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Using Messages Targeting Psychological versus Physical Health Benefits to Promote Walking Behavior: A Randomized Controlled Trial

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Abstract

Background: This study aimed to test the efficacy of a messaging intervention targeting psychological or physical benefits plus goal setting and self-monitoring strategies to promote walking activity in the university context.

Methods: 230 university students from the University of Naples Federico II were randomly allocated to one of four conditions: physical health messages + self-monitoring, psychological health (wellbeing) messages + self-monitoring, self-monitoring and no messages. All three intervention conditions were exposed to goal setting (doing at least 7000 steps a day) and required to monitor their daily progress through the specific step counting app. Participants' walking activity and related psychological variables were assessed at T1 and T2. We ran ANCOVAs and mediation analysis to test our research questions and hypotheses. Analyses were based on the N = 156 who completed all measures at both time points.

Results: Participants in the three experimental (message) conditions reported improvement in psychological variables and behavior. In particular, the messages focused on the physical health benefits, combined with self-monitoring, were the most effective.

Conclusions: Our study provides new information on the factors that could be usefully targeted to promote walking activity (i.e., intention, past behavior, action control and persuasive messages on the physical benefits of walking).

Keywords: physical activity, walking, messaging intervention, self-monitoring, goal setting, persuasive communication

1. Introduction

The World Health Organization (WHO, 2018) defines physical activity as any bodily movement produced by skeletal muscles that require energy expenditure. Regular physical activity results in health benefits in every age group. In childhood and adolescence, physical activity is necessary both for motor skills and osteo-muscular development. In adulthood, physical activity maintains muscle tone and improves the health of the cardiorespiratory and bone apparatus. In older age, physical activity helps maintain self-sufficiency, agility, and reduces frailty, preventing the development of chronic diseases (WHO, 2018). Regular physical activity has several psychological benefits, such as reducing anxiety and improving stress response, self-esteem, mood, wellbeing, general cognitive functioning, and psychological adaptation (Biddle et al., 2000).

There are many different forms of physical activity. These include fundamental movement skills, active play, leisure activities (dancing, walking, cycling, doing home exercises), and sports (WHO, 2016). Among them, walking is an important form of physical activity that improves physical and psychological wellbeing. In this regard, WHO (2008) has promoted and advocated a goal of 10000 steps per day; however, since the goal of taking 10000 steps per day may be difficult to achieve for many, Tudor-Locke and Bassett (2004) have suggested a lower daily threshold of at least 7000 steps per day (corresponding to approximately 60-minutes of walking). Regularly achieving this goal reduces the risks of cardiovascular diseases, hypertension, some cancers, and type 2 diabetes (Pate et al., 1995).

However, past researchers (Keating et al., 2005; Sun et al., 2015) have also shown that university students tend to have a sedentary lifestyle and walk very little. For this reason, health campaigns are devoting attention to developing effective strategies to promote regular walking activity in this segment of the population (Sun, 2015). In the present randomized controlled trial, we tested the efficacy of a messaging intervention focused on health or wellbeing messages plus goal setting and self-monitoring strategies, all aimed at promoting physical activity in the university context. To do so, we integrated two of the main theoretical frameworks used to explain physical activity, that is the Theory of Planned Behavior (TPB; Ajzen, 1991) and the Health Action Process Approach (HAPA; Schwarzer, 2008). Below, both theoretical frameworks are discussed in more detail.

1.1. The Theory of Planned Behavior and Physical Activity

The TPB proposed by Ajzen (1991) has been widely used to explain people's adherence to physical activity and walking activity (e.g., Darker et al., 2010; Downs & Hausenblas, 2005), especially in university students (e.g., Wing Kwan et al., 2009). In this theory, behavioral intentions to perform a given behavior are considered as the key determinant of behavior. In turn, intentions are determined by three factors. The first factor is people's *attitude* toward the behavior, which refers to the subjective favorable or unfavorable evaluation or appraisal of the behavior in question. The second predictor of intention is a social factor named *subjective norm*, which refers to the perceived social pressure to perform or not to perform the behavior. Finally, the third antecedent of intention is related to the individuals' *perceived behavioral control*, which refers to the perceived easiness or difficulty of performing the behavior, and it is assumed to reflect past experience as well as anticipated impediments and obstacles.

Applying these TPB assumptions to predict walking activity, as shown by prior TPB studies (e.g., Darker et al., 2010; Sun et al., 2015), walking activity is more likely and more intensive with stronger intentions to perform it. In turn, stronger intentions are associated with positive attitudes about the behavior (both affective and instrumental), greater perceived support for this behavior from important others, and perceptions of control over walking behavior.

1.2. Additional Predictors of Physical Activity Intention and Behavior

In the present study, we also included the key variables from the HAPA (Schwarzer, 2008), which have been recognized as fundamental predictors influencing people's intention and physical activity behavior (i.e., risk perception, outcome expectancies, and self-efficacy) and as mediators of the intention-behavior relationship (i.e., action planning, coping planning, and action control). In the HAPA model, *risk perception* is one of the main predictors influencing the intention to implement a given health behavior (Schwarzer, 2008). It has been shown that risk perceptions facilitate physical activity intention formation (Lippke et al., 2005). Indeed, if a person perceives that a lack of physical activity is likely to lead to negative health outcomes in the future, s/he will likely adopt prevention strategies. However, risk perception alone is not sufficient for intention formation; it is also necessary to balance the pros and cons of the behavior in question and to have confidence in one's capabilities of performing the action (Schwarzer, 2008). *Outcome expectancies* refer to the anticipated consequences (positive or negative) that result from engaging in a behavior (Williams et al., 2005). If someone perceives the expected outcomes to be beneficial, their intention to engage in that behavior will be stronger (Schwarzer, 2008), and this has been shown for physical activity (Williams et al., 2005). In addition, *self-efficacy* refers to beliefs about one's own capability to successfully perform the desired behavior (Schwarzer, 2008). As pointed out by Lippke et al. (2005), self-efficacy not only plays a crucial role in intention formation but can directly predict action planning or the action itself, even in individuals who do not intend to be physically active.

In the case of the walking activity, Namadian et al. (2016) found that the three aforementioned variables (risk perceptions, outcome expectancies, and self-efficacy) were significantly associated with walking intention in people with type 2 diabetes. However, exploring the factors that predict intention may not be sufficient to provide a full understanding of the decision-making processes within the context of walking activity. For example, intention may not always translate into actual behavior (Sheeran, 2002). To bridge this intention-behavior gap, we referred to constructs that the HAPA model proposes as possible mediators of the relationship between intention and behavior (Sutton, 2008). Planning is one such mediator and has been defined as a self-regulatory factor that has two main components: action planning and coping planning (Sniehotta et al., 2006b). *Action planning* refers to planning in detail the when, where, and how of acting in accordance with one's intentions. *Coping planning* is an independent planning cognition that prepares individuals to successfully deal with unwanted influences on behavior. As pointed out by Sutton (2008), including action planning helps to bridge the intention–behavior gap and to explain *how* intention affects behavior; specifically, individuals with higher levels of intention should be more likely to formulate action plans, and those who formulate action plans should be more likely to implement the desired action. When an individual has formed clear action plans about when, where and how to implement a behavior (for example, "I have a clear plan about what time of day I can walk"), the next step will be to develop coping plans to overcome potential barriers for the performance of the behavior in question (for example, "If I am too tired to walk after work, I will try to motivate myself by thinking about the health benefits I will get"). People who have carefully planned how to deal with risk situations are more likely to maintain the behavior despite any difficulties (Sniehotta et al., 2006b). Sniehotta et al. (2006b) highlighted that action planning and coping planning work jointly, allowing the individual to create a roadmap to action and, consequently, to translate the intention into behavior effectively. In the domain of physical activity, the mediating role of action planning and coping planning in the intention-behavior relation has been widely confirmed (e.g., Arnautovska et al., 2017).

The HAPA model also suggests considering the mediating role of *action control*, described as active self-regulation that represents the most proximal volitional predictor of behavior (Sniehotta et al., 2005). As highlighted by Sniehotta et al. (2006a), the main function of the action control is to facilitate the intention maintenance and the adherence to plans. Without the implementation of effective action control strategies, even strong intentions and detailed action plans might not be translated into behavior. Therefore, action control is seen to mediate the effect of other predictors (e.g., intention and planning) on the behavior. In the context of walking activity, action control has been associated with both intention and walking behavior (Namadian et al., 2016), but no study has considered its mediation role.

Starting from the above considerations, the present study tested the effectiveness of a messaging intervention to promote walking in students and the potential mediating role of each of the aforementioned variables. Moreover, we explored if changes in planning and action control explain how the intention to walk regularly is translated into behavioral change.

1.3. Physical activity interventions

Physical activity interventions aimed at increasing levels of physical activity in physically inactive populations have shown significant benefits for both physical health (WHO, 2018) and psychological wellbeing (Netz et al., 2005). Past studies have shown that persuasive communication is an effective means to induce a change in health behaviors. In particular, persuasive communication conveyed by text messages proved to be effective in modifying engagement with a number of different health behaviors (Carfora et al., 2016; Carfora et al., 2017; Kaptein et al., 2012; Yan et al., 2015). Regarding the application of persuasive communication to promoting physical activity, previous researchers compared messages based on gain and loss framing, showing that gain-framed messages result in stronger intentions to be physically active than loss-framed messages (van't Riet et al., 2009). However, few such studies have examined other aspects of messaging, such as the efficacy of messages that focused on physical benefits (such as increasing cardiovascular flexibility or losing weight) versus psychological benefits (such as improved mood or increased energy levels) of behavior. In one exception, Conner et al. (2011) examined the impact of messaging focusing on the physical versus psychological benefits of physical activity in university students and showed the latter to be more effective in changing physical activity.

However, messages focused on psychological benefits are not always the most effective ones. For example, Bertolotti et al. (2019) showed that health messages (focused on physical health) were more effective than wellbeing messages (focused on psychological wellbeing) in reducing participants' intention to eat red meat, but only when they had a predominantly preventive focus. Therefore, it would be interesting to further compare messages targeting physical or psychological outcomes in terms of impact on walking behavior.

Although persuasive messages can induce a change in attitude, which in turn can influence behavioral change, research has shown that the impact of such messages is stronger when they are used in combination prompts to use specific goal-setting and self-monitoring strategies (Carfora et al., 2019). Sending persuasive messages and, at the same time, setting a clear goal - for example, "taking 7000 steps a day" - can help translate the intention into action. This was shown by a recent study with colorectal cancer survivors in which a combination of goal setting with reminder text messages effectively increased the physical activity levels of study participants (Van Blarigan et al., 2019). In addition, prompting the use of self-monitoring strategies can also increase the impact of persuasive messages. If people periodically monitor their progress, this can help them to achieve the goal by constantly comparing the current state and the desired state (Carfora et al., 2019).

Consistent with the above, the present study combined a messaging intervention with prompts to goal setting and self-monitoring. The goal presented to participants was to take at least 7000 steps a day, while self-monitoring was prompted by asking participants to send daily screenshots of the number of steps taken, using specific smartphone apps.

1.4. Present Study

The present study tested the impact of different messaging interventions on changing cognitions and behavior in relation to walking in university students. In particular, participants were prompted to take at least 7000 steps a day, a goal more easily achievable, compared to the 10000 indicated by the WHO. To implement message intervention, we created a chatbot, that is an artificial intelligence program that simulates interactive human conversation by using pre-set phrases and text-based signals. The chatbot can form the basis of an innovative and friendly-user tool to promote adherence to health behaviors through a smartphone, although to date there are no studies in which this innovative tool has been used to promote walking activity.

Specifically, we investigate the efficacy of physical or psychological (wellbeing) health messages + self-monitoring (Research Question 1 - **RQ1**), without making any specific prediction about which type of message was more persuasive. However, we hypothesized that participants in the experimental (i.e., message) conditions would report improvement in the aforementioned TPB and the HAPA variables – that is attitude, subjective norm, perceived behavioral control, risk perception, outcome expectancies, self-efficacy, action planning, coping planning, action control and intention - (Hypothesis 1 - **H1**) and in walking activity (Hypothesis 2 - **H2**) in comparison with the participants in the control group. Furthermore, we analyzed whether any effect of our persuasive messages on intention and increases in walking activity was explained (mediated) by increased action planning, coping planning or action control (Research Question 2 - **RQ2**).

2. Methods

2.1. Participants

The present study was implemented following receipt of ethical approval by the Department of Humanities of the University of Naples "Federico II". In 2019, 230 university students attending courses in Social Psychology in Naples (Italy) were invited to participate in a study on physical activity and health in exchange for one university credit. Students were required to be in possession of a personal smartphone to participate.

Using GPower 3.1, we estimated the required sample size for detecting a medium-sized effect (ES = 0.25) with an alpha = .05, power = .80, and 4 experimental conditions. The estimated sample size was N = 180 for the between-group comparison. Therefore, we planned a sample size of 200, in order to achieve more than sufficient power to detect the main effect and additional mediation effects, after accounting for expected attrition across two-time.

Among the 200 contacted participants, 171 students provided their contact details and written informed consent and filled out the first questionnaires (N = 171; 20.47% males, 73.53% females; Mean age = 19.76; SD = 1.36). At T2 a total of 156 participants (N = 156; 19.2% males, 80.8% females; Mean age = 19.74; SD = 1.36) filled in the second questionnaire. Only those who completed both questionnaires were considered in the analyses. A participant flow chart is provided in Figure 1. Table 1 reports the baseline characteristics of participants at T1 and the remaining participants at T2.

Insert figure 1

Insert table 1

2.2. Design

At T1, participants in each condition completed the first questionnaire. The last page of the questionnaire allocated each student to one of the four conditions in a 1:1:1:1 ratio using an automatic individual randomization sequence. The four conditions were as follows:

Health messages + self-monitoring (HSM) condition: participants (final sample: N = 39) assigned to this condition received daily messages on the physical health benefits related to taking at least 7000 steps a day. They were also required to install an app to monitor their daily steps. Moreover, they received a daily request for sending a screenshot of daily steps.

Wellbeing messages + self-monitoring (WSM) condition: participants (final sample: N = 37) assigned to this condition received messages on the psychological benefits related to taking at least 7000 steps a day. They were also required to install an app to monitor their daily steps. Moreover, they received a daily request for sending a screenshot of daily steps.

Self-monitoring (SM) condition: participants (final sample: N = 39) assigned to this condition received no messages, but they were required to install an app to monitor their daily steps. Moreover, they received a daily request for sending a screenshot of daily steps.

Control Condition (CC): participants (final sample: N = 41) assigned to this condition received no messages and were not required to monitor their daily steps.

The last page of the questionnaire also provided the link for a chatbot, which was programmed by the researchers to send daily messages that differed in content according to the allocated condition.

Following allocation, every morning for 60 days, participants in the two message intervention conditions received one persuasive message focused on the health or wellbeing benefits of taking at least 7000 steps a day.

At T2, at the end of the two-month intervention, 157 students again filled in the same questionnaire they had completed at T1. In both questionnaires at T1 and T2 we used forced-choice question format to avoid any missing data.

2.3. Messaging Intervention

The present intervention lasted two months. Participants in the HSM, WSM, and SM conditions were exposed to goal setting (doing at least 7000 steps a day); furthermore, they were required to self-monitor their daily progress through the specific step counting app.

In the Health messages + self-monitoring (HSM) condition, participants received every morning (7.30 a.m.) a persuasive message related to the physical benefits of taking 7000 steps a day (e.g., Walking regularly will help reduce the risk of stroke). Moreover, every evening (7.30 p.m.), participants received a message that reminded them to send a screenshot of their daily steps.

In the Wellbeing messages + self-monitoring (WSM) condition, participants received every morning (7.30 a.m.) a persuasive message about the psychological benefits of taking 7000 steps a day (e.g., Walking regularly will help you feel emotionally less tense). Moreover, every evening (7.30 p.m.), participants received a message that reminded them to send a screenshot of their daily steps.

In the Self-monitoring (SM) condition, every evening (7.30 p.m.), participants received only a message that reminded them to send a screenshot of their daily steps.

In the Control Condition (CC) participants did not receive any message from the chatbot (morning or evening).

In the current research, a chatbot on Facebook Messenger was used to send messages to subjects in the experimental conditions. A similar methodology has been successfully used in previous research (Caso et al., 2017) to promote self-control of fruit and vegetable consumption. Table 2 reports the specific behavior change techniques used for each group; Michie et al., 2013). Appendix 1 displays the text of all messages used in HSM and WSM conditions.

Insert table 2

2.4. Measures

Demographic information

Participants were asked to provide their demographic characteristics, including age, sex, weight, height.

Psychological variables

Intention to do 7000 steps a day was assessed with 3 items using a Likert scale ranging from 1 "*definitely do not*" (1) to "*definitely do*" (7) (e.g., "I intend to walk 7000 steps a day"; Carfora et al., 2016). Cronbach's *α* were .92 at T1 and .90 at T2.

Attitude towards doing 7000 steps a day was assessed through 10 items on a semantic differential scale ranging from 1 to 7 (e.g., "Doing 7000 steps a day is *harmful-beneficial; disadvantageous-advantageous; unpleasant-pleasant; useless-useful; dangerous-safe; bad-good; boring-fun; healthy-unhealthy; irresponsible-responsible; not important-important*"; Carfora et al., 2016). Cronbach's *α* were .96 at T1 and .93 at T2.

Subjective norms to do 7000 steps a day was assessed through 5 items on a Likert scale ranging from "*completely disagree*" (1) to "*completely agree*" (7) (e.g., "Significant others think that I should do 7000 steps a day"; Carfora et al., 2016). Cronbach's *α* were .88 at T1 and .90 at T2.

Perceived behavioral control (PBC) over doing 7000 steps a day was assessed through 4 items on a Likert scale ranging from "*completely disagree*" (1) to "*completely agree*" (7) (e.g., "For me it is possible to do 7000 steps a day"; Carfora et al., 2016). Cronbach's *α* were .81 at T1 and .88 at T2.

Risk perception was assessed through 6 items on a scale ranging from "*not at all*" (1) to "*very much*" (7) (e.g., "Considering how far I walk, I think I am personally exposed to the risk of heart disease and the circulatory system"; adapted by Petrillo et al., 2004; Sniehotta et al., 2005). Cronbach's α were .88 at T1 and .93 at T2.

Outcome expectancies were assessed through 6 items on a scale ranging from "*not at all*" (1) to "*very much*" (7) ("If I do 7000 steps a day, I expect my muscles to be more toned"; "If I do 7000 steps a day, I will feel more relaxed"; "If I do 7000 steps a day, I will be able to meet new people"; "If I do 7000 steps a day, I will have to struggle and sweat a lot"; "If I do 7000 steps a day, I will feel more stressed"; "If I do 7000 steps a day, I will have less time to devote to my friends"; adapted by Petrillo et al., 2004; Sniehotta et al., 2005). Cronbach's α were .86 at T1 and .88 at T2.

Self-efficacy was assessed through 14 items on a scale ranging from "*not at all*" (1) to "*very much*" (7) (e.g., "I feel able to walk regularly even when I have personal problems"; adapted by Petrillo et al., 2004; Sniehotta et al., 2005). Cronbach's α were .87 at T1 and .91 at T2.

Action planning was assessed through 3 items on a scale ranging from "*not at all*" (1) to "*very much*" (7) (e.g., "I have a detailed plan compared to when I can walk during the day, e.g., morning, afternoon, evening"; adapted by Petrillo et al., 2004; Sniehotta et al., 2005). Cronbach's α were .85 at T1 and .90 at T2.

Coping planning was assessed through 4 items on a scale ranging from "*not at all*" (1) to "*very much*" (7) (e.g., "I have a plan on what to do if something prevents me from walking regularly"; adapted by Petrillo et al., 2004; Sniehotta et al., 2005). Cronbach's α were .89 at T1 and .93 at T2.

Action control was assessed through 4 items on a scale ranging from "*not at all*" (1) to "*very much*" (7) (e.g., "I check when, where and how I walked"; adapted by Petrillo et al., 2004; Sniehotta et al., 2005). Cronbach's α were .88 at T1 and .91 at T2.

Walking activity was assessed through a single item, obtained from the IPAQ (International Physical Activity Questionnaire; Mannocci et al., 2010), on a scale ranging from 0 to 7. Specifically, the item assessed time spent in walking behavior over the last 7 days ("During the last seven days, how many days have you walked for at least 10 minutes at a time?").

2.5. Data Analysis

All analyses were conducted in SPSS 23. In preliminary analyses, we firstly verified whether randomization was successful and whether the sample was biased in relation to drop out using Chi-square and multivariate analysis of variance (MANOVA). In the main analyses, we conducted different ANCOVAs to compare the four conditions on the dependent variables (intention, attitude, subjective norms, PBC, risk perception, outcome expectancies, self-efficacy, action planning, coping planning, action control, walking activity) at T2, controlling for walking activity at T1 (past behavior) and using Bonferroni correction. Finally, we ran a mediation analysis using bootstrapping in SPSS (PROCESS macro for SPSS; Hayes & Ross, 1987), where the indirect effects were considered significant if bootstrapped 95% confidence intervals (CI) did not include zero.

3. Results

3.1. Preliminary Analyses

To check if randomization was successful, we used a MANOVA on T1 variables plus age. Results did not show any significant main effect of condition ($F_{(36,429)} = 1.13$; $p = .28$, $\eta p2 = .09$), on T1 variables and age. Chi-square did not show any significant differences in gender ($p > .97$) across different conditions. Thus, preliminary findings confirmed that randomization was adequate, and the four conditions were matched on baseline variables. Table 1 reports the mean and SD of all measures.

Attrition analysis showed that our main dependent variables (intention, attitude, subjective norms, PBC, risk perception, outcome expectancies, self-efficacy, action planning, coping planning, action control, walking activity) at T1 were not significantly different between those who complete both questionnaires and those who dropped-out ($p < .32$), except for subjective norm ($t = -.91$, p =.05; d=0.28 drop out: M = 3.95, SD= 1.90, final sample: M = 4.28, SD = 1.23). This would suggest that our final sample was biased towards those with stronger subjective norms towards walking activity. Considering that all the other dependent variables were not different, we can conclude that the final sample was acceptably representative of the initial sample, except in relation to subjective norms.

3.2. Main Analyses

ANCOVAs indicated significant differences in intention, attitude, self-efficacy, outcome expectancies, action control, and walking activity at T2. Although no significant differences were found in the case of subjective norm, perceived behavioral control, risk perception, action planning, and coping planning. For the sake of brevity, we reported below only the significant results.

Analyzing differences in intention, ANCOVA (group: $F_{(43,156)} = 7.94$; $p = .001$, $\eta p2 = .14$; walking activity at T1: $F_{(43,156)} = .65$; $p = .42$, $\eta p2 = .00$) showed that at T2 participants' intention was significantly ($p = .001$) higher in the HSM (*M* = 6.03; *SD* = 1.02) compared to CC (*M* = 4.87; *SD* = 1.48). Results found significant differences for WSM (*M* = 5.86; *SD* = 1.02) or SM (*M* = 5.08; *SD* = 1.09) compared to CC, or in HSM compared to WSM or SM, or in WSM compared to SM.

Considering differences in attitude at T2, ANCOVA results (group: $F_{(43,156)} = 3.78$; $p = .01$, $\eta p2 = .07$; walking activity at T1: $F_{(43,156)} = .26$; $p = .61$, $\eta p2 = .00$) showed that attitude was significantly ($p = .03$) more positive in HSM (*M* = 6.03; *SD* = 1.12) and WSM conditions (*M* = 6.32; *SD* = .58) compared to CC (*M* = 5.96; *SD* = .65), whereas there was no significant difference for SM (*M* = 6.17; *SD* = 1.12) compared to CC. Moreover, results did not find any significant differences in pairwise comparisons between the HSM and either WSM or SM, and between the WSM and SM conditions.

Regarding differences in self-efficacy at T2, ANCOVA results (group: $F_{(43,156)} = 2.81$; $p = .04$, $\eta p2 = .05$; walking activity at T1: $F_{(43,156)} = 12.61$; $p = .001$, $\eta p2 = .08$) showed that self-efficacy at T2 was significantly higher ($p = .05$) in WSM (*M* = 4.48; *SD* = 1.08) compared to CC (*M* = 3.88; *SD* = 1.02). Meanwhile, there were no significant differences in the HSM (*M* = 4.10; *SD* = 1.36) and SM conditions (*M* = 4.01; *SD* = 1.11) compared to CC. Moreover, results did not find any significant differences in the pairwise comparisons between the HSM and WSM conditions, the HSM and SM conditions, and the WSM and SM conditions.

In regard to differences in outcome expectancies, ANCOVA results (group: $F_{(43,156)} = 3.09$; $p = .03$, $\eta p2 = .06$; walking activity at T1: $F_{(43,156)} = 5.37$; $p = .02$, $\eta p2 = .03$) showed that at T2 participants' outcome expectancies was significantly ($p = .05$) higher only in the case of HSM (*M* = 3.69; *SD* = .91) compared to CC (*M* = 3.23; *SD* = .82). Results did not indicate significant differences for WSM or SM conditions compared to CC, nor in the HSM condition compared to the WSM or SM conditions, nor in the WSM condition compared to the SM condition.

Regarding differences in action control, ANCOVA results (group: $F_{(43,156)} = 4.69$; $p = .004$, $\eta p2 = .08$; walking activity at T1: $F_{(43,156)} = 4.43$; $p = .04$, $\eta p2 = .03$) showed that action control at T2 was significantly ($p = .05$) higher in the HSM (*M* = 4.36; *SD* = 1.65) and the WSM conditions (*M* = 4.00; *SD* = 1.59) compared to CC (*M* = 3.70; *SD* = 1.40), whereas the SM condition (*M* 4.54; *SD* = 1.33) was only a marginal higher ($p = .06$) than CC. Moreover, results did not indicate any significant differences in the pairwise comparisons between the HSM and WSM or SM conditions, and between the WSM and SM conditions.

Considering differences in participants' self-reported walking activity at T2, ANCOVA results, controlling for walking activity at T1, (group: $F_{(43,156)} = 3.28$, $p = .02$, $\eta p2 = .06$; walking activity: $F_{(43,156)} = 40.03$, $p = .001$, $\eta p2 = .21$) showed that at T2 participants' walking activity was significantly ($p = .03$) higher in the HSM condition (*M* = 6.00; *SD* = 1.41) compared to CC (*M* = 5.07; *SD* = 1.60), whereas there were not significant differences between the WSM or SM conditions and CC, or between the HSM and both the WSM and SM conditions, or between the WSM and SM conditions.

In sum, after the intervention, we found that the HSM condition was the most effective condition, given that participants in this condition reported greater values of outcome expectancies, attitude, action control, intention, and importantly higher walking activity. In addition, participants in the WSM condition reported only higher attitude, self-efficacy, intention compared to participants in the control, without differences in the walking attitude compared to CC. Finally, regarding participants in the SM condition, after the intervention they had no differences with participants in CC.

3.3. Additional analyses

The above results showed that only participants in the HSM condition reported both higher intention and greater walking activity at T2 when compared to CC. As stated in the literature (e.g., Sniehotta et al., 2006b), three variables could have had a mediation role in the intention-behavior relationship: action planning, coping planning, and action control. Given that among these three possible mediators, in the HSM condition there was an increase only for action control, we therefore tested if, in this group, the intention-behavior relationship at T2 was mediated by action control at T2. This could help us understand if people translated their higher intention in a coherent behavior through increasing their self-regulation strategies. To test this, we ran a mediation analysis.

In the analysis on the HSM condition, we verified if action control at T2 mediated the relationship between participant intention at T2 and walking activity at T2, controlling for walking activity, action control and intention at T1. Results showed intention at T2, B = .49; 95% CI [0.00, 0.98], and action control at T1, B = .58; 95% CI [0.31, 0.85] significantly predicted action control at T2, while intention at T1, B = .03; 95% CI [-0.27, 0.34], and walking activity at T1, B = .48; 95% CI [-0.33, 0.31] did not.

Walking activity at T2 was mainly predicted by action control at T1, B = .52; 95% CI [0.25, 0.79], and walking activity at T1, B = .26; 95% CI [0.00, 0.52]. However, walking activity at T2 was also marginally significantly predicted (p = .08) by intention at T2, B = .35; 95% CI [-0.06, 0.78]. Meanwhile, action control at T2, B = .14; 95% CI [-0.42, 0.13] and intention at T1, B = .04; 95% CI [-0.20, 0.28] did not predict participants' walking activity at T2. Therefore, there was not an indirect effect via action control at T2, *Effect* = .07; 95% CI [-0.40, 0.04], showing that the effect of the intention at T2 on walking activity at T2 was principally attributable to participants' prior action control and walking habits (Figure 2).

Insert Figure 2

4. Discussion and conclusion

The present study aimed to evaluate the impact of different messaging interventions on changing cognitions and walking behavior in university students.

Results showed that participants in the experimental conditions reported improvement in some specific psychological variables and behavior, thus confirming H1 and H2. Specifically, in response to RQ1, results showed significant differences between HSM condition and CC in intention, attitude, outcome expectancies, action control, and walking activity, but no differences were found between HSM and WSM conditions. Previous research (Carfora et al., 2016; Conner et al., 2011) that tested the effect of wellbeing messages (focused on psychological benefits) and health messages (focused on physical benefits) in changing different health behaviors have generally reported the former to be more effective. In contrast, the present research found that messages focused on physical benefits were more effective. The effectiveness of such persuasive messages could be due to the fact that they focus on the benefits of physical activity rather than on the risks of inactivity. Messages can be framed in terms of the advantages related to the implementation of a specific behavior (gain frame) or the disadvantages related to not implementing a specific behavior (loss frame). It has been shown that gain-framed messages are, in general, more effective in increasing disease prevention behavior, whereas loss-framed messages may be more effective at increasing disease detection behaviors (Jensen et al., 2018). Specifically, regarding physical activity, van't Riet et al. (2009) found that gain-framed messages focused on the health benefits of physical activity resulted in more positive attitudes, higher intentions, and higher levels of physical activity, even if the effect of such messages was significant only in relation to the intention. On the other hand, the efficacy of "health focused messages" has also been demonstrated in relation to other health behaviors, such as smoking cessation (Douglas & Free, 2013) and preventing sexually transmitted diseases (Gold et al., 2011).

Although the HSM condition was found to be more effective in changing walking activity, those in the WSM condition also reported significantly higher levels of attitude, self-efficacy, action control compared to participants in the control group. In contrast, the only self-monitoring condition did not induce any change in the psychological variables related to the walking activity and behavior, demonstrating that it is the combination of health/wellbeing messages + self-monitoring and goal setting that is the most effective. However, this result should be interpreted with caution. Since we did not include an experimental condition in which participants received only the persuasive messages without self-monitoring, we cannot definitively say if the HSM and WBM conditions were more effective due to the impact of the persuasive messages or due to the combination of persuasive messages + self-monitoring and goal setting.

In response to RQ2, mediation analyses showed that participants' action control at T1 and intention at T2 (in the case of HSM condition) predicted action control at T2, but the latter did not predict walking activity at T2. Otherwise, walking activity at T2 was predicted by intention at T2, action control at T1, and walking activity at T1; consequently, the mediating role of action control in the relationship between intention and behavior at T2 has not been confirmed. These results suggest that, in the walking activity domain, the most immediate and important predictors of behavior are intention, initial levels of action planning, and past behavior. Indeed, walking activity may be easier to implement and to control in comparison to more structured forms of exercise and, consequently, the initial self-regulation strategies implemented by the individual could be sufficient to produce behavioral change. Alternatively, action control at T2 may not have had a significant effect on walking activity due to the short time frame of the intervention. As evidenced by Sniehotta et al. (2006a), action control plays an important role in a more advanced stage, when the intention is already consolidated. In relation to this, although the participants of the HSM condition reported a significant change in intention at T2, not having considered a follow-up phase precluded an assessment of the role of stability of the intention over time as an explanation of the findings. Future long-term studies could better clarify the mechanisms underlying behavioral change in the case of walking.

Also, as demonstrated by Sniehotta, Scholz, and Schwarzer (2005), action control mediates between exercise intentions and later physical activity only in the volitional phase. Therefore, future research should also take into consideration the particular phase of the process in which the subject is (motivational or volitional) and target the intervention depending on whether the individual is non-intender, intender, or actor (Schwarzer, 2008). In sum, our findings suggest the importance of both motivational and volitional factors for understanding walking behavior, confirming the usefulness of considering both TPB (Ajzen, 1991) and HAPA (Schwarzer, 2008) as key models to explain changes in physical activity.

There are several limitations in the present study. First, our findings may not be generalizable to other student populations, since we only included Italian psychology students. Second, most of the participants were female students, further limiting the generalizability of the results to the male population. Third and finally, we used a *self-report* questionnaire; thus, it is possible that students provided socially desirable answers; for example, they may have underestimated or overestimated their physical activity. Therefore, the findings need to be confirmed using more objective measures.

Despite these limitations, this study also has several strengths. As far as we know, this is the first study that evaluated the effect of health and wellbeing messages specifically on walking behavior. Our findings might have implications for walking promotion interventions targeting university students. First of all, our study provides new information on which factors could be usefully targeted to promote walking activity (for example, intention, past behavior, and action control), although further studies are needed to explore the role of these variables in the intention-walking behavior relationship. Second, we confirmed the efficacy of persuasive messages on changing walking behavior, extending a finding from other health behaviors (Carfora et al., 2016; Carfora et al., 2017; Caso & Carfora, 2017). Furthermore, we found that the most effective messages were those that considered the physical benefits of walking, suggesting that future walking promotion interventions could usefully focus on this type of persuasive messages. Clearly, further studies are needed to confirm the impact of "health messages" on walking behavior in order to maximize the benefits of this new type of persuasive communication.

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Table 1.

Means and standard deviations of measured variables at Time 1 (T1) and Time 2 (T2) in each condition.

Variables	*HSM*				*WSM*				*SM*				*Control group*			
	T1		T2		T1		T2		T1		T2		T1		T2	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Intention to do 7000 steps a day	5.4	1.42	6.03	1.02	5.03	1.52	5.86	1.02	5.62	1.07	5.8	1.09	4.78	.96	4.87	1.48
Attitude towards doing 7000 steps a day	6.24	0.96	6.3	1.12	6.09	.98	6.32	.58	5.85	1.56	6.17	1.12	5.66	1.35	5.96	.65
Subjective norms	4.68	1.28	4.57	1.59	4.26	1.47	4.18	1.35	4.37	1.36	4.25	1.36	3.83	.9	3.88	1.12
Perceived Behavioral Control	5.57	1.21	5.6	1.25	5.57	.96	5.44	1.19	5.36	1.18	5.45	1.2	5.14	.89	5.14	1.15
Risk Perception	2.65	1.26	2.32	1.26	2.13	1	2.44	1.43	2.43	1.28	2.23	1.21	5.57	1.06	2.32	1.11
Outcome expectancies	3.52	.92	3.69	.91	3.38	.94	3.82	1.10	3.29	.74	3.56	.95	3.39	.80	3.23	.82
Self-Efficacy	4.15	1.17	4.1	1.36	4.12	1.04	4.48	1.08	4.23	.97	4.01	1.11	3.98	.89	3.88	1.02
Action Planning	4.09	1.57	4.36	1.65	4.15	1.48	4	1.59	4.06	1.56	4.07	1.56	3.9	1.6	3.96	1.4
Coping Planning	3.67	1.56	3.77	1.66	3.41	1.25	3.55	1.62	3.61	1.41	3.38	1.36	3.43	1.32	3.26	1.33
Action Control	4.28	1.47	4.77	1.38	3.73	1.51	4.58	1.55	4.17	1.32	4.54	1.33	3.89	1.31	3.7	1.4
Walking Activity*	5.79	1.5	6.00	1.41	5.24	1.8	5.68	1.58	5.79	1.44	5.67	1.44	5.63	1.34	5.07	1.6

*number of days spent walking at least 10 mins over the last week

Table 2.

Behavior change techniques used for each group

Group	*Behavior change techniques*
Health + self-monitoring condition (HSM)	Information about physical benefits related to taking at least 7000 steps a day; self-monitoring of behavior; goal-setting.
Wellbeing + self-monitoring condition (WSM)	Information about psychological benefits related to taking at least 7000 steps a day; self-monitoring of behavior; goal-setting.
Self-monitoring condition (SM)	Self-monitoring of behavior; goal-setting.
Control condition (CC)	No behavior change techniques.

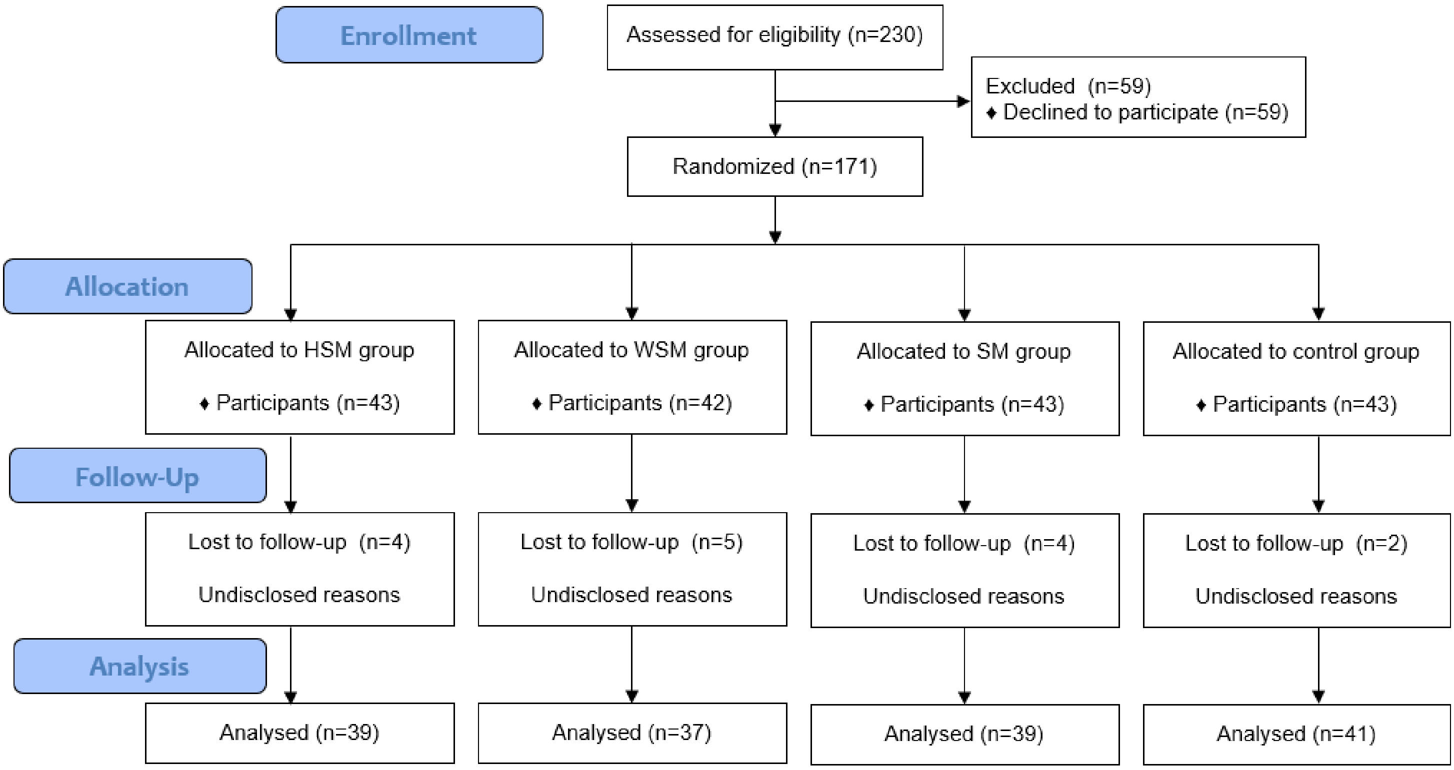
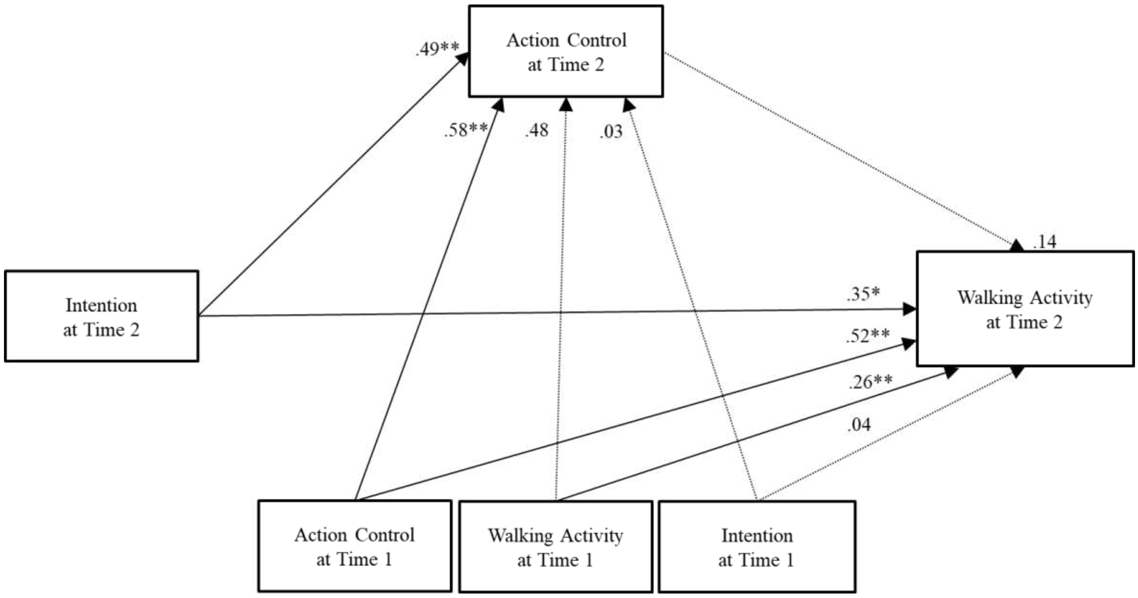


Figure 1. Participant flow chart



Note. *p < .08; ** p < .001. Standardized coefficients are reported.

Figure 2. Mediation of action control in the intention-behaviour relationship at Time 2 in the Health messages + self-monitoring condition.

	HEALTH MESSAGES	WELLBEING MESSAGES
1	The more you walk regularly, the more you strengthen your heart.	The more you walk regularly, the more you strengthen your emotional wellbeing.
2	Walking regularly every day helps you reduce lung problems.	Walking regularly every day helps you reduce bad mood.
3	The more you walk regularly, the more you positively stimulate the nervous system.	The more you walk regularly, the more you stimulate the production of the "happiness hormone" (serotonin).
4	Walk more and decrease the risk of osteoporosis.	Walk more and decrease the nervousness caused by stress.
5	Walking regularly outside improves circulation.	Walking regularly outside improves your mood.
6	Walking regularly every day helps you reduce the colon cancer risk!	Walking regularly every day helps you reduce the feeling of mental slowdown!
7	Walking in the morning will wake you up and give you more physical energy throughout the day.	Walking in the morning will wake you up and give you more mental energy throughout the day.
8	The more you walk regularly, the more you reduce the risk of coronary heart disease.	The more you walk regularly, the more you improve your self-esteem.
9	The number of steps you take and your overall physical health are strongly related	The number of steps you take and your general mood are strongly related
10	Walking regularly helps you fight sexual dysfunction, such as anorgasmia for women and erectile dysfunction in men.	Walking regularly helps you fight negative emotions, such as guilt for not being physically active.
11	Walking regularly outside air helps the respiratory system.	Walking outside frees the mind.
12	Walk every day and avoid breast or prostate cancer.	Walk every day and avoid apathy.
13	The more you walk regularly, the more you keep your body healthy.	The more you walk regularly, the more you keep your mind active.
14	Walking regularly is associated with lower joint problems.	Walking regularly is associated with lower depression risk.
15	The number of steps you take each day improves many physical aspects.	The number of steps you take each day improves many psychological aspects.
16	The more you walk every day, the more you reduce the risk of diabetes.	The more you walk every day, the more you reduce the irritability caused by stress.
17	Walking regularly triggers the creation of lean mass and decreases the fat mass, which helps you control your weight.	Walking regularly triggers the creation of dopamine, which helps you aspire to achieve goals and take action to reach them.

18	The more you walk regularly, the more you have relief from unpleasant physical fatigue.	The more you walk regularly, the more you have relief from unpleasant emotions.
19	Walk regularly and improve your digestive system.	Walk every day and improve your self-esteem.
20	The more steps you take, the more you reduce the risk of lung cancer.	The more steps you take, the more you reduce anxiety.
21	In the morning, you can benefit from a boost of physical energy from a walk.	In the morning, you can benefit from a boost of mental energy from a walk.
22	Walking regularly will help you reduce your risk of stroke.	Walking regularly will help you feel emotionally less tense.
23	The more steps you take in a day, the more your muscles get activated.	The more steps you take in a day, the more you feel you have mental concentration.
24	Humans are not machines. You need moments of activity to help your body. Do it by walking!	Humans are not machines. You need to move away from daily emotional stressors. Do it by walking!
25	The more steps you take, the more you improve your immune system.	The more steps you take, the more you increase your creativity.
26	Walking regularly reduces the risks for the circulatory system.	Walking regularly reduces negative feelings associated with physical inactivity.
27	Walking at the end of the day helps maintain optimal blood sugar concentration levels, reducing the risk of developing metabolic syndrome.	Walking at the end of the day helps you relax and refresh your ideas.
28	The more you walk, the more you can reduce negative physical symptoms.	The more you walk, the more you can reduce negative emotions.
29	Walk more and stay healthier.	Walk more and feel more peaceful.
30	Walking regularly every day helps prevent excessive weight.	Walking regularly every day helps prevent sleepiness.

Appendix 1. Text of the messages used in HSM (health messages) and WSM (wellbeing messages) conditions.