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Original Article

Promoting Stretching Engagement through Health Belief Model-Based Nudges: The Effectiveness of Threat vs. Benefit-Based Nudge Messages

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Abstract

Background: We aimed to investigate the effectiveness of health belief model-based nudge messaging on engagement in stretching that was either threat-based or benefit-based.

Methods: A quasi-experimental design allocated the participants (N=69) into three groups: the threat nudge group, which received messages emphasizing perceived susceptibility and severity; the benefit nudge group, which received messages on the advantages of stretching; and the control group, which received no messages. The study was conducted in South Korea from October to November 2024. Participants' engagement in stretching was measured over a six-week period using the health application, which provided the stretching exercise sessions and tracked and recorded their duration.

Results: The threat nudge group exhibited the largest increase in stretching behavior, significantly outperforming both the benefit nudge group and the control group. The benefit nudge group showed an improvement but it tended to be a generally smaller and less dramatic effect than the threat nudge group. Analysis of variance showed a significant difference in stretching time across groups ($F_{2,67}$ = 26.43, P=.000; η_p^2 =0.44), with post-hoc tests indicating that the threat nudge group significantly outperformed both the benefit nudge and the control group in stretching duration.

Conclusion: One implication of these findings was that, as suggested by the health belief model, perceived threat can be a strong motivator for behavior change in the short term while perceived benefits alone may not be sufficient to drive immediate action. Practically, threat-based messaging can be particularly useful in the short term for physical activity instructors and app developers to motivate clients.

Keywords: Nudge messaging; Low-intensity exercise; Physical activity promotion; Perceived threat; Health behavior change

Introduction

Global levels of physical inactivity represent a growing public health issue with approximately 1.4 billion adults—27.5% of the worldwide adult population—not meeting minimum recommended activity thresholds (1-3). In South Korea, the 2022 National Leisure Activity survey (4) found that only about one fourth (25.5%) of individuals indicated that the most frequently engaged leisure activities were sports-related activities. Furthermore, the National Sports for All Survey (5) indicated a rising non-participation rate, with 32.2% of the population reporting no involvement in physical activities in 2023, up from 25.9% in 2019. This trend is associated with major health risks, including non-communicable diseases such as cardiovascular conditions and diabetes, as well as mental health disorders that burden healthcare systems financially (2). Thus, there is an urgent need for interventions that promote physical activity.

One accessible activity is stretching, an exercise in which muscles are stretched to improve flexibility, range of motion (ROM) and muscular function by different methods such as static, dynamic, ballistic, and proprioceptive neuromuscular facilitation (PNF) stretching (6). For example, static stretching (where a muscle is maintained in an extended position) has been well-studied for its effects on health with respect to improved flexibility of the muscles and joints, reduced stiffness of the muscles and connective tissues, and enhanced muscular endurance, which can result in improvement in gait performance along with decreasing musculoskeletal discomfort (6-10). Kokkonen (8), for example, found that participants who performed static stretching three times a week for approximately 40 min showed increases in lower limb flexibility, muscle strength, power, and endurance. In addition, stretching has shown beneficial mental effects such as decreased anxiety, depression, and psychological distress in patients with chronic diseases—improving quality of life and emotional well-being (11-13). This combination of physical and mental health benefits makes stretching a promising exercise modality, emphasizing the importance of identifying effective strategies to encourage engagement in this widely accessible activity.

The Health Belief Model (HBM), developed in the 1950s, is a key framework in health psychology and public health for predicting health behaviors based on individuals' beliefs and perceptions (14,15). It includes constructs such as perceived susceptibility (belief in personal risk), perceived severity (seriousness of the issue), perceived benefits (positive outcomes of action), perceived barriers (obstacles to action), cues to action (triggers for behavior), and self-efficacy (confidence in one's ability to act) (16-18). These elements help individuals evaluate health risks, weigh costs and benefits, respond to triggers, and believe in their ability to take preventive action. The HBM is widely used to understand public health interventions, particularly in preventive health areas like vaccination, screenings, and chronic disease management (19). HBM-based messages, especially those emphasizing perceived threat, can influence health behaviors by appealing to perceptions of risk and vulnerability (20,21). Messages highlighting susceptibility and severity promote preventive behaviors by creating urgency, while those focusing on benefits and positive reinforcement foster long-term engagement (22, 23). Additionally, research on physical activity interventions using motivational interviewing and home-based counseling highlights the effectiveness of tailored approaches to promote engagement in activities like stretching (24,25).

Further, additional studies have utilized HBM to examine and promote health behavior changes in various domains. For instance, studies evaluating adolescents' perceptions of tobacco addiction and health risks found that smoking adolescents perceived barriers to quitting as more significant than the benefits of quitting (26). Additionally, a study on HBM-based obesity reduction demonstrated that participants who received HBM-based health coaching lost 3.60% of their total weight, compared to 1.57% in the control group (27). Similarly, a study assessing the impact of HBM on nutrition education for type 2 diabetes patients showed significant improvements in perceived severity, perceived threat, and perceived benefits in the intervention group (28). These findings collectively highlight the effectiveness of HBM-based interventions in modifying health behaviors, particularly in the prevention and management of chronic diseases such as obesity and diabetes.

Recent research has actively explored the impact of digital nudge messaging on health behavior change. A nudge refers to a design modification that adjusts how choices are presented to steer users toward a particular decision, and its application has grown rapidly in recent years (29). The most commonly used digital nudges in digital healthcare for promoting behavioral change are feedback and reminders (26, 29). Furthermore, for digital health tools to be effectively designed and implemented, interventions based on behavioral economics are necessary to facilitate positive health behavior changes (27, 30). Moreover, combining nudges with digital health tools can yield even stronger effects on health behavior outcomes (28, 31). Thus, interventions utilizing digital nudges have established themselves as effective strategies for promoting health behavior change. In particular, the Health Belief Model (HBM), one of the key frameworks for health behavior change, can serve as a theoretical foundation for designing digital nudge interventions.

While HBM has been extensively applied to preventive health behaviors, its application to physical activity promotion, particularly in the context of stretching, remains underexplored. Unlike previous studies that focused on disease prevention, this study applies HBM-based nudge messages to encourage engagement in stretching behaviors, addressing physical inactivity as a public health concern. Specifically, we used the HBM framework to develop two types of nudge messages aimed at promoting stretching engagement. Participants received one of two messages: (1) a perceived threat message, which emphasized susceptibility and severity by highlighting the negative health consequences of inactivity, such as increased chronic disease risk; and (2) a perceived benefit message, which focused on the positive outcomes of stretching, including improved flexibility and mental well-being. Through this approach, we aimed to identify which message type more effectively motivates individuals to incorporate stretching into their routines, harnessing the power of health beliefs to increase stretching exercise engagement. By exploring the effectiveness of HBM-driven nudge messaging in the context of stretching, this study aimed to expand the application of HBM to physical activity promotion and contribute to the growing body of research on digital health interventions.

Methods

Study design

This study was quasi-experimental in nature. The data collection was conducted from the 2nd week of Oct 2024 to the end of the 3rd week of Nov 2024 for a total of six wk.

This study was approved by the Institutional Review Board (IRB) of Hankuk University of Foreign Studies (HIRB-202406-HR-004) in order to comply with ethical considerations and protect the rights of the participants involved in this quasi-experimental study. We clearly communicated the objectives and methods of this study to all potential participants, and those who provided written informed consent were allowed to participate in this study. All participants received KRW 50,000 (US $ 36.11 dollar) for the participation.

Ethics Approval

This study was approved by the Hankuk University of Foreign Studies Institutional Review Board (IRB) under reference HIRB-202406-HR-004. All participants signed the informed consent in this study.

Participants

Participant recruitment was conducted from the 3rd to 4th week of Sep 2024 for a total of 2 wk.

During the recruitment process, we used a combination of online and offline strategies to recruit participants. Online recruitment was conducted through social media (Instagram), university communities, and personal network communities to retain voluntary participants. Offline recruitment was conducted by researchers who explained the experiment to university students to encourage their willingness to participate. We also conducted 1:1 personal interview with potential participants who expressed interest in the experiment. The participants were eligible for the participation if they were adults, proficient in internet and mobile phone use, understood the study objectives, voluntarily agreed to participate, and did not have a diagnosed mental health condition.

Sample calculation

We used the G* power calculator (version 3.1.9.4) to calculate an adequate sample size for the current study. The objective was to attain a significance level of 0.05 and a statistical power of 80%, and an effect size of 0.45, utilizing data from a previous study that examined the influence of HBM-based training on physical activity (21). The calculation indicated that 51 participants would be required to attain a power level of 0.8. Considering that a 10% dropout rate is typical according to the previous literature (21), 56 participants were required to achieve a power of 0.8. As a result, 69 participants in this study would provide sufficient statistical power for this investigation.

Outcome measures

In this study, the primary outcome measure was the total seconds spent engaged in stretching exercise. We tracked the amount of stretching exercise participants engaged in through a mobile-based application called "Health" that accurately measured the real-time duration of their stretching exercises during six weeks. The primary comparison of interest was the total amount of stretching time across the three groups: threat nudge group, benefit nudge group, and control group. The cumulative stretching time was used to evaluate the effectiveness of different nudge messages (threat or benefit) in promoting engagement in physical activity.

Procedure and stretching intervention

Participants were assigned to one of the three six-week intervention programs: the threat nudge group, the benefit nudge group, and the control group (Fig. 1). Groups received 18 messages in total (delivered three times a week, at intervals of approximately two days), composed of HBM-related texts. Threat nudge group participants were given a threat message that included physical and psychological threats associated with sedentary behavior (e.g., "If you are sedentary, you are more likely to gain weight", "Sitting can lead to serious injury", and "Sitting for too long will stiffen your body") while benefit nudge group participants were given a benefit message that explained the physical and psychological benefits of stretching (e.g., Stretching is a great way to get your body moving", "Stretching can increase the range of motion of your joints", and "Stretching can help prevent muscle injury"). The control group did not receive any messages.

We used the Health app, an integrated health management tool developed by Samsung that tracks health data such as exercise, sleep, and diet, and supports more than 100 types of exercises. It is an artificial intelligence-driven wellness program that tracks physical activity and provides dietary and nutritional evaluations and mental health support. The app offers physical activity programs, including 32 stretching exercises, 44 full-body aerobic exercises, and 38 resistance exercise programs. The stretching exercise component of the app offers a variety of stretches, including core stretches, hip stretches, and adductor stretches, along with videos explaining their purpose and correct movements.

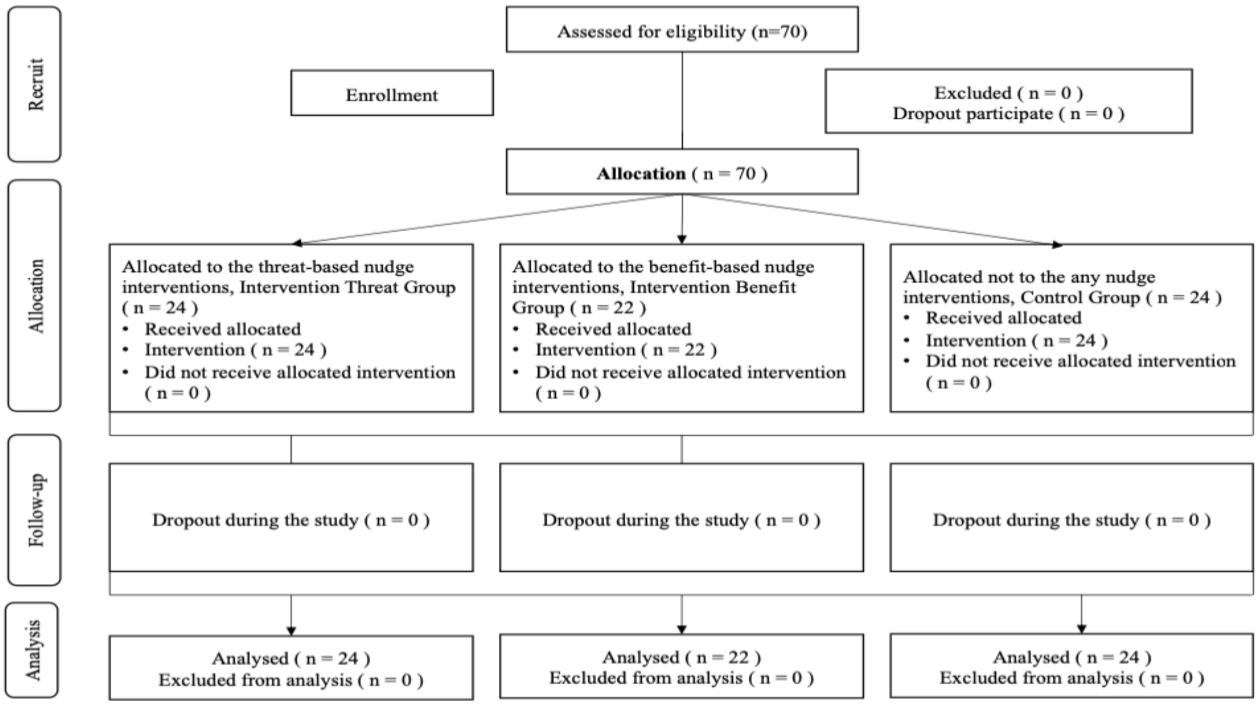

Fig. 1: Research procedure

Among the 32 stretching exercises, the intervention groups were allowed to choose the exercises of their choice as well as choosing the desired level (i.e., beginner, intermediate, or advanced) and number of trials. In this study, the exercise tracking feature of the Health app was deemed suitable because it was necessary to measure and record the amount of stretching in seconds in a non-face-to-face situation. The Health app is able to automatically identify and record activity types and help researchers record the duration of participants' stretching activities. The participants were asked to report this information immediately after every session, which was logged in a secure Google Sheets account. The research team monitored engagement by checking the Google sheet and sent push notifications to both the experimental groups encouraging participation and soliciting regular check-ins/survey responses.

Data analysis

In the first step of our data analysis, we performed a frequency and descriptive analysis, calculating frequencies and percentages for categorical variables and means and standard deviations for continuous variables. Next, we used one-way analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables to compare the groups. For the main analysis, we used ANOVA to assess the statistical significance of differences in stretching duration among the three groups. Subsequently, post hoc tests were conducted to identify which differences between pairs of groups were significant. For this purpose, we used Tukey's Honestly Significant Difference (HSD) test.

Results

Baseline demographic characteristics and outcome variables

Table 1 describes the demographic characteristics of participants across the threat (n=24), benefit (n=22), and control (n=24) groups. There were equal proportions of males and females in all groups (*P*=. 94). Regarding the continuous variables, there were no between-group differences in age, BMI, internet self-confidence or physical activity levels (IPAQ-S scores) (*P*>.05).

Table 1: Demographic characteristics

Characteristics	Threat (n=24)	Benefit (n=22)	Control (n=24)	*P*
Categorical variables, N (%)				
Gender				.94
Male	13 (54.2)	13 (59.1)	14 (58.3)	
Female	11 (45.8)	9 (40.9)	10 (41.7)	
Education				.20
High school diplomat	0 (0.0	1 (4.5)	1 (4.2)	
College students	18 (75.0)	14 (63.6)	22 (91.7)	
Bachelor's degree	6 (25.0)	6 (27.3)	1 (4.2)	
Graduate school	0 (0.0)	1 (4.5)	0 (0.0	
Experience in mobile-based physical activity app				.13
Yes	14 (58.3)	13 (59.1)	8 (33.3)	
No	10 (41.7)	9 (40.9)	16 (66.7)	
Physical activity participation				.45
No	7 (29.2)	8 (36.4)	3 (12.5)	
Once or twice a week	7 (29.2)	6 (27.3)	13 (54.2)	
Three or four times a week	5 (20.8)	4 (18.2)	4 (16.7)	
Five times or everyday	5 (20.8)	4 (18.2)	4 (16.7)	
Internet use per day				.17
Less than one hour	0 (0.0)	2 (9.1)	0 (0.0)	
One to two hour	2 (8.3)	5 (22.7)	2 (8.3)	
Two to three hour	9 (37.5)	4 (18.2)	6 (25.0)	
Three to four hour	1 (4.2)	3 (13.6)	5 (20.8)	
More than 4 hour	12 (50.0)	8 (36.4)	11 (45.8)	
Continuous variables, Mean (Standard Deviation)				
Demographic characteristics				
Age	23.38 (2.01)	24.59 (1.94)	23.54 (1.58)	.65
BMI	22.51 (3.20)	22.06 (2.11)	23.02 (2.66)	.49
Internet self-confidence	4.00 (0.83)	3.59 (0.85)	3.83 (0.76)	.24
IPAQ-S	2,155.01 (3,050.96)	1755.37 (1670.60)	1464.78 (1817.12)	.59

Main analysis

Fig. 2 shows the cumulative amount of time (in seconds) spent participating in stretching over time for the three groups. The threat nudge group exhibited a durable and significant increase in stretching exercise duration over 6 wk (over 5,000 seconds at the end point). In contrast, the benefit nudge group demonstrated a slight increase, leveling off around 1,000 seconds. The cumulative stretching time for the control group remained below 1,000 seconds, indicating significantly less participation, which may correlate with a lack of intervention or encouragement.

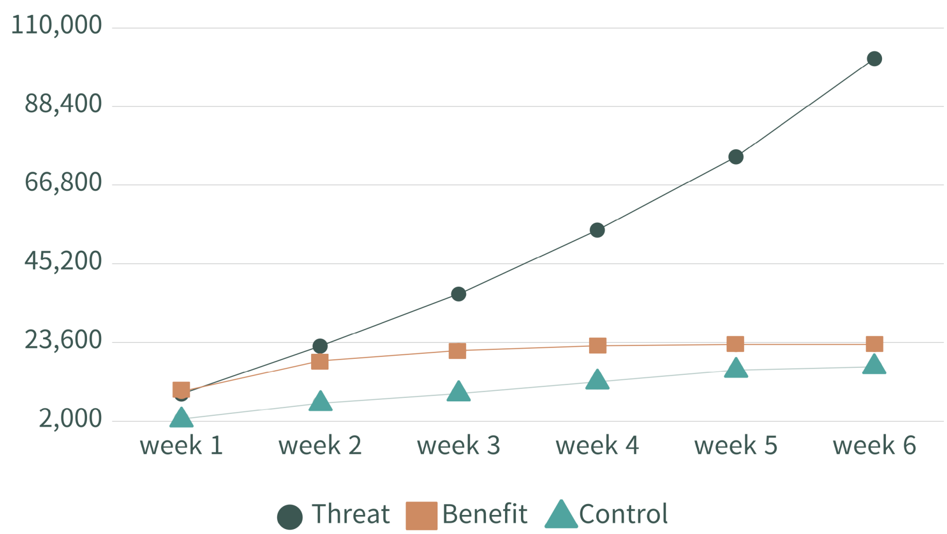

Fig. 2: Cumulative mean time spent participating in stretching over time for the three groups (in Seconds)

An ANOVA was performed to test the difference between groups in amount of stretching, and significant differences among groups were found ($F_{2,67}$ = 26.43, P<.001; η_p^2 =0.44). Post-hoc Tukey HSD tests revealed that the amount of stretching by the threat nudge group was significantly greater than both the benefit nudge group (general mean difference=3183.89 [standard error = 544.08], P<.001) and the control group (general mean difference=3524.87 [standard error = 532.12], P<.001). On the other hand, the benefit nudge group did not differ significantly from the control group (general mean difference =340.98 [standard error=544.08], P=.80). Additionally, the average participation frequency of the threat nudge group was 9.41 sessions, which was more than twice that of the benefit nudge group (4.5 sessions) and the control group (3 sessions). Table 2 shows the stretching amounts in each group.

Table 2: Comparison of total stretching duration across the three groups

Variable	Threat (n=24)	Benefit (n=22)	Control (n=24)	Threat vs. Control	Benefit vs. Control	Threat vs. Benefit
	M (SE)	*M (SE)*	*M (SE)*	*GMD (95% CI)*	*GMD (95% CI)*	*GMD (95% CI)*
Total duration of stretching exercise in seconds	4232.16 (2616.8)	1048.27 (1093.2)	707.29 (1399.6)	3524.87 (2249.43 to 4800.31)***	340.98 (-963.12 to 1645.08)	3183.89 (1879.79 to 4487.99)***

*** P < .001

Discussion

The current study tested the effect of HBM-based nudge messages on stretching behavior, specifically comparing the threat messages (emphasizing perceived susceptibility and severity) to the benefit messages (highlighting perceived benefits of stretching), with a control group receiving no motivational messages. The results offer important insights regarding messaging strategies that might enhance physical activity participation.

Summary of key findings and interpretation

First, the threat nudge group, which received messages highlighting the negative consequences of inactivity (perceived susceptibility and severity), demonstrated the largest increase in stretching behavior over the six-week period. These participants significantly outperformed both the benefit nudge group and the control group. This outcome is consistent with previous studies, which highlight perceived susceptibility and severity as strong motivators for health behavior change (20,21). In this context, participants reminded of the negative consequences of inactivity, such as increased health risks, were more likely to engage in stretching exercise. Thus, the fear of negative consequences appears to be a powerful driver of behavior change in this context, supporting the use of threat-based messaging in physical activity interventions.

Second, the benefit nudge group, which received messages focused on the advantages of stretching, did show an increase in the amount of stretching exercise compared to the control group, though the improvement was not statistically significant and as substantial or consistent as in the threat nudge group. The insignificant increase in amount of stretching exercise in the benefit nudge group in this study indicates that perceived benefits may not be as compelling or immediate in driving behavior change as perceived threats. In fact, research indicates that while perceived benefits can motivate behavior, they may not always be as compelling in driving immediate action as perceived threats (18, 32). Further, benefit-based messages are more effective when combined with additional motivational strategies, such as social support or cues to action, which may explain why the benefit nudge group in this study exhibited little improvement in behavior (23).

The comparison between the threat nudge and benefit nudge groups suggests that perceived threat is a stronger motivator for immediate behavior change in physical activity promotion. Fear-based messaging, emphasizing susceptibility and severity, often elicits more immediate responses than benefit-focused messages (20). However, this finding contrasts with HBM literature, which argues that both perceived threat and benefits drive health behavior change (14, 16). Combining perceived benefits with other motivating factors, like social support and self-efficacy, fosters sustained behavior change (23, 32). Therefore, while threat-based messages may drive short-term action, long-term adherence may benefit from strategies integrating both threats and benefits, along with support mechanisms.

This study contributes to understanding how HBM components, particularly perceived susceptibility and severity, can be applied in health interventions, especially for physical activity (20,21). It suggests that health interventions focused on changing physical activity behaviors should emphasize perceived risks to prompt immediate action (22). Additionally, the results challenge the notion that perceived benefits and threats are equally impactful, emphasizing the need for further exploration of how these factors interact in different contexts.

Practical implications

The results of this study have a number of practical implications that may be helpful to participants in exercise and application developers interested in facilitating health behaviors. Individuals who engage in physical activity can benefit from understanding how different types of messages influence their behavior. Self-awareness of perceived susceptibility and severity can facilitate implementation, leading a person to engage in stretching when they know worst-case scenario health outcomes that may result from being sedentary (21). Participants aware of this can look for, or respond to, cues (indications of possible health risks associated with a sedentary lifestyle), which will maintain their motivation for sustained PA behavior.

App developers in the field of fitness and health behavior change could include threat-based nudges within their notifications/push prompts. The possible strategy can be, for instance, reminders of cardiovascular or musculoskeletal dangers related to inactivity and suggestions to encourage users to engage in more regular physical activity. Given that prior research has shown that perceived benefits motivate behavior change, app developers should create a balanced approach that alternates between threat and benefit-based nudges to maintain user engagement over time. Personalization features that allow users to choose the type of message they find most motivating could enhance the app's effectiveness.

Limitations

This study has several limitations. Key limitations of this study are the somewhat small sample size, with the sample overwhelmingly consisting of young adults. The composition of the sample makes it difficult to generalize the results to other populations such as older individuals or those with various health conditions and different socioeconomic backgrounds. Longitudinal studies using larger, more diverse samples are needed to improve generalizability.

Further, we only studied stretching exercise, which may limit the generalizability of our results to other health behaviors. It would be interesting to determine whether this intervention effect is generalizable, for example to aerobic or resistance exercises, and whether it holds across levels of intensity, such as moderate or vigorous intensity levels. Such an expanded study would allow us to test whether both threat and benefit mediate health domain differences.

Another limitation is its reliance on app-based tracking to measure stretching activity. While the Samsung Health app provides an automated and structured method for recording stretching duration, it may not capture all stretching behaviors performed by participants. For example, informal or unstructured stretching outside of the app's tracking system may not have been recorded, potentially leading to an underestimation of actual engagement. Future studies may consider incorporating self-reported logs, wearable motion sensors, or direct observation to complement app-based tracking and enhance the accuracy of behavioral measurement.

Finally, the current study left out a key moderating variable that would affect how participants respond to threat or benefit messages. The moderating effect of factors such as individual personality traits, motivation, prior knowledge in health matters, and self-regulation skills could also have a significant impact on the effectiveness of interventions. Research is needed to determine the extent to which other variables interact with threats or benefits, potentially informing personalized health behavior change campaigns.

Conclusion

The present study provides evidence that HBM-based nudge messages, particularly threat-based messages about perceived susceptibility to and severity of health effects associated with not stretching successfully facilitate stretching involvement. Our findings stress the effectiveness of threat-based messages in stimulating short-term behavior increases, but suggest that it is possible that a combination of threat and benefit messages could provide additional benefits. Further, these insights have important implications for the interventions targeting physical inactivity and provide useful guidance for future interventions targeting physical inactivity that could promote sustained health behaviors.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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