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An Assessment of the Literature on Childhood Vaccination from a Behavioural Economics Perspective

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ABSTRACT

Childhood vaccination is a key public health strategy that safeguards lives and stop the spread of infectious illnesses. Despite the known advantages of vaccination, several nations still have poor immunization rates for children. There has been a rise in focus on concepts of behavioural economics to boost vaccination rates in the recent years. This literature review attempts to provide an overview of the data on behavioural economics interventional ability to boost immunization rates in children. After an extensive examination of electronic databases, we included 44 papers that satisfied the requirements for inclusion in this paper. Various behavioural economics concepts, such as default options, framing and messaging, incentives, and reminder systems, were studied in the study. Overall, the research suggests that raising vaccination rates for children may be accomplished by using behavioural economics concepts. Our review underlines the potential for behavioural economics to raise child immunization rates and provide guidance to academics, politicians, and healthcare professionals on how to create successful immunization programs.

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1. Introduction

Childhood vaccination is the practice of immunizing children against communicable illnesses by giving them vaccines, which contain weakened or incapacitated forms of the illness-causing pathogens (CDC, 2023c). They stimulate the immune system of the body to produce antibodies that fight and kill the pathogens if exposed to them in the future. Vaccination is suggested and administered by healthcare providers, and is often compulsory for children to begin schooling or go to day care centres (CDC, 2023a). Vaccines have been effective in reducing the prevalence and death rates from various diseases, such as polio, measles, and hepatitis B (Orenstein & Ahmed, 2017). For example, measles inoculation in the 1960s caused a major reduction from 500,000 to less than 100 cases per year in the United States (CDC, 2023b). In the same way, smallpox was eliminated through vaccination and is notably one of the greatest communal health achievements in the medical history (Breman & Arita, 1980).

Childhood vaccination is one of the most important communal health accomplishments achieved by mankind (CDC, 2023c). It has saved hundreds of lives by averting the spread of various communicable diseases (CDC, 2023c). However, some parents or societies continue to be hesitant with regards to vaccinating their kids on one pretext or the other like safety concerns, misinformation, or personal beliefs (Pearce, Law, Elliman, Cole, & Bedford, 2008). Vaccine hesitancy can be defined as "delay in acceptance or refusal of vaccines despite availability of vaccination services" (Jacobson, Sauver, & Rutten, 2015). Low vaccination rates in many countries, lead to outbreaks of vaccine-preventable diseases. Vaccine hesitancy has risen as a substantial challenge to the success of vaccination programs (Galagali, Kinikar, & Kumar, 2022; Obohwemu, Christie-de Jong, & Ling, 2022). Routine Vaccination Coverage — Worldwide, 2021, by World Health Organization regions is shown in Table 1. Consequently, it is important to comprehend the factors that affect immunization behaviour to plan effective interventions programs.

Behavioural economics smears through psychology, sociology, and neuroscience to comprehend the decision making behaviour of the people in economics perspective (Thaler & Sunstein 2008). Behavioural economics identifies that people's decisions are often influenced by cognitive biases, emotions, and social context, which can lead to suboptimal choices which is in direct contradiction to traditional economic approach which consider people to make rational decisions (Kahneman, 2011; Voinson, Billiard, & Alvergne, 2015). The application of behavioural economics has been done in various sectors, like health, education, and public policy, to plan interventions that push people to make better choices (Thaler & Sunstein 2008). Hence, behavioural economics suggests a more realistic approach to understanding decision-making behaviour.

Table 1
Number and Global percentage of zero-dose children, by WHO region— 2021

		WHO Region						Economic Classification		
Characteristic	**Global**	**Africa**	**Americas**	**Eastern Mediterranean**	**Europe**	**South-East Asia**	**Western Pacific**	**Low**	**Middle**	**High**
No. of countries	194	47	35	22	53	11	27	28	106	58
No. of surviving infants (millions)	130.5	38.1	13.6	18.2	10.2	32.8	17.6	24	94.2	11.8
Global % of surviving infants	—	29	10	14	8	25	13	18	72	9
No. of zero-dose children (millions)	18.2	7.7	1.9	2.1	0.3	4.6	1.6	5	12.8	0.3
Global % of zero-dose children	—	42	10	11	2	25	9	27	70	2

Note: Adapted from Routine Vaccination Coverage — Worldwide, 2021 (Rachlin, Danovaro-Holliday, Murphy, Sodha, & Wallace, 2021)

The significance of this study is applying insights from behavioural economics to childhood vaccination can assist to overcome some of the barriers to immunization and boast vaccination rates. It can help to recognize the important cardinals which accelerates vaccine approval and plan interventions that are more effective in encouraging vaccination behaviour. Existing research on childhood vaccination identifies a research gap in understanding parents' decision-making from a behavioural economics perspective. Traditional public health campaigns which usually neglect the complex cognitive and social factors that influence decision may not be sufficient to change people's vaccination behaviour (Betsch & Sachse, 2013). They primarily focus on rational decision-making, while behavioural economics offers a framework to explore the influence of cognitive biases, social factors, and economic incentives on parents' vaccination choices. Linking this research gap enhances understanding of behavioural factors and barriers,

facilitating targeted interventions to improve vaccination rates. The research objective of this paper is, "To provide insights into the behavioral economics aspects of childhood vaccination, with the goal of understanding the decision-making process of parents and identifying effective strategies to improve vaccination rates". The key question keeping in view the research objective is what are the key Behavioural Economics concepts relevant to childhood vaccination? Moreover, after identification what are the Behavioural Economics challenges in promoting childhood vaccination? And how can Behavioural Economics interventions increase childhood vaccination Rates?

2. Methodology

To find pertinent research, a thorough search of electronic databases (such as PubMed, Embase, Google scholar and Psych INFO) was carried out. The search used a combination of behavioural economics and child vaccination-related keywords. To find related papers, the reference lists of the included studies and pertinent review articles were also consulted. The search included research released from year 2000 to the present. The titles and abstracts of the shortlisted papers were examined by two independent reviewers to determine their suitability for inclusion and they were included in the review after they satisfied the criteria defined. The study design includes randomized controlled trials, quasi-experimental studies, observational studies, or literature reviews and were written in English language. The population of the selected studies were children under 18 years of age and their parents with behavioural economics interventions to increase childhood vaccination rates. The included studies had vaccination rates or vaccine-related behaviour as outcomes.

From the initial search results of 1367 articles, and screening the titles and abstracts, 77 papers were shortlisted. 33 studies that did not meet our inclusion criteria were excluded. The full text of the remaining 44 studies were included in our final analysis. The studies included were conducted in various countries, including the United States, Canada, Australia, and the United Kingdom. The sample sizes of the studies ranged from 50 to 50,000 participants.

3. Insights from Previous Literature

3.1 Overview of Behavioural Economics Concepts Relevant to Childhood Vaccination

Behavioural economics has gained attention from communal health practitioners recently so as to understand and address the factors that impact individuals' choices with respect to childhood vaccination. It provides insights as to how people make decisions in everyday situations and suggesting interventions that may improve outcomes for both individuals and society. An overview of several key concepts in behavioural economics that are pertinent to childhood immunization is as under: -

3.1.1 Prospect Theory and Loss Aversion

Prospect theory is a central concept in behavioural economics, developed by Kahneman and Tversky (1979) which outlines how people assess and make decisions under conditions of risk and uncertainty. People tend to be more responsive to losses than to gains, meaning that they are more likely to take risk to avoid losses than to go after potential gains (Kahneman, 2011; Tversky & Kahneman, 1991). This phenomenon, also known as loss aversion, has a important implication for public health interventions such as childhood vaccination, which may be framed as a potential loss (e.g., risk of side effects) or a potential gain (e.g., protection from diseases) (Azarpanah, Farhadloo, Vahidov, & Pilote, 2021). For example, a study by Gallagher and Updegraff (2012) found that parents were more likely to immunize their children when they got messages emphasizing the risks of not vaccinating (i.e., loss-framed messages) than when they received messages highlighting the benefits of vaccination (i.e., gain-framed messages).

By understanding how people weigh potential losses and gains, public health practitioners can develop messaging and framing strategies that are more likely to be effective in promoting vaccination. Moreover, parents may be more concerned about the side effects of the vaccine than a risk of their child contracting a vaccine-preventable disease (Kestenbaum & Feemster, 2015). These findings suggest that public health practitioners can consider framing messages about childhood vaccination in ways that emphasize the potential losses associated with not vaccinating.

3.1.2 Social Norms

Social norms are unwritten rules that dictate what is considered acceptable behaviour within a group or society. Social norms refer to the shared expectations and beliefs of a group, which can influence individuals' behaviour and decisions (Cialdini & Goldstein, 2004). Social norms can influence vaccine uptake by shaping people's attitudes and behaviours towards vaccination. Conversely, if vaccine hesitancy is prevalent, individuals may be less likely to vaccinate to avoid social disapproval (Hornsey, Harris, & Fielding 2018). In the context of childhood vaccination, social norms can play a powerful role in shaping parents' attitudes and beliefs about vaccination. For example, more parents would vaccinate their children if they take vaccination as a social norm or if they believe that other parents in their community support vaccination (Brewer, Chapman, Rothman, Leask, & Kempe 2017).

By leveraging social norms through targeted messaging and community engagement, public health practitioners can encourage greater uptake of childhood vaccination. For example, a study by Bicchieri, Xiao, and Muldoon (2011) revealed that parents are more likely to vaccinate their wards when they received messages emphasizing the high vaccination rates of other parents in their community (i.e., descriptive norms).

3.1.3 Defaults and Choice Architecture

Defaults refer to the pre-set options or choices that are presented to individuals in decision-making contexts. Choice architecture refers to the design of these decision-making contexts, including the way that choices are presented and framed. Behavioural economists have found that defaults and choice architecture can have a significant impact on people's choices and behaviour (Thaler & Sunstein, 2008). For example, making vaccination the default option (i.e., automatically enrolling children in vaccination programs unless parents opt out) has been shown to increase vaccination rates in some contexts (Brewer et al., 2017).

3.1.4 Overconfidence Bias

Overconfidence bias is a cognitive bias that commonly referred to as the overconfidence effect, causes people to falsely overestimate their abilities and expertise (Slovic, Fischhoff, & Lichtenstein, 1982). It can make people to undervalue the risks and perils of not vaccinating, which ultimately leads to vaccine hesitancy (Betsch, Böhm, & Chapman, 2015). For example, parents may misunderstand their ability to protect their child from vaccine-preventable diseases through hygiene or nutrition and underestimate the importance of vaccination (Kestenbaum & Feemster, 2015).

Overconfidence bias might cause some parents to assume that they can appropriately weigh the dangers and benefits of vaccination without the assistance of medical professionals in the case of child immunization. For example, a study by Hornsey et al. (2018) found that parents which were more confident in their ability to assess vaccine risks were less likely to vaccinate their children. These findings imply that public health practitioners should be aware of the role of overconfidence bias in vaccine reluctance and explore ways to combat it, such as giving clear

and correct information about the risks and benefits of vaccination and emphasizing the importance of role and consulting with a healthcare professional.

3.1.5 Anchoring Effect

The anchoring effect is a cognitive bias which describes people's tendency to make their decisions primarily on the first piece of knowledge they are provided. (the "anchor") (Tversky & Kahneman, 1974). The anchoring effect can influence vaccine uptake by influencing people's perceptions of the risks and benefits of vaccination. For example, If people are fed misinformation about vaccination prior to receiving valuable information, they may get fixated on the negative information and be less inclined to vaccinate their kid (Dube et al., 2013).

Individuals can do biased assessments and conclusions as a result of this effect. Anchoring effect may arise in the context of pediatric vaccination when parents get information from untrustworthy means, like anti-vaccine websites or social networking sites, which may distort their perceptions of the dangers and benefits of vaccination. Research has shown that anchoring effect can be a significant factor in vaccine hesitancy (Nyhan, Reifler, Richey, & Freed, 2014). For example, a study by Garett and Young (2021) found that exposure to anti-vaccine information can increase vaccine hesitancy among parents, even when they are aware that the information is unreliable. Therefore, this suggest that health professionals should be mindful of the anchoring effect's role in vaccine reluctance and consider ways to counteract this bias, such as giving accurate and trustworthy information on the risks and merits of vaccination from trusted sources.

3.2 Behavioural Economics Challenges in Promoting Childhood Vaccination

Behavioural economics offers promising strategies for promoting childhood vaccination, but there are also numerous challenges that should be addressed. In this section, some of the common challenges that hinder vaccine uptake will be reviewed, and how they can be addressed from a behavioural economics perspective.

3.2.1 Misinformation and Misconceptions

Vaccine misinformation and misconceptions are common and they lead to vaccination reluctance and rejection (Garett & Young, 2021; Osuagwu et al., 2023). Misconceptions is incorrect information that is transmitted accidentally, whereas misinformation is false information which is shared on purpose. Both can have a detrimental impact on vaccination acceptance by causing misunderstanding and scepticism in the parents and public at large. Misconceptions and misinformation spread quickly on social networking sites and other internet platforms, making it difficult to confront and rectify.

Studies have shown that people are more likely to believe misinformation if it aligns with their pre-existing beliefs, values, and attitudes. In such cases, corrective messages that challenge misinformation may not be effective in changing attitudes and behaviour. Behavioural economics interventions that take into account people's existing beliefs and values may be more effective in addressing misinformation and misinformation. Whenever somebody refuse to vaccinate because they are sceptical of vaccines, it is critical to dispel misconceptions (Betsch et al., 2015).

Misinformation and misconceptions regarding vaccine safety and effectiveness are pervasive and can have a significant impact on vaccine uptake. Some parents believe that vaccines cause autism, despite overwhelming evidence to the contrary (Nyhan & Reifler, 2015). While many other believes that vaccines are not necessary because the diseases they prevent are no longer a threat. One approach to addressing misinformation is to provide corrective

information that challenges these misconceptions (Betsch et al., 2015). However, research has shown that simply presenting factual information may not be enough to change beliefs. In some cases, corrective information can even backfire and reinforce misinformation, particularly when the corrective information is seeming as threatening to one's worldview (Nyhan & Reifler, 2015).

3.2.2 Psychological Reactance

Psychological reactance is a psychological phenomenon that happens when people feel their liberty or autonomy is vulnerable. When people perceive that they are being coerced or pressured into a certain behaviour, they may experience reactance and resist the behaviour. This can be particularly relevant in the context of childhood vaccination, where parents may feel that their autonomy and decision-making power are being challenged. If vaccination is perceived as a norm or coercion, reactance will result in deliberately opposing it (Betsch et al., 2015).

Studies have shown that using strong or coercive language to promote vaccination can actually decrease vaccine acceptance (Brewer et al., 2017). Instead, behavioural economics interventions that respect parents' autonomy and decision-making power may be more effective in promoting vaccination. For example, providing information in a non-coercive manner and highlighting the benefits of vaccination while acknowledging potential concerns may be more effective in increasing vaccine acceptance (Hornsey et al., 2018). To mitigate reactance, health officials and communicators can use messaging that emphasizes the benefits of vaccination and avoids language that is coercive or judgmental (Opel et al., 2013). They can also frame vaccination as a choice that empowers parents to protect their children from preventable diseases.

3.2.3 Fear of Side Effects

Fear of side effects is another challenge in promoting childhood vaccination. While vaccines are generally safe and effective, rare but serious side effects can occur. Fear of these side effects can result in vaccine hesitancy and refusal, especially amid parents who believes that the hazards of vaccination to be higher than the benefits.

Behavioural economics interventions that address fear of side effects can include framing vaccine information in terms of relative risks and benefits, and providing clear and transparent information about the risks of vaccination (Betsch et al., 2018). For example, providing information about the risks of not vaccinating can help to put the risks of vaccination into perspective. To address fear of side effects, health officials and communicators can provide clear and transparent information about vaccine safety, including the risks and benefits of vaccination. They can also use social proof to demonstrate that the vast majority of children who receive vaccines experience no or mild side effects (Thunström, Nordström, Shogren, Ehmke, & van't Veld, 2016).

3.2.4 Trust in Healthcare Providers and Government Institutions

Adoption of vaccines depends on public confidence in medical professionals and public organisations. Families who have confidence in both the government and their medical professionals are far more inclined to vaccinate their kids than those who have mistrust for these organisations. Providing straightforward and unambiguous information about the reliability and effectiveness of vaccinations, as well as being open and honest with parents, are two behavioural economics interventions that attempt to enhance confidence in healthcare practitioners and governmental organisations (Hornsey et al., 2018). Local community leaders and personalities can be engaged in the marketing of vaccines which can also assist to foster trust and boost vaccination uptake (Ozawa, Paina, & Qiu, 2016).

To build trust, healthcare providers can engage in open and honest dialogue with parents about the benefits and risks of vaccination (Kumar, Chandra, Mathur, Samdariya, & Kapoor, 2016). They can also use strategies such as storytelling to help parents understand the importance of vaccination and to address any concerns that they might be having (Marotta & McNally, 2021).

4. Behavioural Economics Interventions to Increase Childhood Vaccination Rates

Behavioural economics offers valuable insights into understanding and improving vaccination behaviour. This section discusses how behavioural economics principles can be applied to increase childhood vaccination rates. The following strategies are based on research in the field of behavioural economics as discussed in earlier sections and have shown promising results. They also underline the potential for behavioural economics in providing guidance to academics, politicians, and healthcare professionals on how to create successful immunization programs: -

4.1 Default Options

Default options are choices made on behalf of individuals if they do not express a preference and can be defined as "the tendency for decision makers to stick with the default, or the option that takes effect if one does not make an explicit choice" (Li & Chapman, 2013). Individual vaccination decisions also get affected by the default effect (Chapman, Li, Colby, & Yoon, 2010). Making vaccination the default option encourages more individuals to choose it (Sundaram et al., 2018). In the context of childhood vaccinations, the default option is usually to vaccinate unless the parent or guardian explicitly opts out. Default options capitalize on the human tendency towards inaction or status quo bias.

Parents are more likely to vaccinate their children if vaccination is the default option because it requires more effort to opt out. A study by Opel et al. (2013) revealed that the proportion of parents that decided to inoculate their children increased significantly when vaccination was the default option (from 42.4% to 70.7%). Default vaccination does not prohibit the implementation of other forms of vaccination policy alongside it. Furthermore, vaccination at school as the default choice will be ethical and moreover will be successful in empowering a community to attain herd immunity (Giubilini et al., 2019).

4.2 Framing

The way information is presented can influence decision-making. Framing messages is important in the context of childhood vaccinations because it can affect parents' perceptions of the risks and benefits of vaccination. For example, emphasizing the benefits of vaccination (e.g., protecting children from serious diseases) rather than the risks (e.g., side effects) is more likely to persuade parents to vaccinate their children. Similarly, presenting vaccination as a social norm, such as by stating that "most parents vaccinate their children," can also be effective in increasing vaccination rates (Brewer et al., 2007). Research has shown that framing vaccination messages positively can be more effective in increasing vaccine uptake than framing messages in a negative or fear-based way (Nyhan & Reifler, 2015). Positive messages can highlight the benefits of vaccination, such as the protection against serious diseases, while also addressing common concerns, such as vaccine safety (Brewer et al., 2017).

4.3 Incentives

Rewards and/or penalties linked to vaccination decisions are known as incentives, and they have been found to dramatically enhance immunization rate (Stone et al., 2002). Incentives

can be used to motivate parents to vaccinate their children. Financial incentives, such as offering a small amount of money or a gift card, have been effective in increasing vaccination rates. Incentives should be added, and the societal value of vaccination should be emphasised when people choose not to vaccinate because they believe the dangers exceed the benefits (Betsch et al., 2015). A study by Erdem, Erdem, and Monson (2023) found that offering a small financial incentive significantly increased the proportion of parents who vaccinated their children by 2.64 to 4.23 percentage. However, incentives may not be effective in all contexts, and there are concerns that they may lead to unintended consequences, such as reducing intrinsic motivation to vaccinate.

4.4 Reminder Systems

Reminder systems are another intervention that can increase vaccination rates. Reminder systems can be implemented in various ways, such as through phone calls, text messages, or letters. Immunization rates can increased by 1 to 20 percentage as a result of reminders (Jacobson et al., 2015). A study found that telephone reminders increased the number of children who received all recommended vaccines (Lemstra, Rajakumar, Thompson, & Moraros, 2011). Text message reminders were effective in enhancing vaccination rates among children and it can cause 39% relative increase as reported by a study conducted in Western Australia (Regan, Bloomfield, Peters, & Effler, 2017).

4.5 Using Social Norms

As discussed earlier, social norms can influence vaccine uptake. By leveraging social norms, health communicators can encourage vaccination behaviour by emphasizing the social consensus around vaccination (Brewer et al., 2017). For example, messages that emphasize the high vaccination rates in a particular community can create a social norm that encourages parents to vaccinate their children (Brewer et al., 2018).

4.6 Making Vaccination Convenient

Research has shown that convenience is a key factor in vaccine acceptance. By making vaccination more convenient, such as offering vaccinations in schools or workplaces, health officials can increase vaccine uptake (Brewer et al., 2017). Additionally, simplifying the vaccination process, such as by providing clear and concise information about vaccination or reducing the number of required vaccinations, can also increase uptake (Flood et al., 2010; Hornsey et al., 2018).

4.7 Engaging in Dialogue

Engaging in dialogue with the vaccine-hesitant parents can be a good approach for growing and enhancing vaccine uptake. Research has shown that listening to parents' concerns and addressing their questions and fears can lead to increased vaccine acceptance (Opel et al., 2013). Additionally, engaging in dialogue can help to build trust and increase assurance in the vaccination process (Brewer et al., 2017). In a study conducted in the USA, reviews of parents in the intervention neighborhoods revealed statistically significant changes in attitudes towards vaccinations, and the proportion of respondents who identified as "vaccine-hesitant" fell from 22.6% to 14.0% (Schoeppe et al., 2017).

5. Conclusion

Ensuring childhood vaccination is essential for safeguarding kids from different diseases. Behavioural economics has shown its relevance for the issue of childhood immunisation. The initiatives to raise childhood vaccination rates can be guided by an appreciation of the cognitive

aspects. Further research should be conducted to identify the most effective ways of implementing these interventions in different contexts while ensuring ethical considerations. Overall, this literature review highlights the potential of applying behavioural economics to childhood vaccination and provides important insights for policymakers and healthcare providers looking to design effective vaccination programs.

5.1 Limitations of the Study

The studies encompassed in this review are limited to English language publications and may not be representative of all studies on the topic. Moreover, there can be publication bias as research with negative findings are less likely to be published. The studies included in this review were conducted in different countries, which may limit generalizability to other settings. Lastly, the review was limited to studies that used a behavioural economics perspective and may not have included other important factors that can influence childhood vaccination.

5.2 Future Research Directions

The findings of this review also point towards several future research directions. For instance, more studies are needed to identify the most effective behavioural economics interventions for increasing childhood vaccination rates in different contexts. Furthermore, studies are needed to understand the mechanisms through which these interventions work and to identify ways to overcome the challenges associated with promoting childhood vaccination using behavioural economics. Lastly, further research should examine the long-lasting effects of these interventions on childhood vaccination rates and on the health of vaccinated children.

Authors Contribution

Muhammad Javed Ramzan: manuscript preparation, study design and concept, revision
Saqib Munir: data collection, methodology and data analysis
Akram Ali Shah: literature review, discussion, drafting and proofreading

Conflict of Interests/Disclosures

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