1 (min = .00, max = .048; see Figure D1).
- Dependent variable should be approximately normally distributed
    - Assumption is not met. Shapiro-Wilk test shows a significance result ($p < .001$) and Q-Q plot shows non-normal distribution (Figure D2), which means the null-hypothesis of normality is rejected. Histograms show a non-normal distribution as well (Figure D3 and Figure D4).
- Homogeneity of variances
    - Assumption is met. Levene's test is not significant, meaning the null hypothesis of equal variances is not rejected ($F(5, 364) = .56$, $p = .729$).

- Sphericity
    - Assumption is met. Sphericity is not applicable in this study design.

Assumptions of Mediation Analysis

- Linearity between the dependent, independent and mediator variables
    - The independent variable is categorical and linearity does not apply. The linearity was checked between the mediator and dependent variable. Figure D5 shows linearity.
- No multicollinearity
    - Assumption is met. Multicollinearity was checked for both mediation models separately. Results of collinearity are shown in Tables D1 and D2.
- Independent observations
    - Assumption is met. Guaranteed through the study design.
- Homoscedasticity
    - Assumption is met. Homoscedasticity is seen in Figures D6 and D7.
- Normality
    - Assumption is not met, as shown in previous section.
- No outliers
    - Assumption is met, as shown in previous section.
- No autocorrelation
    - Assumption is met. Durbin-Watson = 2.225, indicating no correlation between residuals.

Appendix D

Tables and Figures

Figure D1

Cook's Distances

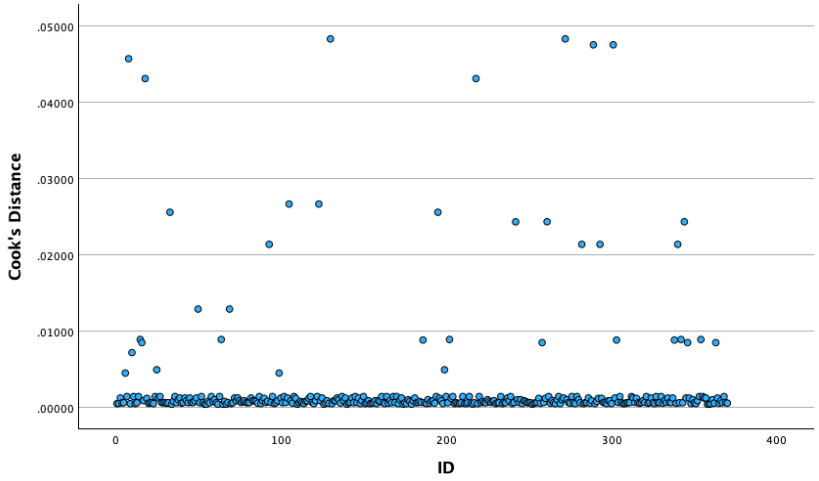


Figure D2

Q-Q Plot of Post-measure of Intention

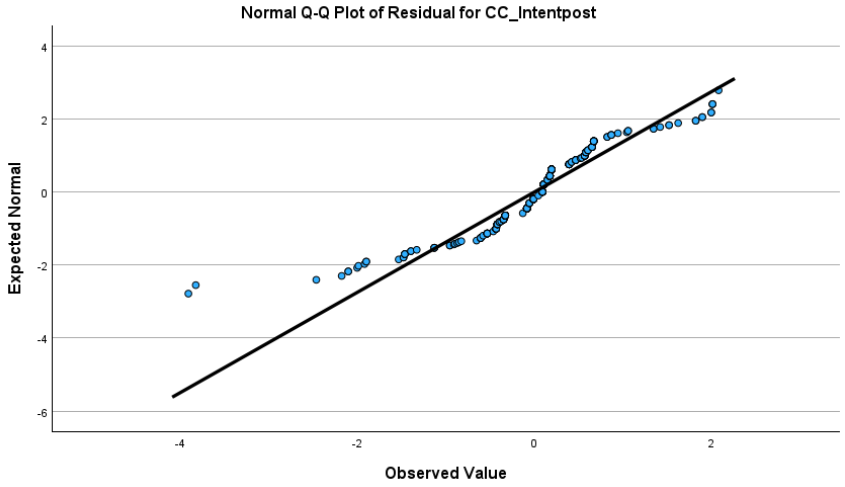


Figure D3

Histogram of Pre-measure of Intention

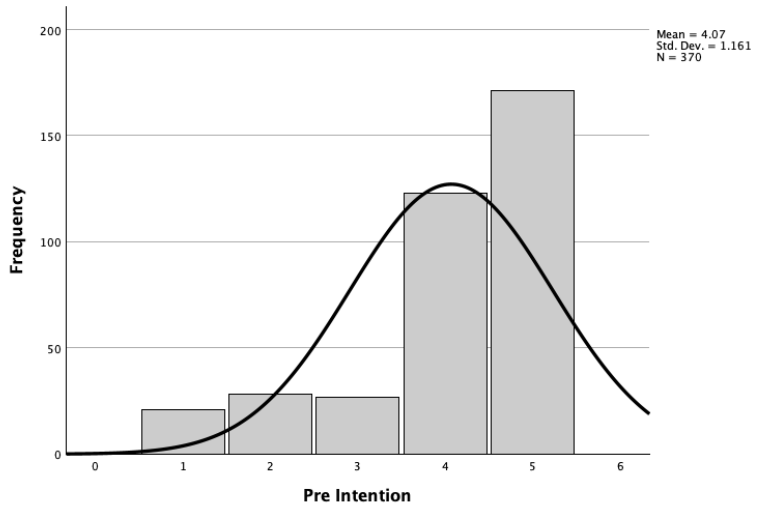


Figure D4

Histogram of Post-measure of Intention

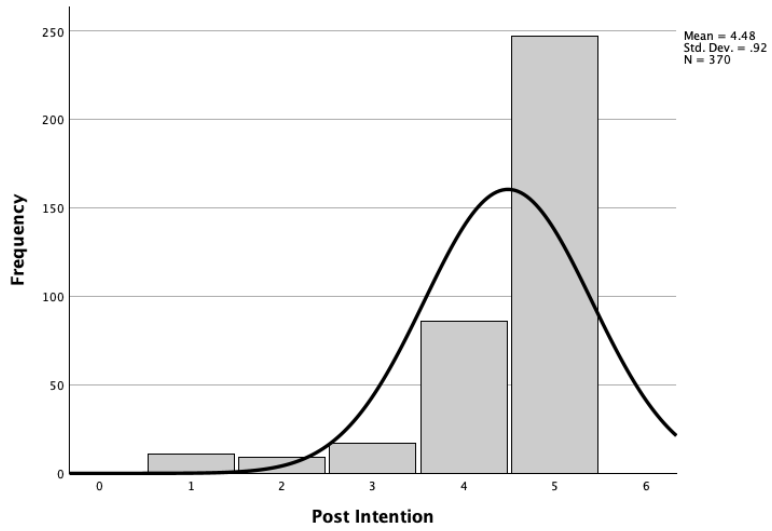


Table D1

Collinearity Statistics for Framing

	Collinearity statistics	
	Tolerance	VIF
Dummy gain-frame	.999	1.001
Informed decision making	.999	1.001

Table D2

Collinearity Statistics for Messengers

	Collinearity statistics	
	Tolerance	VIF
Dummy RIVM	.763	1.310
Dummy female role model	.764	1.309
Informed decision making	.988	1.012

Figure D5

Scatterplot Linearity M → Y

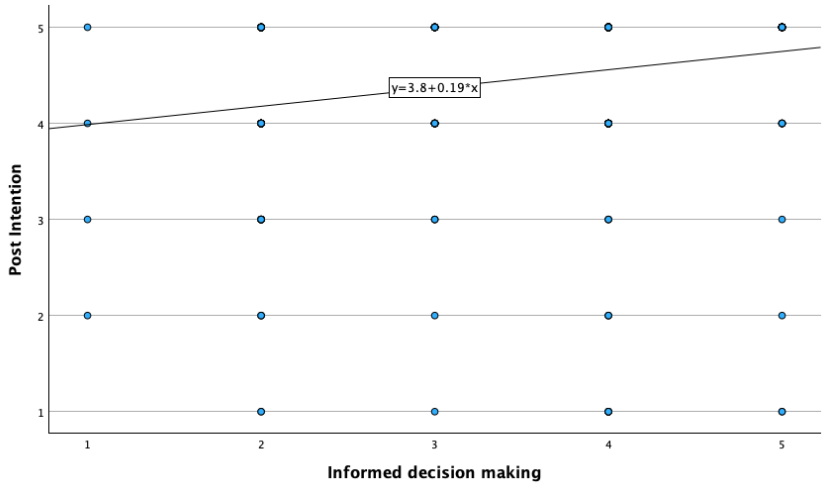


Figure D6

Scatterplot Residuals for Framing

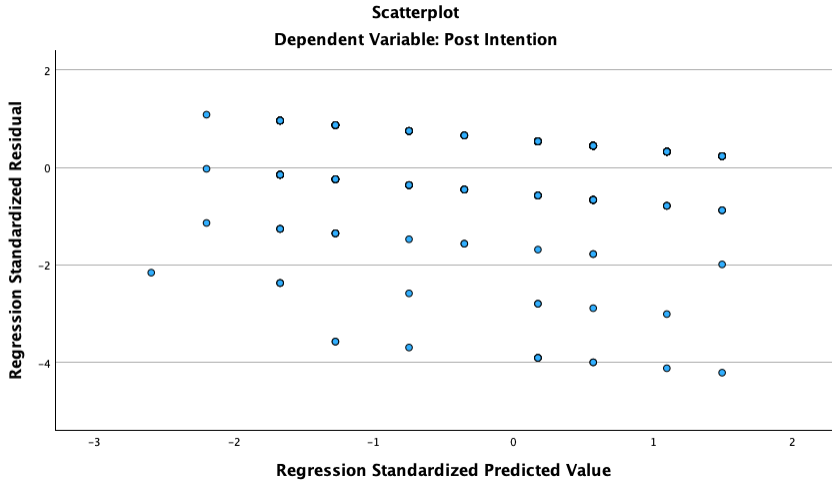


Figure D7

Scatterplot Residuals for Messengers

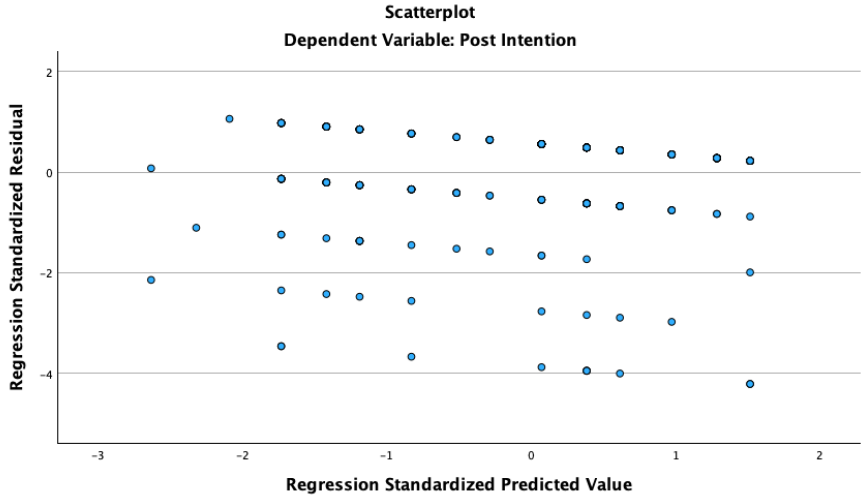


Table D3

Mediation Analysis Framing

Pathway	Coefficient	*SE*	*t*	*p*	95% *CI*
Total effect (c)	-0.07	0.10	-0.74	.463	-.26; .12
Direct effect (c')	-0.08	0.09	-0.87	.383	-.27; .10
Path (a) X → M	0.06	0.11	0.54	.592	-.16; .28
Path (b) M → Y	0.19	0.04	4.35	< .001	.11; .28
Indirect effect (ab)	0.01	0.02*			-.03; .06**

Note. N = 368. Bootstrap samples = 5.000. *CI* = Confidence Interval.

* = Bootstrap standard error.

** = Bootstrap confidence interval

Table D4

Mediation Analysis Messenger – Family doctor vs. RIVM

Pathway	Coefficient	*SE*	*t*	*p*	95% *CI*
Total effect (c)	-0.02	0.12	-0.164	.870	-0.25; 0.21
Direct effect (c')	-0.05	0.11	-0.421	.674	-0.27; 0.18
Path (a) X → M	0.15	0.13	1.145	.253	-0.11; 0.42
Path (b) M → Y	0.19	0.04	4.237	< .001	0.10; 0.28
Indirect effect (ab)	0.03	0.03*			-0.02; 0.09**

Note. N = 370. Bootstrap samples = 5.000. *CI* = Confidence Interval.

* = Bootstrap standard error.

** = Bootstrap confidence interval

Table D5

Mediation Analysis Messenger – Family doctor vs. female role model

Pathway	Coefficient	*SE*	*t*	*p*	95% *CI*
Total effect (c)	-0.14	0.12	-1.17	.243	-0.37; 0.09
Direct effect (c')	-0.05	0.12	-0.98	.328	-0.34; 0.11
Path (a) X → M	-0.13	0.14	-0.98	.330	-0.40; 0.14
Path (b) M → Y	0.19	0.04	4.237	< .001	0.10; 0.28
Indirect effect (ab)	-0.03	0.03*			-0.09; 0.03**

Note. N = 370. Bootstrap samples = 5.000. *CI* = Confidence Interval.

* = Bootstrap standard error.

** = Bootstrap confidence interval.