

A Systematic Review of Applications of Behavioral Economics in the Health Sector

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ABSTRACT

People often make poor decisions when it comes to their health, such as choosing high-calorie food choices, taking medicines in the wrong way, and delaying treatment when they have a disease. Since traditional economic theory assumes that people make decisions based on a rational process, behavioral economics argues that humans can make imperfect decisions. This paper provides a more detailed framework for understanding and influencing behavior. This paper uses a combination of comparative literature analysis and case analysis to provide a background overview for future research by comparing and contrasting articles on the same topic, especially on food choice, medicine use, and treatment process. Several successful cases of testing the effectiveness of behavioral-based nudge interventions are presented. It also summarizes the common limitations in the research studying this topic. This study revealed that most studies investigating food choices show that interventions can effectively change people's decisions to choose healthier foods. Regarding medication use, although some articles indicate that the available interventions to improve the quality of antimicrobial prescriptions are not as effective, others demonstrate the potency of different interventions to limit unnecessary use or overdoses. It is beneficial to consider social norms when designing interventions.

Keywords: Food choice, Behavioral economics, Nudge interventions, Medicine use

1. INTRODUCTION

Due to the current state of health concerns, many research papers have attempted to introduce behavioral economics into their study to provide solutions to existing problems from various perspectives. Nudge guides or encourages users to follow the designer's preferred path or make ideal decisions by changing the minor features in the user's decision-making process. Nudge interventions are particularly significant in implementing and developing policies, the use of drugs, and changes in medical procedures. This systematic review focuses on topics relevant to people's lives, i.e., the choice of food, the use of medicines (antimicrobial), the treatment of diseases (HIV), and organ donations.

Studies have shown that choosing healthy foods, such as eating more fruits and vegetables, is beneficial for physical and mental health and is a long-term investment in future happiness [1]. Finding ways to entice people to make healthier food choices unwittingly is gaining a lot of attention. Not only does behavioral economics play a role in such small behaviors in life, but nudge intervention is also effective in decisions that

can affect people's life safety. The treatment of HIV is lengthy, and urging patients to continue receiving treatment has also become the key to effectively improving the survival rate of HIV patients. In terms of medication, many people have not only failed to relieve the original symptoms due to wrong prescriptions or overdose, but worsened their condition. Antimicrobial is a typical example of that. Besides, organ donation could be a saving-life function during an emergency that decides people's death indirectly. Increasing the registration rate of the donation should be highly valued and emphasized.

By comparing and analyzing the methods used and the conclusions reached by studying the literatures on the same topic, it is clear that behavioral economics plays an inestimable role in those mentioned above subtly affecting health fields. The purpose of this systematic review was to update earlier reviews on the efficacy of behavior-based interventions in improving people's health, focusing on studies since 2010. Besides, this review attempts to recognize several common limitations in current behavior-based research designs.

2. METHOD

Scopus and PubMed, the largest databases of abstracts and citations of peer-reviewed literature have been used to search for related articles. The date range of publication was set after 2010 (inclusive). Inclusion criteria require papers to illustrate the application of behavioral economics concepts in the field of health, especially in food choice and medicine use. The content of books or a chapter within a book has been excluded. Search terms include “behavioral economics”, “nudge”, “food choice”, “interventions”, “medicine use” and so on. Through such a scope, more than 300 articles have been searched out. Twenty papers were included in this systematic review by reading the abstract, methods, and conclusion. The selected articles fell into two categories influenced by behavioral economics: food choice and illness/medicine use. The systematic analysis of articles in these different fields will be carried out in three dimensions: 1) the background of that category, the reason for getting attention from researchers. 2) the methodology of their analysis, the exploration they made within the same type of topics but different approaches. 3) the conclusion, the commonalities and differences in their findings.

3. FOOD CHOICE

3.1. Reasons Got Attention

In the last decade of research papers discussing behavioral economics on health, a large part of the paper is about changing group food choices through nudge intervention.

Even with improved per capita standard of living, an analysis of nationally representative dietary data figured out that less than 10% of Americans met recommended fruit or vegetable intake [2]. Roughly only 5% of U.S. children meet the federal dietary recommendations [3]. Therefore, researchers have begun to see whether making some inconspicuous changes can lead to healthier food choices for specific groups. Youth, student and low-income populations are particularly valued. The new federal nutrition standards for school meals not only limit the maximum and minimum energy provided but also require students to take a minimum amount of fruits or vegetables [4]. In order for the new standards to be better implemented and reached, the school’s food and nutrition department needs to use the power of researchers to understand how to encourage students to choose healthier foods and eat more fruits or vegetables.

3.2. Methodology

Of the articles selected, their research methods fall into two main categories. One is where authors design experiments to investigate how nudge intervention

changes their study topic. The other was to review the published articles, identify the high-quality papers that met their criteria through a particular screening process, and then systematically analyze them to categorize or summarize the different or similar conclusions reached in the same field.

When designing experiments, the designers usually compare the data changes before and after the implementation of the nudge intervention and use statistical methods to judge whether such changes are significant and draw corresponding conclusions. Some experiments tested different interventions simultaneously. For example, in a randomized controlled trial of client selection, the experimenters compare the taking rate of the protein bar by placing them at the front and the end of the dessert area in terms. They concurrently offered packages of twelve and individual packages in different sessions. In terms of statistical perspective, they created a binary variable indicating whether the intervention increased the rate of choice. Based on a logistics regression generated from the binomial distribution, confidence interval, pairwise difference, and odds ratio have been used to test the significance [5]. In some relatively simple experiments, which investigated only one form of intervention, the p-value was checked by univariate ANOVA to test the statistical significance of the differences [4]. Half of the selected articles used similar methods.

As far as systematic review papers are concerned, in the step of screening articles, some authors score the quality of related articles according to the established criteria to select dozens of articles with the highest scores. In contrast, some authors keep the articles that meet the requirements without any numerical or statistical analysis. The papers recorded in detail the information points of the article. Typically documented are population sample, intervention, behavior theory, measures, and results.

3.3. Conclusions

Food choice and preference have particularity and temporary dependence compared to items requiring follow-up treatment such as microwave or television [6]. One article suggested that students are not regularly taking fruits and vegetables even if the school lunch has been offered to them. They suggested that schools need to make efforts in nutrition education and use strategies based on marketing and behavioral economics to encourage teenagers to make healthier food choices [4]. While another reviewing article presents that school meal nudges have a positive association with selection behaviors and a negative association with waste, but their impact on consumption is not clear [3]. Similar findings have been obtained in studies not limited to schools that the interventions modestly increase fruit and vegetable intake [7]. This paper also finds that the

placement and convenience interventions have the most influence on increasing vegetable consumption. When it comes to placement-based intervention, a research paper provides evidence that placing the product in the first place and keeping the product in the original package leads to an increase in selection among food pantries [5]. They also discovered that overlap of interventions might enhance their effectiveness. These articles all prove from different angles that behavior-based interventions can make people choose healthier foods. However, stronger behavior interventions are required to achieve a healthier selection of food across the population.

4. ILLNESS AND MEDICINE

4.1 Reasons Got Attention

One of the topics highlighted in these selected articles is HIV. In 2018, young women aged 15-24 years accounted for 26 percent of all new HIV infections in sub-Saharan [8]. Antiretroviral therapy (ART) is the treatment for HIV, which needs the patients to take HIV medicines every day [9]. It requires incredibly high perseverance to maximize resistance and suppression of the virus. However, only 25% of HIV-infected individuals in sub-Saharan Africa are virally suppressed [10]. Traditional strategies used to improve compliance with ART often mistakenly rely on individuals' conscious awareness, and fail to consider a series of influencing factors of decision making. Oral antiretroviral pre-exposure prophylaxis (PrEP) is the most effective preventive intervention currently available [16]. The implementation of this method has also become an essential factor in effective HIV prevention.

Another category that was focused on in this category was antimicrobial. About 50% of the hospitalized patients in America received at least one type of antimicrobial a day, and half of them take more than one [11]. However, 25%-68% of antimicrobial prescriptions are deficient [12]. The use of social marketing to influence prescribing practices for acute patients is limited. Researchers would like to explore the effectiveness of interventions to improve the antimicrobial prescribing quality to fill this gap. Not only for humans, but the use of antimicrobial in poultry was also being studied. Researchers aim to take antimicrobial drug use patterns as a direction for future intervention measures and explore effective interventions that promote judicious antimicrobial use.

The third topic of interest is organ donation registrations. Statistics on organ donation show that the demand for donors is increasing, but the supply of available donors is insufficient, and the gap between them is still increasing [15]. While the promotional messages are not the only method, the whole marketing mix could be functioned together and encourage people

to become organ donors [14]. Given that, researchers began to investigate what kind of intervention should be used to increase the number of organ donor registrations.

4.2 Methodology

Most of the articles selected in this category use highly relevant methods to data analysis, rather than just theoretical discussions. They all tested the effectiveness of more than one intervention.

As for ART adherence improvement, patient-centered design has been used to develop interventions, including interactive posters, taking-home calendars, and small plastic pillboxes [10]. They also generated in-person interviews about patients' clinic experience and perceptions of interventions. Retention in care at 6 months after baseline and the percentage of appointments completed during the 6-month observation period were measured. They applied Pearson's chi-square test to compare proportions and t-test to compare means. Unadjusted logistic and linear regression models were used to test the association between interventions. They calculated the odds ratio and mean difference with a 95% confidence interval to ensure the result. They also conducted a sensitivity test of the effectiveness of scheduling appointments and walk-in visits.

The interview is also used to explore antimicrobial to conduct a designed KAP survey. The research team studying antimicrobial use in the poultry sector in Kenya uses focus group discussions (FGDs) and in-depth interviews (IDIs) to collect qualitative data [13]. During data analysis, they also used Chi-square tests by creating a dummy variable indicating whether a respondent reported giving antimicrobials to birds. They combined qualitative interviews and quantitative data generated from the KAP survey to provide more comprehensive insight.

The nudge interventions conducted in the field experiment of organ donor registrations consist of two process changes and four promotion measures. They provided a simplified version of the organ donor registration form [14]. They tested the impact of handing out the information brochure and three different prompts along with the simple-version form, respectively. It's worth mentioning that they did a detailed data analysis. Starting from model-free evidence to examine the effectiveness of behavioral interventions and process changes; followed by logistic regressions with the fixed effect of time and each agent; then they present validity and robustness checks to test their hypothesis and address potential confounding variables, including historical trend, agent-day of the week and the busyness of the center (Figure 1); ending with seven follow-up posttests to investigate the empirical evidence support for their interventions' impact.

| | M | R1 | R2 | R3 |
|--|------------------|------------------|------------------|------------------|
| Preexperiment standard process phase | .86 (.12) | .84 (.19) | .82 (.22) | .86 (.13) |
| Preexperiment acclimation phase | 2.09*** (.50) | 2.09*** (.50) | 2.28*** (.59) | 2.03*** (.47) |
| Control condition | 1.00 (.) | 1.00 (.) | 1.00 (.) | 1.00 (.) |
| Information condition | 1.99*** (.40) | 2.02*** (.48) | 2.23*** (.62) | 1.87*** (.38) |
| Reciprocal altruism condition | 1.85*** (.12) | 1.88*** (.33) | 2.14*** (.48) | 1.74*** (.17) |
| Imagine self condition | 1.81* (.44) | 1.87 (.70) | 2.19 (.92) | 1.99*** (.51) |
| Imagine other condition | 1.25 (.14) | 1.29 (.44) | 1.55 (.56) | 1.31* (.17) |
| Postexperiment acclimation phase | .76 (.12) | .80 (.39) | .92 (.47) | .75 (.13) |
| Postexperiment standard process phase | .86 (.10) | .93 (.65) | 1.20 (.86) | .78 (.11) |
| Time trend (days) | | 1.00 (.02) | .99 (.02) | |
| Customers per agent | | | | .95 (.02) |
| Day-of-week fixed effects | Yes | Yes | Yes | Yes |
| Agent fixed effects | Yes | Yes | Yes | Yes |
| Agent \times day-of-week fixed effects | No | No | Yes | No |
| N | 10,027 | 10,027 | 9,056 | 10,027 |

*p < .05.
 **p < .01.
 ***p < .001.

Notes: Column M is our main specification, column R1 adds a linear time trend, column R2 adds agent \times day-of-week fixed effects, and column R3 adds customers per agent. Standard errors are robust and clustered at the daily level. Our dependent variable is registration as a new organ donor (i.e., consent = 1, no consent = 0).

Figure 1 Robustness Check in Organ Donor Registration Result (odds ratio)

4.3 Conclusion

Unlike articles in the field of food choice, which are consistent in their conclusions, some articles are contrary to each other regarding the use of behavioral economics for the treatment of diseases and drugs. A systematic review found that interventions used to improve the prescription of antimicrobials were of poor quality and were not designed on a reliable theoretical scientific basis [12]. The influence of social norms, attitudes, and beliefs on prescribing is not considered when designing and evaluating such interventions [12]. While another article that also studied antimicrobial suggested that highlighting the dangers of antimicrobial and the proper use of the drug by using bright colors can reduce unnecessary antimicrobial purchases or use [13]. In terms of improving ART adherence, a research paper indicates that interventions based on social norms and priming are not only effective in enhancing persistence in treatment for people living with HIV, but also improving patient satisfaction with clinic services [10]. This also proves that applying social norms in the intervention will affect the effectiveness to some extent. Regarding o registering organ donations, a field experiment indicates that providing a simpler version of the registration form and encouraging people with different prompts enable them to increase new registrations [14].

5. CONCLUSION

The methodologies used in the selected research papers have several common limitations. Firstly, the generalizability of these approaches should be increased. For example, the food choice study regarding students was only conducted in five schools [4]; the interventions improving ART adherence were designed and tested only in two clinics in Tanzania [10]. The statement

derived from the research cannot be widely used among the public and only provides a reference. Secondly, it is difficult to distinguish the effectiveness of individual intervention components. Since interventions are often packaged and implemented, multiple interventions are carried out simultaneously. Among these reviewed articles, only one study of food selection in the pantry explicitly calculates whether the benefits of stacking interventions are increased compared to a single intervention. The rest of the articles only confirm that the use of interventions is effective, but do not clarify whether a specific initiative has the greatest or least benefit, and it is even possible that some measures in this series of interventions are meaningless. Thirdly, spillover effects and confounding variables might exist. The characteristics of the population of interest are not recorded, and detailed information on education, income, race, occupation, etc. is not collected. In implementing interventions, people may notice changes in the surrounding environment, especially interventions that require the cooperation of staff to implement. Participants who have experienced changed services may tell their companions who haven't come, then people who were originally in the control group will change their behavior due to this information. It is worth mentioning that studies on organ donor registration provide different directions of robustness checks to address potential confounders. Lastly, there is no apparent connection between the behavioral economic theory and the interventions undertaken. Only a few articles briefly introduce the design source of intervention. There is no detailed theory and knowledge based on behavioral economics to present and explain the rationale for the interventions they experimented with and why they were designed as they were.

In conclusion, most of the selected papers studying food selection indicate that the nudge interventions

could efficiently change people's decisions and increase the proportion of choosing healthier options. While some articles suggest poor quality of existing antimicrobials prescription quality-improvement interventions, other papers prove the validity of different types of nudges restricting the unnecessary use of drugs. The consideration of social norms in designing interventions is useful.

REFERENCES

- [1] Wahl, D.R., Villinger, K., König, L.M. et al (2017). Healthy food choices are happy food choices: Evidence from a real life sample using smartphone based assessments. *Sci Rep* 7, 17069. <https://doi.org/10.1038/s41598-017-17262-9>
- [2] Kimmons, J., Gillespie, C., Seymour, J., Serdula, M., & Blanck, H. M. (2009). Fruit and vegetable intake among adolescents and adults in the United States: percentage meeting individualized recommendations. *Medscape journal of medicine*, 11(1), 26.
- [3] Metcalfe, J.J., Ellison, B., Hamdi, N. et al (2020). A systematic review of school meal nudge interventions to improve youth food behaviors. *Int J Behav Nutr Phys Act* 17, 77. <https://doi.org/10.1186/s12966-020-00983-y>
- [4] Smith, S. L., & Cunningham-Sabo, L. (2013). Food choice, plate waste and nutrient intake of elementary- and middle-school students participating in the US National School Lunch Program. *Public Health Nutrition*, 17(6), 1255–1263. <https://doi.org/10.1017/S1368980013001894>
- [5] Norbert L.W. Wilson, David R. Just, Jeffery Swigert, Brian Wansink (2017), Food pantry selection solutions: a randomized controlled trial in client-choice food pantries to nudge clients to targeted foods, *Journal of Public Health*, Volume 39, Issue 2, Pages 366–372, <https://doi.org/10.1093/pubmed/fdw043>
- [6] Hayes, J. E., DePasquale, D. A., & Moser, S. E. (2011). Asymmetric dominance as a potential source of bias in hedonic testing. *Food Quality and Preference*, 22(6), 559–566. <https://doi.org/10.1016/j.foodqual.2011.03.006>
- [7] Thomson, C. A., & Ravia, J. (2011). A Systematic Review of Behavioral Interventions to Promote Intake of Fruit and Vegetables. *Journal of the American Dietetic Association*, 111(10), 1523–1535. <https://doi.org/10.1016/j.jada.2011.07.013>
- [8] HIV and AIDS in East and Southern Africa Regional Overview. Avert. (2020, August 25). Retrieved from <https://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/overview>.
- [9] U.S. Department of Health and Human Services. (n.d.). HIV treatment: The basics. National Institutes of Health. Retrieved from <https://hivinfo.nih.gov/understanding-hiv/fact-sheets/hiv-treatment-basics>.
- [10] McCoy, S. I., Fahey, C., Rao, A., Kapologwe, N., Njau, P. F., & Bautista-Arredondo, S. (2017). Pilot study of a multi-pronged intervention using social norms and priming to improve adherence to antiretroviral therapy and retention in care among adults living with HIV in Tanzania. *PLoS ONE*, 12(5). <https://doi.org/10.1371/journal.pone.0177394>
- [11] Magill SS, Edwards JR, Beldavs ZG, et al (2011). Prevalence of Antimicrobial Use in US Acute Care Hospitals. *JAMA*. 2014;312(14):1438–1446. doi:10.1001/jama.2014.12923
- [12] Charani, E., Edwards, R., Sevdalis, N., Alexandrou, B., Sibley, E., Mullett, D., Franklin, B. D., & Holmes, A. (2011). Behavior Change Strategies to Influence Antimicrobial Prescribing in Acute Care: A Systematic Review. *Clinical Infectious Diseases*, 53(7), 651–662. <https://doi.org/10.1093/cid/cir445>
- [13] Kiambi, S., Mwanza, R., Sirma, A., Czerniak, C., Kimani, T., Kabali, E., Dorado-Garcia, A., Eckford, S., Price, C., Gikonyo, S., Byarugaba, D. K., & Caudell, M. A. (2021). Understanding Antimicrobial Use Contexts in the Poultry Sector: Challenges for Small-Scale Layer Farms in Kenya. *Antibiotics*, 10(2). <https://doi.org/10.3390/antibiotics10020106>
- [14] Robitaille, N., Mazar, N., Tsai, C. I., Haviv, A. M., & Hardy, E. (2021). Increasing Organ Donor Registrations with Behavioral Interventions: A Field Experiment. *Journal of Marketing*, 85(3), 168–183. <https://doi.org/10.1177/0020242921990070>
- [15] Organ, eye, and tissue donation registration. Donate Life America. (2020). Retrieved from <https://www.donatelife.net/>.
- [16] Celum, C. L., Delany-Moretlwe, S., McConnell, M., van Rooyen, H., Bekker, L.-G., Kurth, A., Bukusi, E., Desmond, C., Morton, J., & Baeten, J. M. (2015). Rethinking HIV prevention to prepare for oral PrEP implementation for young African women. *Journal of the International AIDS Society*, 18(4Suppl3)