



Exploring the effect of risk and benefit information provision on vaccination decision-making



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ABSTRACT

In the era in which people are bombarded with misinformation about vaccination, research regarding the degree to which various types of risk or benefit information affect perceptions of vaccines and intentions to vaccinate is critical. The present research utilizes a robust methodology to quantify the extent to which risk and benefit information affects vaccination intentions. Our work demonstrates an inverse relationship between the perceived risks and benefits of a vaccine. By providing information about either risks or benefits of a vaccine, our findings suggest that we can change one's perception of both the risks and benefits of the vaccine. Considering that the main cognitive barriers to vaccination are related to concerns about efficacy and safety, our results suggest that vaccine messages can be framed to address the audience's main concerns, whether it be about the low efficacy of the vaccine or its safety, knowing that both frames would carry similar outcomes.

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1. Introduction

In recent years, the perceived threat of infectious diseases has declined as a consequence of global immunization initiatives. At the same time, however, there has been an increase in concerns about vaccine safety [10]. Both of these factors have resulted in a more pronounced emergence of anti-vaccine movements and the consequent prevalence of (mis)information about risks and efficacy of vaccination. Perceived risks and benefits have been documented as critical factors affecting vaccination decisions [1,6,7,26]. However, there is limited empirical research that quantitatively investigates the effect of information exposure on perceived risks and benefits of vaccination, and childhood vaccination specifically. In an era where people are bombarded with (mis)information about the risks and benefits of vaccination [17], it is important to understand the degree to which the perceived risk and benefits of vaccines are influenced by exposure to various types of information. The present research investigates the extent to which individuals' perceptions of risk and benefit regarding vaccination are affected by exposure to information implying that a vaccine might be high or low in risk or benefit.

In addition, we investigate the degree to which the intention to vaccinate changes after individuals are provided with information implying that a vaccine is high or low in risk or benefit. The focus of the present paper is to provide greater information regarding how individuals react to public health messaging and promotion of vaccination and can be used to inform health communication methods and interventions.

2. Background

Numerous studies have shown the significant roles that perceived risk and perceived benefit play in vaccination behaviour [1,6,7,26]. Following Andrew Wakefield's retracted paper that falsely suggested a link between the measles, mumps and rubella vaccine and autism [23], anti-vaccine sentiment re-emerged and inaccurate information about the potential risks and inefficacy of vaccines were widely disseminated through various sources [15]. Dissemination was largely amplified via the growth of the Internet, changing the way people can and do access health information [25]. Despite an acknowledgement by vaccine researchers that health information, including vaccination, is often obtained through unfiltered channels, and that access is only increasing as a consequence of globalization, the diffusion of the news media, and social networking [3,26], there is limited knowledge regarding how the content of such sources actually influences vaccination

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intentions. As individuals continue to be exposed to various types of information both prompting and denying vaccination, it is crucial to understand the degree to which the perceived risk and the perceived benefit of vaccines are influenced by the exposure to this information. This understanding helps with developing more effective health communication methods or policies to regulate the negative impacts that various information might have on people's vaccination behaviour.

Traditional models of judgement and decision-making recognize risk and benefit as two distinct mental constructs influencing people's decisions [14,20]. The nature of benefits one gains from taking an action is distinct than the risks associated with that action. For instance, the benefits one gains from taking antibiotics are different from the risks one is exposed to by taking antibiotics. However, in recent years, several studies have shown that the judgement of risk and the judgement of benefit are not distinctly separate and on the contrary, are in fact perceived as being inversely related [1,11], Finucane et al. [12]. That is, it is frequently observed that the higher the perceived risk, the lower the perceived benefit, and vice versa. Using the above example, recent theorizing would suggest that individuals' perceived benefits of taking antibiotics are lower if the perceived risks of taking antibiotics are higher. Previous studies primarily focused on the relationship between the judgement of risk and benefit in social decisions concerning social utilities (e.g. the use of nuclear energy, food preservatives, or vaccines for the society) as opposed to personal health decisions [1,11]. In the present research, our first objective was to extend earlier research by investigating the relationship between the judgement of risk and benefit when one is making a *personal decision* about vaccinating his/her own child. Furthermore, as previously mentioned, there is little research investigating the degree to which the judgement of risk and benefit in personal decisions specific to vaccination are affected by exposure to information regarding risk and benefit. Therefore, the second objective was to investigate how information on the high/low risks/benefits of a vaccine affects peoples' judgement of risk and benefit of the vaccine. Finally, the third objective of this study was to identify if information regarding risks/benefits changed intentions to vaccinate. The following research questions were explored:

- (1) How are the judgement of risk and the judgement of benefit related when individuals make personal evaluations of childhood vaccination?
- (2) To what extent do individuals' judgements of risk and benefit of childhood vaccination change when exposed to new information about the risks or benefits of a vaccine?
- (3) To what extent does one's intention for vaccinating one's child change when exposed to new information about risk or benefit of a vaccine?

In order to explore the aforementioned questions, respondents were given information about a hypothetical disease and vaccine and asked to indicate their perceived risk and benefit of the vaccine and indicate if given the information provided, they would vaccinate their child. Respondents were then subjected to four different conditions, each providing different types of new information about the risk/benefits of the disease and its vaccine. We then investigated if their perceived risk and benefit of the vaccine for a second time, as well as if their intention to vaccinate their child(ren) changed after the exposure to the new information.

Throughout this work, we considered the perceived risk of the vaccine as the perceived potential side effects of the vaccine. The perceived benefit in this work is considered as the perceived effectiveness of the vaccine to prevent the related vaccine preventable disease.

3. Method of study

Four hundred participants were recruited through Amazon Mechanical Turk (www.mturk.com). The only condition for recruiting participants was that they had to be a parent. We included this participation criterion because it is usually parents who make decisions about their child(ren)'s vaccination and thus there might be differences between how parents and non-parents perceive the risks and benefits of childhood vaccinations. We also included an attention check in the survey, which resulted in eliminating 32 respondents. The respondents were asked to respond to the following question: "If you had an option to choose one of the following options, which one would you choose?" (A) A free lottery ticket with a 50% chance to win \$200, (B) A free lottery ticket with a 80% chance to win \$195, or (C) A free lottery ticket with a 40% chance to win \$100. Option B was clearly the best choice. Therefore, respondents were removed from the study if they chose any other options. As a result, the final number of respondents was 368 from which 52% were male (*Mdn* age = 35–44 years old; *Mdn* number of children = 1). Table 1 displays respondents' demographic information in more details. It should be noted that that this study was part of a larger study in which respondents' affective evaluation of the vaccine were also measured

Table 1
Descriptive statistics of the respondents' demographic information.

	Total	
	n	%
Age		
18–24	9	2.5
25–34	141	38.5
35–44	113	30.9
45–54	58	15.8
55–64	33	9.0
65–74	10	2.7
75 and older	2	0.5
Education		
Completed some high school	2	0.5
High school graduate	18	4.9
Completed some college	65	17.7
Associate degree	34	9.2
Bachelor's degree	172	46.7
Completed some postgraduate	14	3.8
Master's degree	53	14.4
Ph.D., law, medical degree, or other advanced degree beyond a Master's degree	10	2.7
Number of Children		
Zero	0	0
One	187	50.9
Two	126	34.3
Three	36	9.8
Four or more	18	4.9
Age of the youngest child		
0–4 years	138	37.6
5–9 years	97	26.4
10–14 years	51	13.9
15–19 years	27	7.4
19 and older	54	14.7
Household income		
Less than \$25,000	74	20.1
\$25,000–\$34,999	63	17.1
\$35,000–\$49,999	53	14.4
\$50,000–\$74,999	86	23.4
\$75,000–\$99,999	53	14.4
\$100,000–\$149,999	31	8.4
\$150,000 or more	8	2.2
Gender		
Male	191	51.8
Female	176	47.7
Different identity	2	0.5

through an adapted version of the Alhakami and Slovic's [1] work. Following [18]'s approach we asked the participants to rate the a hypothetical vaccine called Respiratory Discoloration Disease vaccine (RDD vaccine) against a series of descriptive statements; however, the results of the affective scale are beyond the scope of the present paper.

At the beginning of the survey, respondents were asked to read a description about a new and highly contagious disease and the associated vaccine. As mentioned above, the new disease was named Respiratory Discoloration Disease (RDD). The RDD and its vaccine were developed intentionally to be very similar to the Measles, and Measles, Mumps and Rubella (MMR) vaccine. The use of a new name, RDD, as opposed to MMR was intentional as we did not want any pre-existing perspective or beliefs about MMR to affect our results. On the other hand, we wanted to set the information about the most controversial vaccine as our baseline to see how people received risk and benefit information about the MMR vaccine not knowing that the information is in fact related to MMR vaccine. We provided respondents with information about the symptoms and the complications of the disease as well as the efficacy and the side effects of the vaccine. The information provided in the study mimicked information presented on the Center for Disease and Control and Prevention's website about measles and the MMR vaccine [21]. See Appendix A, for the exact wording.

After respondents read the main information about RDD and its vaccine, we asked them to rate how beneficial/risky they thought the RDD vaccination was on a 7-point Likert scale from *not beneficial/risky at all* to *extremely beneficial/risky*. The order in which we asked the questions about the perceived risk and benefit of the vaccine were counterbalanced between the respondents.

Next, the respondents were asked to answer the following question on a 5-point Likert scale from *yes, I would vaccinate my child* to *no, I would not vaccinate my child* using the following:

Imagine that you have a 1 year old child, would you vaccinate your child with the RDD vaccine?

After reading the main scenario and answering the questions, respondents received the following instructions telling them that they were going to receive new information about the RDD disease and vaccine:

Further studies have provided new findings regarding the RDD disease and its vaccine. In the following page, you will be presented with a complementary piece of information. Please read it carefully, as you will be asked to answer similar questions based on this new extra piece of information.

Respondents were then randomly assigned to one of the four conditions in which they received a new piece of information indicating that the vaccine was either high in benefit (96 respondents), low in risk (90 respondents), low in benefit (93 respondents), or high in risk (89 respondents). In each condition, we provided a complementary piece of information that only included information about either high risk, high benefit, low risk, or low benefit of the vaccine. For instance, if the new piece of information was supposed to imply that the vaccine has high benefits, the description only included the information about the high benefit of the vaccine and did not include any information about the potential risks of the vaccine (see Table 2). After reviewing the gray literature on the arguments that the pro- and anti- vaccine communities share online [2,19,22,24,16], we adopted arguments related to risk and benefit of the vaccines to develop the scenarios, displayed in Table 2, with an intention to provide information about high/low risk/benefit of the vaccine.

Table 2

The descriptions given to the respondents in each condition.

Condition	Scenario
High-benefit condition	RDD vaccination is highly effective in protecting an individual from the RDD virus without causing the suffering of the severe consequences of the disease itself. RDD vaccination is the only way to protect a person from the dangerous and highly contagious RDD virus as there is no treatment for it. RDD vaccine creates immunity by boosting the body's own immune system. In recent years, all the individuals who received the vaccine have been 100% immune towards the disease.
Low-risk condition	Since the complications of the vaccine are extremely rare, there is not enough evidence for scientists to be sure if the complications are even caused by the vaccination; and therefore, there is not any meaningful link between the RDD vaccine and these consequences. In a set of reliable recent studies, the risk of the RDD vaccination have been shown to be almost zero. In recent years there has not been any documented complications of the vaccination.
High-risk condition	In recent years, several severe problems have been reported following RDD vaccine, these include severe allergic reactions, and problems such as permanent brain damage, long-term seizures, coma, or lowered consciousness, and deafness. Scientists state that these complications are not common, but recently several cases of these severe complications have been reported.
Low-benefit Condition	Although physicians believe that vaccination is the only scientific way to protect a person from the dangerous and highly contagious RDD virus, some people claim that there is no need in getting the vaccine as they can control the consequences of the infection by other methods such as herbal medicines. Moreover, it is shown that 10% of the vaccinated individuals who take the RDD vaccine do not develop immunity. In recent years, there have been some individuals who received the vaccine and still were affected by the virus.

After the respondents read the new information, they were asked to answer the same set of questions that they received after reading the main scenario (i.e. questions about their perceived risk and benefit of the vaccine and their intention to vaccinate their children).

4. Analysis and results

In the following, we explore our three main research questions. First, we discuss the relationship between perceived risk and perceived benefit in different conditions. Then, we explore the degree to which perceived risk and perceived benefit of the RDD vaccine changed after exposure to new risk or benefit information. Subsequently, we identify the degree to which the intention for child vaccination changed after the exposure to various risk or benefit information.

4.1. The relationship between perceived risk and perceived benefit

As discussed earlier, previous studies have shown that the judgement of risk and the judgement of benefit are inversely related when making a judgement about social utilities [1]. We extend this research and investigate the relationship between the judgements of risk and benefit when one is making a *personal decision* about vaccinating his/her own child.

We found that, similar to social decisions, there was a significant negative relationship between the judgement of risk and the judgement of benefit when it comes to vaccination decisions. In other words, the higher the perceived benefit, the lower the perceived risk and vice versa. This was true at time 1, after reading the general information and prior to any additional information ($r(366) = -0.54$ $P < 0.001$), as well as at time 2, after reading the

new piece of information in each of the different conditions (see Table 3). One implication of this, as further examined below, is that it will be difficult, if not impossible, to affect perceptions of risks or benefits in isolation. Rather, changed perceptions of risks as a result of exposure to risk information will likely affect perceptions of benefits, and vice versa. It should be noted that a UNIANCOVA analysis showed no significant difference between the correlations of the perceived risk and benefit of the vaccine among the different conditions ($P = 1$).

4.2. Changes in perceived risks and benefits after new information

We next examined the extent to which individuals' judgements of risk and benefit of childhood vaccination changed after exposure to new information about the risks or benefits of a vaccine. In order to precisely address this issue, we considered two separate questions. First, did exposure to new information lead to changes in perceived risks and benefits? Second, did the magnitude of change depend on the particular type of information?

4.3. Did exposure to new information lead to changes in perceived risks and benefits?

4.3.1. Perceived benefits

We first ran a series of paired-sample T-tests to investigate the degree to which the exposure to new information changed respondents' perceptions of the benefits of the RDD vaccine from time 1 to time 2 (see Fig. 1 and Table 4). Respondents' perceived benefit of the vaccine significantly increased after receiving information about either the high benefit or the low risk of the vaccine; similarly, the perceived benefit of the vaccine significantly decreased after receiving information about either the high risk or the low benefit of the vaccine.

4.3.2. Perceived risks

We next ran a series of paired-sample T-tests to investigate the degree to which the exposure to new information changed respondents' perceptions of the risks of the RDD vaccine from time 1 to time 2 (see Fig. 2 and Table 4). Respondents' perceived risks of the vaccine significantly decreased after receiving information about either the high benefit or the low risk of the vaccine; similarly, the perceived risks of the vaccine significantly increased after receiving information about the high risk of the vaccine. Interestingly, although perception of risk increased by exposure to information about the low benefit of the vaccine, the increase was not statistically significant.

These findings generally indicate that exposure to either risk or benefit information about a vaccine can significantly change one's perception of both the risk and the benefit of the vaccine. More specifically, providing information about high benefits or low risks of a vaccine usually result in a simultaneous increase and decrease in the perceived benefit and perceived risk of the vaccine, respectively. Similarly, providing information indicating the low benefit or the high risk of a vaccine resulted in a simultaneous increase

and decrease in the perceived risk and benefit of the vaccine, respectively.

4.4. Did the magnitude of change in perceived risks and benefits depend on the particular type of information?

We were interested in understanding if information about risk or benefit would have different effects on the degree to which one's perception of risk or benefit changes. Therefore, we calculated two change scores for each participant: time 2 perceived benefits – time 1 perceived benefits; time 2 perceived risks – time 1 perceived risks. To assess whether the magnitude of these changes in the perceived risk and benefit differed as a function of condition (i.e. information type), we conducted an analysis of variance (ANOVA) for each of these change variables between the different conditions.

4.4.1. Change in perceived benefits

There was a significant difference between the magnitude of change in perceived benefits between the four conditions $F(3,363) = 66.841$, $P < 0.001$. Post hoc analyses were conducted using the Scheffé post hoc criterion for significance. There was no significant difference in the magnitude of change in perceived benefit between the high-benefit and low-risk information conditions ($|M_{diff}| = 0.13$, $P = 0.94$). In addition, the magnitude of change in perceived benefits in the low-benefit information condition was significantly more negative than the high-benefit and the low-risk information conditions ($P < 0.001$). Perhaps most interestingly, the magnitude of change in perceived benefits in the high-risk information condition was significantly more negative than the low-benefit information condition ($P = 0.009$) as well as the other conditions ($P < 0.001$) (see Fig. 3).

4.4.2. Change in perceived risks

There was a significant difference in the magnitude of change in perceived risks across the four information conditions $F(3,364) = 59.568$, $P < 0.001$. Post hoc analyses were conducted using the Scheffé post hoc criterion for significance. The magnitude of the change in perceived risks in the high-risk information condition was significantly more positive than all of the other conditions ($P < 0.001$). There was no significant difference in the magnitude of the change in perceived risks between the high-benefit and the low-risk information conditions ($|M_{diff}| = 0.41$, $P = 0.19$). However, the magnitude of change in perceived risks in the low-benefit information condition was significantly more positive than the high-benefit and the low-risk conditions ($P < 0.001$) (see Fig. 3).

The analysis showed that providing information indicating that the vaccine is either beneficial (i.e. high benefit condition) or safe (i.e. low risk condition), had a similar effect on the degree to which the perceived risk and the perceived benefit decreased and increased, respectively. Additionally, the analysis suggested that exposure to information about the low benefit of the vaccine significantly decreased the perceived benefits and increased the perceived risks. Similarly, the analysis indicated that exposure to information about the potential risk of the vaccine not only was most likely to affect changes in perceived risks, but also changes in perceived benefits. In fact, the degree to which perceived benefits and perceived risks decreased and increased, respectively, was the highest when exposed to information implying that a vaccine may be high in risk. This finding suggests that although people are aware of the adverse and sometimes fatal consequences of a disease, they are still very sensitive to receiving any information implying that a vaccine may have potential side effects (i.e. potential risks of a vaccine). Subsequently, they perceive the vaccine as being significantly less beneficial and more risky after exposure to brief information about the potential risks of the vaccine.

Table 3
The correlation between perceived risks and benefits in each condition.

Condition	Correlation
High-benefit	$r(94) = -0.63^{**}$
Low-risk	$r(88) = -0.64^{**}$
Low-benefit	$r(91) = -0.71^{**}$
High-risk	$r(87) = -0.77^{**}$

** All correlations are significant at $p < 0.001$.

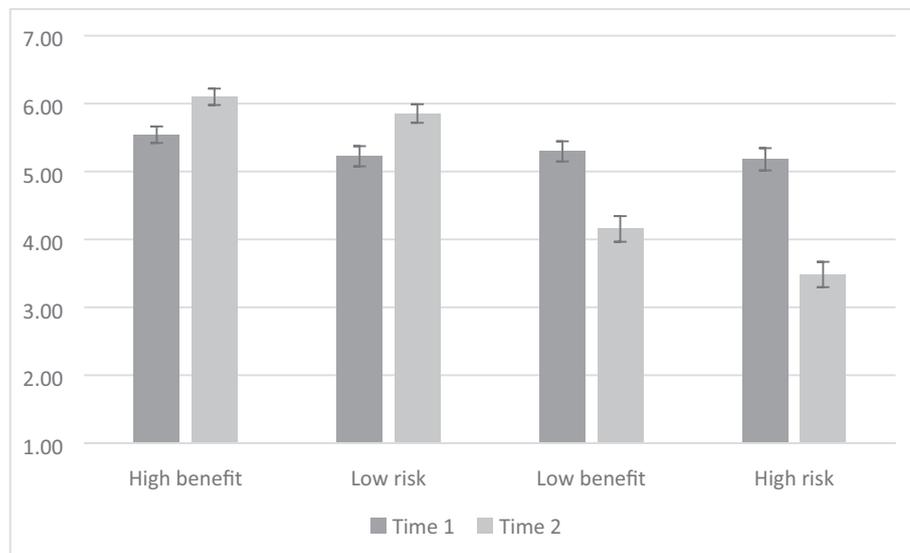


Fig. 1. Average perceived benefit of the RDD vaccine when exposed to different types of information in different conditions. The error bars show the standard error.

Table 4

Results of the paired *t*-test analysis between the perceived benefit/risk at time 1 and the perceived benefit/risk at time 2.

Pair: Benefit at time 2 & benefit at time 1 Condition:	Paired differences							
	Mean difference*	Std. Deviation	Std. Error Mean	95% Confidence interval of the Difference		t	df	Sig (2 -tailed)
				Lower	Upper			
High benefit	0.563	1.141	0.116	0.331	0.794	4.831	95	<0.000
Low risk	0.629	0.993	0.105	0.420	0.838	5.978	88	<0.000
Low benefit	-1.143	1.411	0.148	-1.437	-0.849	-7.727	90	<0.000
High risk	-1.697	1.433	0.152	-1.999	-11.166	-11.166	88	<0.000
Pair: Risk at time 2 & risk at time 1 Condition:	Paired differences							
	Mean difference*	Std. Deviation	Std. Error Mean	95% Confidence interval of the Difference		t	df	Sig (2 -tailed)
				Lower	Upper			
High benefit	-0.708	1.230	0.126	-0.958	-0.459	-5.640	95	<0.000
Low risk	-1.122	1.297	0.137	-1.394	-0.851	-8.210	88	<0.000
Low benefit	0.130	1.092	0.114	-0.096	0.356	1.146	90	0.250
High risk	1.236	1.470	0.156	0.926	-11.166	7.934	88	<0.000

* The mean difference is the average of the difference between the perceived benefit/risk at time 2 and the perceived benefit/risk at time 1.

4.5. Intention of vaccination

Our third research question examined the extent to which individuals' intentions for vaccinating their child(ren) changed after exposure to new information about the risks or benefits of a vaccine. Similar to the above analysis, we first examined whether exposure to each type of new information led to changes in vaccination intentions. We then examined whether the magnitude of the change depended on the particular type of information.

4.5.1. Changes in vaccination intentions after exposure to new information

We ran a series of paired-sample *T*-tests to investigate the degree to which the exposure to new information influenced respondents' intentions to vaccinate their children from time 1 to time 2 (see Table 5 and Fig. 4). The analysis indicated that the intention to vaccinate their child significantly increased after exposure to information about either high benefits or low risks of the vaccine. Similarly, the intention to vaccinate their child

significantly decreased after exposure to information about either low benefits or high risks.

4.5.2. Did the magnitude of change in vaccination intentions depend on the particular type of information?

To investigate this question, we first calculated the changes in the intention for vaccination before and after receiving the new information by subtracting the intention for vaccination in time 2 from the intention for vaccination in time 1, for each condition. We then ran an ANOVA to compare the changes in the intention between the different conditions.

An analysis of variance showed that there was a significant difference between the changes in the intention to vaccinate one's child between the four conditions $F(3,364) = 175.739$, $P < 0.001$ (see Fig. 5). Post hoc analyses using the Scheffé post hoc criterion for significance showed that there was no significant difference in the magnitude of the change in the vaccination intentions between the high-benefit and the low-risk information conditions ($|M_{diff}| = 0.03$, $P = 1$). Also, the magnitude of the change in vaccination

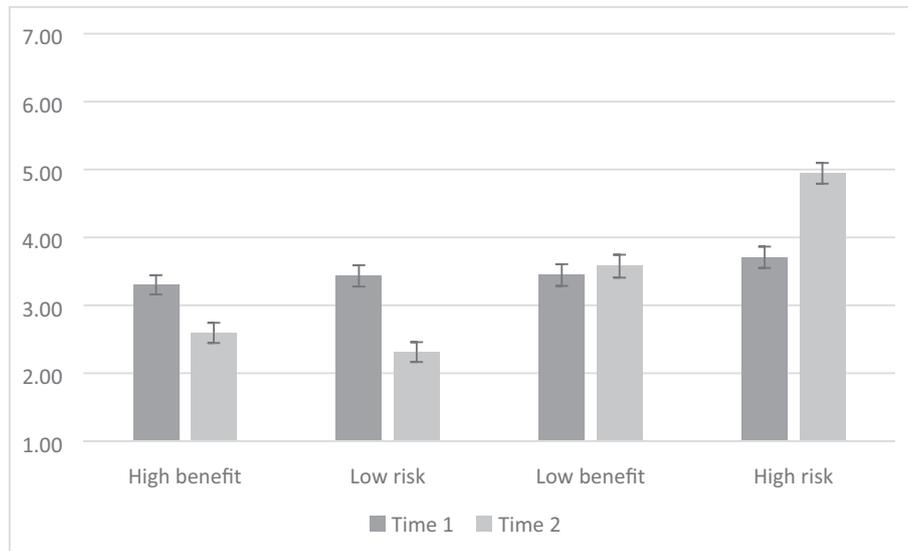


Fig. 2. Average perceived risk of the RDD vaccine when exposed to different types of information in different conditions. The error bars show the standard error.

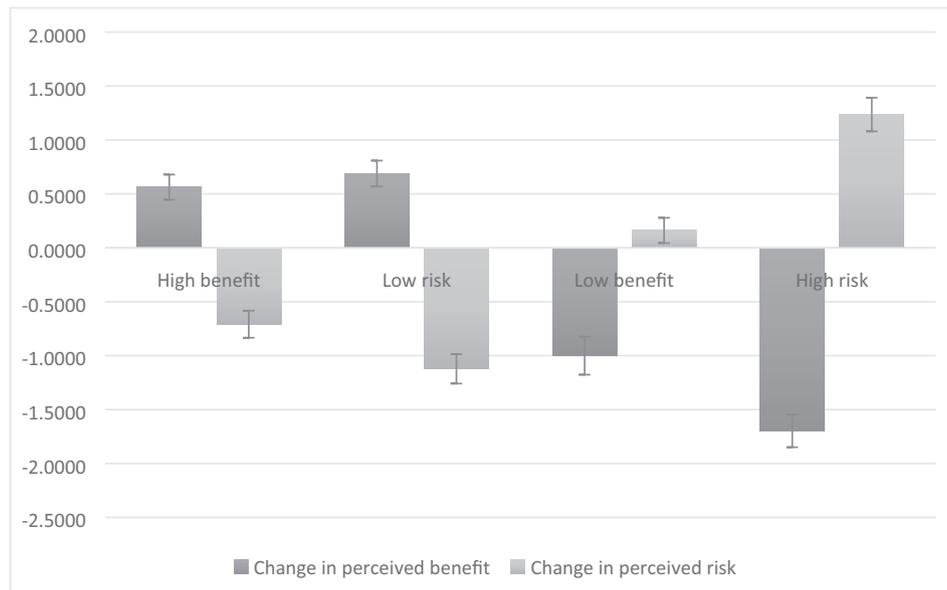


Fig. 3. The changes in the perceived risk and the perceived risk from time 1 to time 2. The error bars show the standard error.

Table 5

Results of the paired t-test analysis between the intention to vaccinate at time 1 and the intention to vaccinate at time 2.

Pairs: Intention at time 2 & intention at time 1 Conditions	Paired differences							
	Mean difference*	Std. Deviation	Std. Error Mean	95% Confidence interval of the Difference		t	df	Sig (2 -tailed)
				Lower	Upper			
High benefit	0.448	0.844	0.086	0.277	0.619	5.197	95	<0.000
Low risk	0.478	0.864	0.091	0.297	0.659	5.245	88	<0.000
Low benefit	-0.441	0.650	0.067	-0.575	-0.307	-6.536	92	<0.000
High risk	-1.011	1.028	0.109	-1.228	-0.795	-9.281	88	<0.000

intentions in the low-benefit conditions was significantly more negative than the low-risk or the high-benefit conditions ($P < 0.001$). Last, the magnitude of the change in intention to vaccinate in the high-risk condition was significantly more negative than in all the other conditions ($P < 0.001$).

Similar to the analysis of the changes in the perceived risks and benefits of the vaccine, the analysis showed that providing information about either the high benefit of a vaccine or information indicating that a vaccine is low in risk have a similar effect on the degree to which the intention to vaccinate increased.

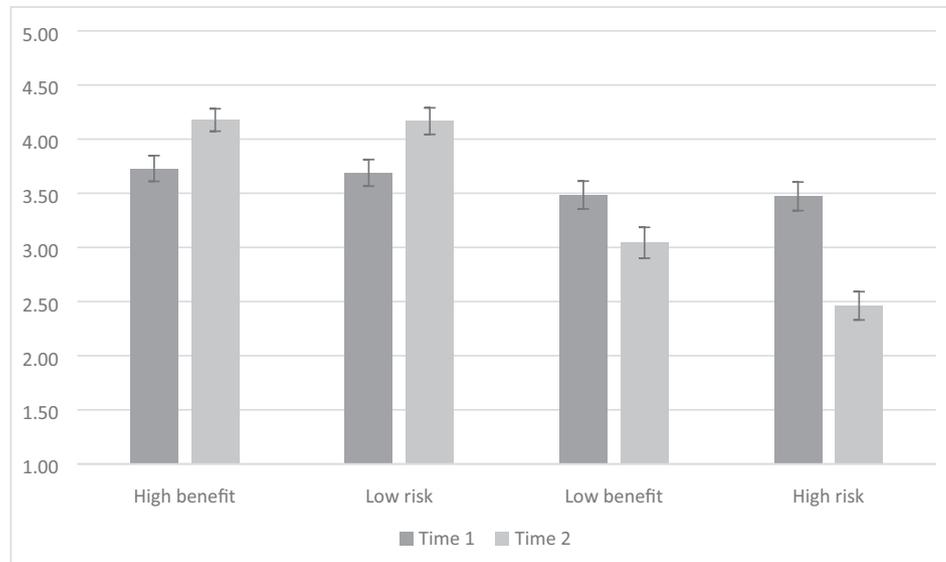


Fig. 4. The average intention to vaccinate when exposed to different types of information in each condition. The error bars show the standard error.

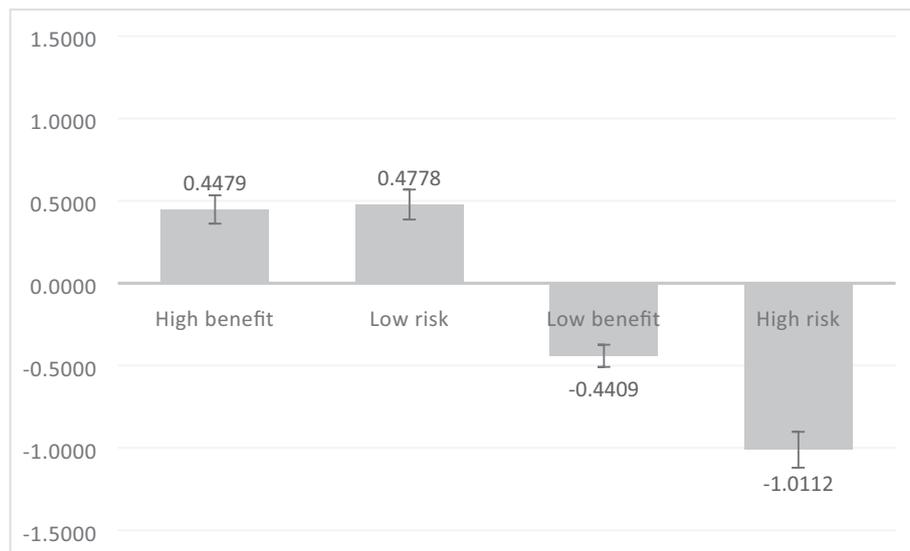


Fig. 5. The change in the intention for vaccination after reading the new piece of information. The error bars show the standard error.

Furthermore, the analysis indicated that an exposure to information implying the high risk of a vaccine drastically decreased one's intention for child vaccination compared to any other type of information. This finding suggests that receiving information about the risk of the vaccine may be most likely to negatively affect people's vaccination behaviour.

5. Discussion

Although it is assumed that exposure to new information influences people's vaccination decisions, there is little work investigating how this information affects their perception of the risks and benefits of the vaccine and vaccination intention or behaviour. In this study, we first explored the relationship between the judgement of risk and benefit in personal decisions regarding vaccination, and then investigated the degree to which an exposure to information regarding the high/low risks/benefits of a vaccine affects one's perception of the risks and benefits of the vaccine; and subsequently, their intention to vaccinate their children.

Judgement of risk and benefit have been shown to be inversely related when people make a judgement about a societal problem concerning social utilities [1,11]. In this work, we expanded this finding and explored the relationship between the perceived risks and benefits in personal decisions concerning vaccination. We found that similar to social decisions, the judgment of risk and benefit are inversely related when it comes to personal decisions to vaccinate. That is, the higher the perceived risks of a vaccine, the lower its perceived benefits, and vice versa. For instance, when one perceives a vaccine to be risky (i.e. to have side effects), then he/she is significantly more likely to perceive the benefits of the vaccine as less than what he/she would have perceived did he/she perceive the vaccine as safer, and vice versa. In other words, this finding indicates that by providing information about either risks or benefits of a vaccine, we may be changing one's perception of both the risks and benefits of the vaccine.

Moreover, we showed that the information implying that a vaccine might be beneficial or safe has similar effects on perceived risk, perceived benefit, and the intention to vaccinate. More

specifically, our findings showed that the effects of exposure to information about the safety or the effectiveness of a vaccine were not significantly different in the degree to which one's perception of the risk and benefit of the vaccine decreased and increased, respectively. Similarly, the degree to which the intention to vaccinate increased was not significantly different between the high benefit and the low risk information provision conditions. These results suggest that vaccine messages can be framed to address the audience's main concern whether it be about the low efficacy of the vaccine or its safety, knowing that both frames would carry similar outcomes. Another implication of this result is to inform health care providers and public health communication agents to include discussions around this information and to clearly communicate the information about the safety and benefits of the vaccines, seeing how influential information conveying the low risk or the effectiveness of the vaccine is on the decisions to vaccinate.

We also showed that information conveying the low benefits of a vaccine significantly decreased the perceived benefits and increased the perceived risk of the vaccine, and consequently, significantly decreased the intention to vaccinate. This finding indicates the significant role that the perceived benefit has on the intention to vaccinate. Our study provides further empirical evidence to support previous research identifying that the low perceived benefit of vaccines (as has been seen with Influenza or HPV) is the most influential factor contributing to the low rates of uptakes [8,9].

Finally, our study showed that exposure to information about the potential side effects of a vaccine can change one's perceived benefit and risk of a vaccine, significantly more than the exposure to any other types of information. Respondents' overall evaluation of the vaccine as well their intention to vaccinate changed the most negatively when presented with risk information about the vaccine. In fact, we showed that despite informing the respondents about the severe and even fatal consequences of the disease, exposure to anecdotal examples/information implying that the vaccine might be high in risk negatively affected respondents' cognitive evaluation of the vaccine; and consequently, drastically decreased their intention for vaccination. This finding shows how detrimental exposure to the information implying the high risk of a vaccine may be in vaccination behaviour and indicates the importance of regulating falsely presented risks information regarding vaccination to the public.

6. Limitations and future work

Although the effect of the perceived risk and benefit in vaccination behaviour is extensively studied in the literature [4,5,8,9,13], the present research was the first of its kind to quantify the extent to which risk and benefit information affects vaccination intentions. This study was based on a hypothetical scenario to investigate the role of risks and benefits information on vaccination decisions while controlling for the effects of participant's potential pre-conceived biases about certain vaccines. However, future research should be conducted to investigate the degree to which the risk and benefit information affects one's existing attitudes and beliefs about vaccination. For instance, a potential future direction of this work would be to investigate how the perception of risks and benefits of the actual MMR vaccine would be affected when providing different types of risks and benefits information. Furthermore, the methodology used in this work can be furthered utilized to explore the effect of other types of risks or benefits information, for instance the effect of herd immunity, on the intention to vaccinate.

One of the limitations of this work was that we only measured respondents' intention to vaccinate. Future steps could be to monitor the respondents' behaviour and study the degree to which var-

ious types of information affect their subsequent vaccination behaviour. Another limitation of this work was that we did not measure the participants' prior beliefs/attitudes about vaccination. Future researchers can include this factor in their analysis and explore the degree to which prior beliefs may play a role in the extent to which the perceived risks and benefits change after exposure to new information.

It is also important to mention that we only measured respondents' perceived risk, perceived benefit and their intention to vaccinate their child(ren) right after exposure to the new information. Therefore, the significance of the findings of this paper might be limited to that timeline. A possible next step would be to study the long-term effects of exposure to risks and benefits information on vaccination behaviour.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Please read this information carefully, you will be asked to answer the following questions based on this information.

Public health agencies have identified a new virus that leads to Respiratory Discoloration disease. The disease is highly contagious and is spread by coughing and sneezing, close personal contact or direct contact with affected persons.

In the following, you will be presented with some information regarding the RDD disease and its vaccination. More information will be provided afterwards.

A.1. Symptoms and complications

The first sign of RDD is usually a high fever followed by a runny nose, a cough, red and watery eyes, and small white spots inside the cheeks can develop. After several days, the skin color changes to red in various spots, usually on the face and upper neck. Over about 3 days, the discoloration spreads, eventually reaching the hands and feet. This condition lasts for 5–6 days, and then fades. RDD can lead to complications. The most serious complications include blindness, brain swelling, severe diarrhea and related dehydration problems, ear infections, or severe respiratory infections such as pneumonia. Most RDD related deaths are caused by complications associated with the disease. Complications are more common in children under the age of 5, or adults over the age of 20.

A.2. Cure

No specific treatment exists for RDD disease. However, there is a vaccine that can prevent individuals from getting the disease.

A.3. Vaccination and side effects of vaccination

A vaccine, like any medicine, is capable of causing serious health concerns, such as severe allergic reactions. The risk of

RDD vaccine causing serious harm, or death, is extremely small. Getting RDD vaccine is much safer than getting RDD. Most children who get RDD vaccine do not have any problems with it.

The following is the list of potential side effects:

A.4. Mild problems

Fever (up to 1 person out of 6) Mild rash (about 1 person out of 20).

Swelling of glands in the cheeks or neck (about 1 person out of 75).

If these problems occur, it is usually within 614 days after the shot.

A.5. Moderate problems

Seizure (jerking or staring) caused by fever (about 1 out of 3000 doses).

Temporary pain and stiffness in the joints, mostly in teenage or adult women (up to 1 out of 4).

Temporary low platelet count, which can cause a bleeding disorder (about 1 out of 30,000 doses).

Severe problems (very rare)

Serious allergic reaction (less than 1 out of a million doses).

Several other severe problems have been reported after a child gets this vaccine, including: Deafness, Long term seizures, Coma, or lowered consciousness Permanent brain damage

Appendix B

B.1. The scenarios in each condition

B.1.1. High benefit

RDD vaccination is highly effective in protecting an individual from the RDD virus without causing the suffering of the severe consequences of the disease itself. RDD vaccination is the only way to protect a person from the dangerous and highly contagious RDD virus as there is no treatment for it. RDD vaccine creates immunity by boosting the body's own immune system. In recent years, all the individuals who received the vaccine have been 100% immune towards the disease.

B.1.2. Low benefit

Although physicians believe that vaccination is the only scientific way to protect a person from the dangerous and highly contagious RDD virus, some people claim that there is no need in getting the vaccine as they can control the consequences of the infection by other methods such as herbal medicines. Moreover, it is shown that 10% of the vaccinated individuals who take the RDD vaccine do not develop immunity. In recent years, there have been some individuals who received the vaccine and still were affected by the virus.

B.1.3. High risk

In recent years, several severe problems have been reported following RDD vaccine, these include severe allergic reactions, and problems such as permanent brain damage, long-term seizures, coma, or lowered consciousness, and deafness. Scientists state that these complications are not common, but recently several cases of these severe complications have been reported.

B.1.4. Low risk

Since the complications of the vaccine are extremely rare, there is not enough evidence for scientists to be sure if the complications are even caused by the vaccination; and therefore, there is not any meaningful link between the RDD vaccine and these consequences. In a set of reliable recent studies, the risk of the RDD vaccination have been shown to be almost zero. In recent years there has not been any documented complications of the vaccination.

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