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Saving energy at university campus via intervention to reduce elevator usage – a case study from Germany

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Recently, the need for energy saving has become a challenge for German society. Rising prices of energy, and urgent need to mitigate and adapt to climate change, made it necessary to reflect and change behaviors on a population level. Simultaneously, the population faces increased sedentary lifestyle and health system promotes benefits of daily movement and sports. By using stairs, instead of taking the elevator, could be part of the solution for both problems. This applies for buildings, such as universities, which usually have hundreds of students and staff circulating daily. In this sense, this study aims to analyse how an intervention to increase stair usage, by involving motivational stickers and posters, could impact the behavior of students and staff. To achieve its goal, a field study and a questionnaire has been conducted at one German University. The results showed, after the intervention, that the elevator usage decreased by nearly 7%. According to the questionnaire nearly a fifth of all participants felt motivated by the stickers to choose the stairs over the elevator. While before the intervention male participants were 1.76 times more likely than females to take the stairs, the difference in stair usage after the intervention was not statistically significant anymore. Individual students and staff members were 1.44 times more likely to take the stairs than when grouped with others. This difference in stair usage individually or in a group increased from nearly 8% before the intervention to 17% after the intervention. Although short, the intervention showed to be successful and the results indicated that elevator interventions should be utilized in future contexts at a population level to spread the message that by reducing elevator usage, energy can be saved, and human fitness improved.

KEYWORDS

energy saving, stairs vs. elevator usage, intervention, human health, climate change, human behavior

1. Introduction

Over the last decades, scientists have been warning about climate change and the wasteful usage of non-renewable resources (Sterk et al., 2013). One of the main obstacles in everyday life is how to adapt our current habits to become more sustainable as to save energy, reduce consumption, reduce waste production, etc. (United Nations, 2022). In the winter of 2022/2023, saving energy has become an important issue due to its rising prices, resulting in possible impoverishment and loss of wealth in German society (Kockel et al., 2022). The Institut der deutschen Wirtschaft (IW) used a model simulation to specify the impact of the energy crisis on German society. According to the IW ca. 307,000 people in

FIGURE 1
Action of posting motivational stickers next to the elevators.

Germany will lose their jobs because of the energy crisis and the gross domestic product will decrease by 2% in 2023 (Michelle et al., 2022). The Statistisches Bundesamt preliminary estimates indicate that consumer prices increased by 10.0% in September as compared to the same month in the previous year. Germany's inflation rate has not been this high since 1951 (Statistisches Bundesamt, 2022). Saving energy has become a necessity in every area of life. Therefore, one possibility that could be explored is to use elevators less and also enjoy the health benefits of using stairs instead.

According to the WHO and the Centers for Disease Control and Prevention (CDC) adults should engage in at least 30 min or more of moderate-intensity aerobic physical activity on most days of the week (CDC, 2022). Unfortunately, large segments of the population do not meet these standards yet. In 2014, almost half (49.8%) of the population of the European Union aged 18 or over were not involved in any kind of sports activities (Eurostat, 2017). Daily stair climbing can be part of the recommended physical activity.

A social intervention with the goal of saving energy has been implemented during the winter semester 2022/2023 by the Green Office of a University of Applied Sciences in Germany. This intervention involved motivational stickers stating, "Use your own energy" with a sketch of stairs, next to the elevators and staircases as well as posters with relevant information about saving energy at the entrances of the university building (Figure 1).

Interventions to decrease elevator and increase stair usage have been successfully done before (Meyer et al., 2010; Moloughney et al., 2019) and it has even been recommended to use elevator interventions involving signage on a population level (Bauman et al., 2017). Although this topic has been tackled before, the optimization of the process to trigger societal changes is still missing, and consequently two main issues remain: (1) to come up with the strategy that will remain motivational on long-term, and (2) to understand what is the main trigger that drives the behavioral change. It has already been demonstrated that by increasing stair usage health benefits, such as improving body composition and lowering blood pressure, are notable (Meyer et al., 2010). However, this fact alone is not motivational enough to lead to behavioral changes, showing a need for better understanding of the drivers to decision making.

In this context, the main goal of this research aims to understand what drives the preferences of students and university staff between stairs and elevators. Bearing this in mind, the following research question (RQ) has been developed: How intervention can influence the decision making when choosing between stairs and elevators, and what are the main drivers for making decision?

In order to understand the process and to answer the research questions, while relying on the existing literature (Lee, 2009; McGloin and Thomas, 2016), two potential relevant drivers have been identified: (1) exploring if there are gender differences in terms of how each one of the gender categories reacted to the previously mentioned intervention and (2) exploring if the fact of people being in a group influenced their decisions in taking the elevators or the stairs after the intervention. The goals of this study were developed based on previous research on the impact the size of a group on collective action since, individuals could make different decisions when alone when compared when they are in groups (McGloin and Thomas, 2016) and the gender aspects since some studies suggest that women tend to have higher pro-environmental attitude and perceive the seriousness of environmental problems than men (Lee, 2009).

The novelty aspect of this study is threefold. Firstly, this is the first study that investigates an intervention related to attitudes toward energy saving and connecting it with the possible drivers to decision making. Secondly, it contributes to the literature on gender aspects related to pro-environmental attitudes at universities. Thirdly, it brings a practical case that green offices from other universities could adopt, contributing to making their institutions more sustainability oriented.

A field study followed by a questionnaire was used to explore the research goals.

1.1. Hypotheses setting

This study has two main hypotheses to be tested, which are connected to the secondary goals explored in the previous section: (a) To explore how gender affects elevator usage, and (b) To explore how being in a group or alone changes elevator usage among students and staff.

The first goal was conceived due to some papers arguing about the existence of gender differences in environmental behavior. These studies explore the extent to which categorical variables impact environmental-friendly behaviors. For example (Dalen and Halvorsen (2011) explored if there is a statistical difference between males and females in five areas such as transportation recycling, energy and water saving, organic food and sustainable ways of transportation, indicating that women, on average, believe that they can contribute to a better environment and, because of that, this might lead to more pro-environmental behaviors (Dalen and Halvorsen, 2011). Other studies, also explored the level at which the gender variable impact pro-environmental behaviors and attitudes, suggesting that farmer woman, through the essentialist lens, would be more environmentally oriented than men farmers (Burton, 2014). Therefore, there is evidence that women tend to have higher pro-environmental attitudes and perceive the seriousness of environmental problems than men (Lee, 2009), and the following hypothesis is proposed:

H1: There is difference in elevator usage between males and females before and after the intervention.

The second hypothesis proposed in this is connected to the collective behavior theory, where some authors suggest that individuals could act differently when compared to when they are alone (Le Bon, 1897; Hogg and Tindale, 2008). This is particularly important since three concepts could change students' behaviors regarding their choice of taking the elevator or the stairs. The first one is contagion, where individuals in a crowd could be influenced by other individuals through their behaviors and emotions (Le Bon, 1897; van Haeringen et al., 2022). The second, in turn, is related to the principle of deindividuation, where some individuals might experience a reduced sense of personal identity, which could lead to lower responsibility for their actions (Zimbardo and Leippe, 1991). Finally, the third is related to emergent norms, where the collective norms may differ from the individual ones, changing their behaviors and shaping collective actions (Smelser, 2011). In this context, it is expected that the pro-environmental behaviors and attitudes of students when the group will be different from the behavior and attitudes of students alone when choosing between stairs and elevators.

H2: There is a difference in elevator usage depending on being in a group or alone with students and staff before and after the intervention.

2. Theoretical background

2.1. Economical, environmental, and human health benefits of using stairs instead of elevators

Recently, there has been an increasing focus on incorporating climate, sustainability, circularity, and energy-saving practices in the operations and strategic decisions of universities and organizations. The specific measures taken by universities and organizations vary. However, some common practices include waste reduction, becoming more energy efficient, and more sustainable by promoting sustainable transportation and offering more sustainable food options (Freie Universität Berlin, 2016; UC Berkeley, 2023).

There are several examples of sustainability practices among higher education institutions, as for example the University UC Berkeley in California, which is on their way to become "zero waste" (eliminating all non-essential single-use plastic) and to become "carbon neutral" (by saving energy through different measures such as taking the stairs instead of the elevator) (UC Berkeley, 2023). Similar to UC Berkely, California, a sustainability mission statement, created with the assistance of the department of sustainability and energy (Stabsstelle Nachhaltigkeit und Energie) and approved by the academic senate, has been in place at Freie Universität Berlin, Germany, since 2016 (Freie Universität Berlin, 2016). However, no specific studies have been conducted in order to measure impact of the actions, and therefore this gap in knowledge shows that the current study brings an additional value into the understanding of these kind of interventions and actions.

The above-mentioned kind of sustainability strategy is not in place at the campus where the elevator intervention has taken place at. Various sustainability studies have been conducted at this campus, but there is no strategic master plan for a more sustainable campus yet. However, those strategic plans are urgently needed in order to show efficient results. Nonetheless, there are small efforts such as a Green Office, solar panels on the roof and different initiatives from students.

The amount of energy that can be saved by using the stairs instead of elevators is dependent on multiple factors such as model of the elevator and the direction the elevator is moving. Furthermore, elevators do not consume the same amount of energy for every floor they pass, because loads and duration vary depending on the trip. Every elevator trip has a distinct power profile. These characteristics make it impossible to analyze the immediate power requirement of individual elevators or elevator groups. As a result, it is difficult to determine how an elevator stock, will benefit from energy efficiency improvements (Tukia et al., 2019).

Elevators are typically responsible for <10% of the total annual electricity consumption of a building. However, the ratios change over time and between buildings, and can reach 40% of the total consumption during peak usage hours (Tukia et al., 2018). A study published by Patrão et al. (2009) showed that if elevators are used inefficiently the standby consumption of energy can represent up to 80% of the total energy consumed by the elevator per year.

On the other hand, several studies have demonstrated that physical inactivity raises the risk of premature death and raises the risk for several non-communicable diseases (Zhang and Chaaban, 2013; Muller et al., 2016). Doing short bouts of exercise which accumulate to 30 min over the course of a day, has the same effect on the reduction of mortality risk as doing 30 min of exercise once per day (Saint-Maurice et al., 2018). In some respects, these short but more frequent periods of exercise have even been shown to be superior to one longer period of exercise during the day (Holmstrup et al., 2014). Daily stair climbing is a strenuous lifestyle exercise

that can have an impact on a number of health-related outcomes for individuals.

With data from the Harvard Alumni Health Study Rey-Lopez et al. (2019) evaluated the relationship between the number of floors climbed per week and all-cause mortality and cardiovascular mortality in men. The number of stairs climbed routinely was found to be inversely related to all-cause mortality and stair climbing was linked to a lower risk of death from any causes (Rey-Lopez et al., 2019). A study conducted by Whittaker et al. (2021) found that not climbing stairs on a daily basis correlated with an increased incidence of metabolic syndrome, a collection of conditions that when combined, increase your risk of coronary heart disease, diabetes, stroke, and other serious health issues (Whittaker et al., 2021). The study concluded that daily stair climbing is likely protective against metabolic syndrome.

Increasing stair use can also be effective for improving body composition, fitness, blood pressure and lipid profile in individuals with an inactive lifestyle. Therefore, increasing stair use might be a simple way to reduce the risk of cardiovascular disease at a population level (Meyer et al., 2010). Therefore, this combination of multifunctional benefits of using stairs was a trigger for this study, which is exploring motivational interventions that can bring beneficial results.

2.2. Interventions concerning elevator use

Several studies on interventions to reduce elevator usage and to instead encourage stair usage have been previously conducted. In this section two of those studies are described and two meta-analyses are summarized.

In 2010 a study was conducted in a university hospital building. A 12-week marketing campaign encouraging the use of stairs including posters was organized. Aerobic fitness, physical activity, anthropometrics, insulin sensitivity, blood pressure, lipids, and C-reactive protein were evaluated in 77 selected employees with an inactive lifestyle at baseline, after 12 weeks, and after 6 months (Meyer et al., 2010). The study produced the following results: in contrast to 4.5/day (1.8–7.2) at baseline, the median daily number of one-story staircase units ascending and descending during the intervention was 20.6/day (14.2–28.1) ($P < 0.001$) and there were positive changes in weight waist circumference, fat mass and diastolic blood pressure. At 6 months, the median daily number of one-story stair units that were ascended and descended had dropped to 7.2 (3.5–14.0). Meyer et al. (2010) concluded that encouragement of stair use at work can reduce the risk of cardiovascular disease by a significant amount at the population level by improving fitness, body composition, blood pressure, and lipid profile in asymptomatic individuals with an inactive lifestyle (Meyer et al., 2010).This approach was also tested on a larger scale and under different settings when three municipal government office buildings in Canada launched the "Active Stairs Pilot" and monitored the results between the years 2013 and 2016 (Moloughney et al., 2019). The intervention was launched in several stages and consisted of door wraps, wayfinding cues, and point-of-decision prompts installed in every stairwell. There was a significant increase in stair use (odds ratio = 1.36; 95% confidence interval: 1.31 to 1.41). Environmental improvements were linked to an additional significant increase in stair use (odds ratio =1.31; 95% confidence interval: 1.25 to 1.37). Here the average absolute increase was 3.5%, which persisted for 1 year. Moloughney et al. (2019) concluded that adding environmental stairwell improvements to office buildings increased stair usage more consistently than prompts alone could.

In 2014 a systematic literature review covering stair-use interventions in worksites and public settings was conducted by Bellicha et al. (2015). They conducted a thorough search of stair-use interventions carried out in workplaces or public places. 50 of the 8571 articles found were included. A rise in stair climbing was observed during the intervention period in 64% (25 studies in workplaces) and 76% (35 studies in public settings) respectively. The study found that external validity elements were significantly underreported. Bellicha et al. (2015) concluded that there is evidence that stair-use interventions work to increase stair climbing in public spaces, but that there is less evidence of this effect in workplaces. They recommended that future studies should address issues like the ideal intervention sequencing or the potential significance of environmental interventions. They also proposed that interventions should include process evaluation as a core component. This finding was used as a basis to conduct the current research, and focus it on work place, investigating if gender or groups have specific impact on the intervention.

Finally, another meta-analysis on the subject was published by Bauman et al. (2017), which specifically focused on studies in which motivational signs were used to improve stair use. Using the calculation of pre-estimates and post-estimates of stair use, all studies in which promotional signs were used to increase stair usage since 1980 were included. 50 comparable studies in which signage was used to increase stair usage were found. The aim of the meta-analysis was to determine if there was sufficient evidence of intervention effects to support a population-wide approach for the use of promotional signs to increase stair use. Following interventions based on signage, the absolute median increase in stair use was 2.2% from baseline across interventions. Participants were 52% more likely to use stairs after exposure to promotional signs, according to the overall pooled odds ratio (adjusted odds ratio = 1.52, 95%; confidence interval: 1.37 to 1.70). The research emphasized that few stairs use interventions are implemented at a population level, and that researchers continue to publish stair use interventions without regard to the needs of policymakers. They recommended that instead of repeating short-term, modest-scale stair sign interventions, researchers should look into how well they can be adopted and scaled up. This recommendation was one of the motivations for this study to identify and assess the drivers impacting participants' decision making.

To summarize, it has been shown that interventions concerning elevator usage are effective in most instances, but not in all. The tendency so far shows that stair usage can be increased, and elevator usage can be decreased, but it depends on type of intervention and type of building. Promotional signs have been shown to improve stair use, but environmental improvements appear to have a larger impact. How well the intervention works is dependent on the setting and the intervention itself. Until now it has not been fully

researched what sort of impact being in a group or being alone has on the decision of taking the elevator or the stairs when an intervention is taking place, nor the role of gender as drivers in decision making. Therefore, this study suggests that identifying key drivers has a crucial role for the success of the intervention, and assessing this is the focus of this research.

3. Methods

The main goal of this research is to understand the extent to which students and university staff change their preferences for the usage of the elevators or the stairs, after the intervention at the Campus, in order to determine if the overall intervention was successful. The secondary research goals could only be explored in case the intervention was successful. So far it has not been fully researched what kind of impact being in a group or alone, has on the decision of an individual who is contemplating taking the elevator or the stairs when an intervention is taking place. Therefore, as a secondary research goal, this research will also evaluate being in a group or alone as a confounder on the decisions of students and staff. It will also be explored if there is a difference in elevator usage related to gender. To answer the research question two main methodologies were employed. The first one was a field study and the second one was a questionnaire. The research setting matrix is summarized in Table 1. The field study and the questionnaire are being described in the following section.

An intervention concerning elevator usage was designed to support students and staff in changing their behavior. This intervention will be described in the next chapter.

3.1. Field study

The first part of the research was a field study in cooperation with the University Green Office, which involved posters about energy saving at the entrances and stickers at the elevators and staircases showing a staircase and the sentence "Use your own energy". The poster displayed informative text about the Sustainable Development Goal (SDG) 7 as well as ideas how to save energy. The main suggestion was to use stairs instead of elevators.

Before the initiative started (September 2022), a count was done to measure how many people were taking the elevators and how many were taking the stairs until 1,615 people were counted. The same counting procedure was done after the initiative started (October 2022) and the stickers and posters were displayed. The counting was conducted 20 min before the start of the lessons until lessons started, during the times from 8:10 to 8:30, from 10:00 to 10:15, from 12:15 to 12:30 and from 14:15 to 14:30 to have as many students and staff as possible utilizing the stairs and the elevators during the time of counting. There are nine elevators located on the campus Bergedorf and during the counting, up to 4 people assisted simultaneously with the counting. The elevators chosen for the counting were the most frequently used.

During both the count before the initiative and the one after, three additional features about each person that was counted were written down. These features were: (a) does the person seems to be male or female, (b) are they a student or staff and is the individual in a group or alone. If the individual was in a group, the group size and if all members of the group took the stairs or elevator or if the group was divided in their decision, were written down as well. In a case where it was hard to distinguish the gender of a person or if a person was a student or staff the person was not counted.

3.2. Questionnaire

The second part of the research was a questionnaire, which was used to ask participants 16 multiple-choice questions and one open-ended question. The questionnaire consisted of closed questions that covered demographics such as age and gender. These were followed by questions about the perceived willingness of the participants to use the stairs instead of the elevator before and after the intervention. Participants were also asked about different factors that would impact their decisions on taking the elevator or the stairs. Those factors were being in a group or alone, time of day, waiting time and how many floors the participant needed to go up. The questionnaire was specifically designed for this paper. The questionnaire was not pre-tested due to the limited resources, but it has been checked by the sustainability unit team and university ethics department before officially used for the study.

The questionnaire was available in English and German to allow a wide range of participants to take part in the study. An E-Mail asking students and staff to participate was sent out by a staff member of the university via a mailing list. The questionnaire was available on the platform SoSci and was designed to take approximately 10 min for respondents to answer. The goal was to collect responses from at least 200 participants. The questionnaire was conducted over 4 weeks from 26 October to 22 November 2022.

In total, 406 participants used the link to take part in the questionnaire. Overall, 386 participants finished the questionnaire. The website with the questionnaire was opened 459 times in total and of those 459 times, the questionnaire was finished in 84.09% of cases. The completion rate was 95.07%.

Data cleansing was used to improve the validity of the data. After using these filter questions, the 386 participants were reduced to 304. Because only 4 non-binary people answered the questionnaire there would not have been significant results for that gender group and they were excluded as well as participants that did not want to reveal their gender which left 299 sets of data. The data was cleansed further by excluding everyone who answered <8 of the 16 questions as maximum of 50% missing answers was accepted. Furthermore, the relative speed index (RSI) was used for data cleansing. The RSI can be used to filter if a participant answered the questionnaire strikingly fast, which could mean that questions were not read carefully (Leiner, 2019). After cleaning the data, 293 data sets remained that could be analyzed for the evaluation of the study.

3.3. Data analysis

3.3.1. Field study data analysis

The data were analyzed and interpreted using both Excel and IBM SPSS Statistics 26. Descriptive analysis was used to describe

TABLE 1 Research setting matrix.

Main research goal	Secondary goals	Hypothesis/Proposition	Methods
To assess how did the elevator intervention impact the behavior of students and staff at the university campus	To explore how gender effects elevator usage.	H1 There is a difference in elevator usage between males and females before and after the intervention.	**Data collection:** Field study Questionnaire **Data analysis:** Descriptive Statistics **Software used:** Microsoft Excel IBM SPSS 26
	To explore how being in a group or alone changes elevator usage among students and staff.	H2 There is a difference in elevator usage depending on being in a group or alone with students and staff before and after the intervention.	**Data collection:** Questionnaire **Data analysis:** Descriptive Statistics Non-parametric tests **Software used:** Microsoft Excel IBM SPSS 26

elevator usage before and after the intervention. All of the variables that were used during the counting were nominal. For that reason, percentages and the odds ratio (OR) were used to explore the data. To analyze how the intervention impacted different groups the odds ratio for gender, being in a group or alone and being a student or staff in context with elevator usage, was calculated.

3.3.2. Questionnaire data analysis

The data were analyzed and interpreted using Excel and IBM SPSS Statistics 26. Statistical analyses such as frequency and descriptive analysis were used to describe participants demographics and their willingness toward using the stairs instead of the elevator before and after the intervention. How being in a group or being alone and the gender of the participants is connected to elevator usage is being explored using descriptive and frequency analysis as well. Measures of central tendency were calculated for ordinal variables. The data that had interval or ratio scales was processed using the Mann–Whitney *U*-Test for independent samples because according to Kolmogorov-Smirnov and Shapiro-Wilk the data did not follow a normal distribution. Several hypotheses were tested, and they will be described in the following sections. Through all statistical tests a significance level of 5% was accepted.

4. Results

The results coming from the field study and the questionnaire have been synergized with each other and the theoretical background to reject or accept the hypotheses and find out which implications the study could have on future interventions regarding elevator usage.

4.1. Field study results

The field study produced two sets of data. The first data set was collected during the count conducted from 27 September to the 6 October and the second one was counted from the 7 October to the 14 October 2022.

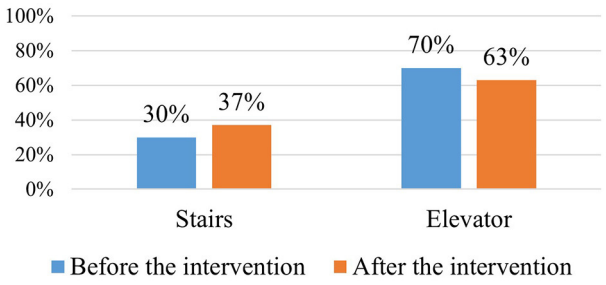

FIGURE 2
Preferences of participants in stairs and elevators usage before and after the intervention.

4.1.1. Descriptive analysis

In both counts data collection was conducted until the sample size reached 1,615 participants. In the first counting, the sample consisted of 718 (44.46%) males and 897 (55.54%) females, while 1,547 (95.79%) were students and 68 (4.21%) staff. 746 (46.19%) of participants counted were on their own and 869 (53.81%) were in a group. In total, 483 (29.91%) took the stairs and 1,132 (70.09%) took the elevator. In the second count the sample consisted of 796 (49.29%) males and 819 (50.71%) females. 1,561 (96.66%) were students and 54 (3.34%) were staff. 751 (46.50%) of those counted were alone and 864 (53.50%) were in a group. The male-to-female ratio (first count 0.80, second count 0.97), the staff-to-student ratio (first count 22.75, second count 28.91) and the single-to-group ratio (first count 0.86, second count 0.87) were similar in both samples.

In total 595 (36.84%) took the stairs and 1,020 (63.16%) took the elevator. There was a difference in elevator and stair usage between samples. Stair use increased by 6.93% after the intervention (Figure 2).

4.1.2. Gender and elevator usage

Before the intervention 36.49% ($n = 262$) of the males counted were using the stairs and 63.51% ($n = 456$) were using the elevator. In comparison, only 24.64% ($n = 221$) of the females were using the stairs and 75.36% ($n = 675$) were using the elevators. The stair usage was 11.85% higher in males than females before the intervention.

Males and females were impacted quite differently by the intervention. Stair usage among females increased by 11.50% after the intervention. In comparison, stair usage increased only by 1.07% among males after the intervention. After the intervention, 36.14% ($n = 296$) of the females were using the stairs, nearly the same percentage as males before the intervention. The effect of the intervention on males was much lower in comparison to females.

Before the intervention males were 1.76 times more likely to take the stairs than females (OR 1.76, 95% CI 1.42 to 2.18). The 95% confidence interval did not overlap the null value, which indicates statistical significance. After the intervention males were only 1.07 times more likely to take the stairs than females (OR 1.07, 95% CI 0.88 to 1.31). Due to the 95% confidence interval overlapping the null value, there might not be a statistically significant difference in elevator usage between males and femsales after the intervention.

4.1.3. Group size and elevator usage

Before the intervention students and staff, that were alone, were more likely to take the stairs than students and staff in a group. 34.18% ($n = 255$) of those who were alone, were taking the stairs, compared to 26.24% ($n = 228$) that were in a group and taking the stairs. Students and staff that were alone were nearly 8% more likely to take the elevator than the ones that were in a group. After the intervention, 45.94% ($n = 342$; increased by 11.76%) of the students and staff that were alone, were taking the stairs. The stair usage of students and staff in a group only increased by 2.70%. Before the intervention students and staff that were alone were nearly 8% more likely to take the stairs than students and staff in a group, and after the intervention, the difference increased to 17%.

When only dividing students and staff into being alone or being in a group, it seems like the intervention did not have an impact on students and staff when being in a group. But this does not seem to be true. When students and staff in a group are also divided into group size categories, there are nuanced differences between the groups' elevator usage before and after the intervention (Table 2).

For groups of two stair usage increased by 2.36% after the intervention. It also increased for groups of four (by 8.69%) and groups of five (by 6.29%). For groups larger than five it increased the most with an increase in stair usage of 20.02%. The stair usage decreased after the intervention in groups of three by 8.57%. Being in a large group did seem to make it more likely for the intervention to have a positive effect, while the smaller groups with two or three people were impacted less by the intervention.

Students and staff that were alone were 1.44 times more likely than students and staff in groups to take the stairs before the intervention (OR 1.44, 95%, CI 1.16 to 1.79). Because the 95% confidence interval does not overlap with the null value, a statistical significance can be assumed. After the intervention the odds for students and staff that were alone to take the elevator were even higher with an odds ratio of 2.12 (95% CI 1.72 to 2.60). Again the 95% confidence interval does not overlap with the null value, indicating a statistical significance.

4.1.4. Differences between students and staff

During the first count 1,547 students and 68 staff were counted. In the second count 1,561 students and 54 staff were counted. The number of students that were counted was a lot higher than the number of staff. Before the intervention, 70.58% ($n = 47$) of staff and 70.07% ($n = 1{,}080$) of students were taking the elevator, which was very similar. After the intervention, 57.40% ($n = 31$) of staff and 63.36% ($n = 985$) of students took the elevator. For staff, elevator usage decreased by 13.18% after the intervention. The elevator usage of students decreased by 6.71%. The decrease in elevator usage was nearly twice as much in staff, compared to the decrease in students.

Before the intervention students were 1.07 times more likely than staff to take the stairs (OR 1.07, 95% CI 0.63 to 1.82). Because the 95% confidence interval does overlap with the null value there might not be a statistically significant difference in elevator usage between students and staff before the intervention. After the intervention students were slightly less likely than staff to take the elevator. Staff was 1.14 more likely than students to take the elevator (OR 1.14, 95% CI 0.67 to 1.94). Again the 95% confidence interval overlapped with the null value, indicating that there might not be a statistically significant difference in elevator usage between students and staff before and after the intervention.

4.1.5. Field study observations

Capturing notes about observations was initially not part of the field study, however, a few subjective observations were written down during the counting. During the period of the intervention, it was observed that students and staff would approach the elevator and seemingly automatically press the button. While waiting they would look at the motivational sign, reconsider and then take the stairs instead. This would happen more often with students or staff that were alone, but it also happened when groups approached the elevator. Sometimes, while waiting for the elevator, one of the group members would point at the sign and a conversation would start. Then the group would change their decision and take the stairs instead of the elevator.

4.2. Questionnaire results

The questionnaire was available from the 26 October to the 22 November. 406 participants used the link to take part in the study and of those 406 data sets, as explained in the third section, 293 have been analyzed in the following sections.

4.2.1. Sample description

Of the 293 participants 94 (32.08 %) were male and 199 (67.92%) were female. While there was nearly an equal number of males and females in the field study, one third of the participants in the questionnaire were male and two third were female.

Nearly 90% ($n = 255$; 87.03%) of the participants were students at the university, 9.56% ($n = 28$) were working at the university and 5.12% ($n = 15$) were working and studying at the university.

The participants' age range was between 18 and 64 years. With 54.27% ($n = 159$) most of the participants were between 18 and 24 years old. The second largest group of participants were those belonging to the 25–34-year-old age group with 33.11 % ($n = 97$). Followed by participants in the age range between 55 and 64 which

TABLE 2 Change in elevator usage among groups before and after the intervention.

		Sample	Observations	Total of observations	Percentage	Difference
Group: two persons	Stairs	Before the intervention	97	350	27.71%	2.36%
		After the intervention	114	379	30.08%	
	Elevator	Before the intervention	253	350	72.29%	−2.36%
		After the intervention	265	379	69.92%	
Group: three persons	Stairs	Before the intervention	61	219	27.85%	−8.57%
		After the intervention	43	223	19.28%	
	Elevator	Before the intervention	158	219	72.15%	8.57%
		After the intervention	180	223	80.72%	
Group: four persons	Stairs	Before the intervention	14	128	10.94%	8.69%
		After the intervention	21	107	19.63%	
	Elevator	Before the intervention	114	128	89.06%	−8.69%
		After the intervention	86	107	80.37%	
Group: five persons	Stairs	Before the intervention	37	115	32.17%	6.29%
		After the intervention	25	65	38.46%	
	Elevator	Before the intervention	78	115	67.83%	−6.29%
		After the intervention	40	65	61.54%	
Group: More than five persons	Stairs	Before the intervention	19	59	32.20%	20.02%
		After the intervention	47	90	52.22%	
	Elevator	Before the intervention	40	59	67.80%	−20.02%
		After the intervention	43	90	47.78%	

were 6.14% ($n = 18\%$). The age ranges 35–44 years and 45–54 years were the least represented with 3.75% ($n = 11$) and 2.73% ($n = 8$).

4.2.2. Impact of the elevator intervention

Nearly two-thirds ($n = 188$; 66.20%) of the participants noticed the stickers at the elevators that asked students and staff to "Use your own energy" while 33.80% ($n = 96$) did not. Of those that noticed the sticker 32.98% ($n = 62$) agreed that it motivated them to take the stairs more often, while 67.02% ($n = 126$) did not feel more motivated by the stickers. Of all participants in the study 21.16% ($n = 62$) felt more motivated by the stickers to take the stairs. When asked how the stickers influenced their decision to take the elevator or the stairs 71.28% ($n = 134$) said the stickers did not change their behavior. 21.28% ($n = 40$) were more aware of the importance of energy saving through their decisions. 6.91% ($n = 13$) were taking the elevator less to save energy and 0.53% ($n = 1$) agreed that the sticker motivated them to take the stairs more often. No one answered that they were only taking the stairs from now on. On the other hand, 85.48% ($n = 53$) would have preferred for the stickers to stay at the elevators to remind them to take the stairs more often and only 2 participants (3.23%) would have preferred not to have the stickers next to the elevators anymore.

In general, 30.65% ($n = 19$) thought that the sticker would probably motivate them for a very long time, 27.42% ($n = 17$) did not know for how long the stickers would motivate them and 17.74% ($n = 11$) thought the stickers would motivate them for 1 to 3 months to take the stairs more often. 9.68% ($n = 6$) said they would be motivated for less than a month and another 9.68% ($n = 6$) agreed that they would be more motivated for 4 to 6 months. With 4.84% ($n = 3$) the least number of participants said that they would be motivated for more than 6 months.

To further explore differences between participants that felt motivated and participants that did not feel motivated by the stickers, three hypotheses were tested. The Mann–Whitney *U*-Test for independent samples was used for testing because as previously mentioned the data did not follow a normal distribution.

The first hypothesis was that there is a significant difference in stair usage between participants that were motivated and participants that were not motivated by the stickers. For the first hypothesis the null hypothesis can be rejected as displayed in Figure 3 as participants that felt motivated by the sticker were a lot more likely to take the stairs than the elevator (y-axis in the graph being: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always). The second hypothesis that was tested was that there is a significant difference in elevator usage between participants that were motivated and participants that were not motivated by the stickers. Matching the results of the first hypothesis that was tested, the null hypothesis can be rejected again and there is a significant difference between both groups. Participants that did not feel motivated by the stickers, were a lot more likely to take the elevator than participants that felt motivated by the stickers.

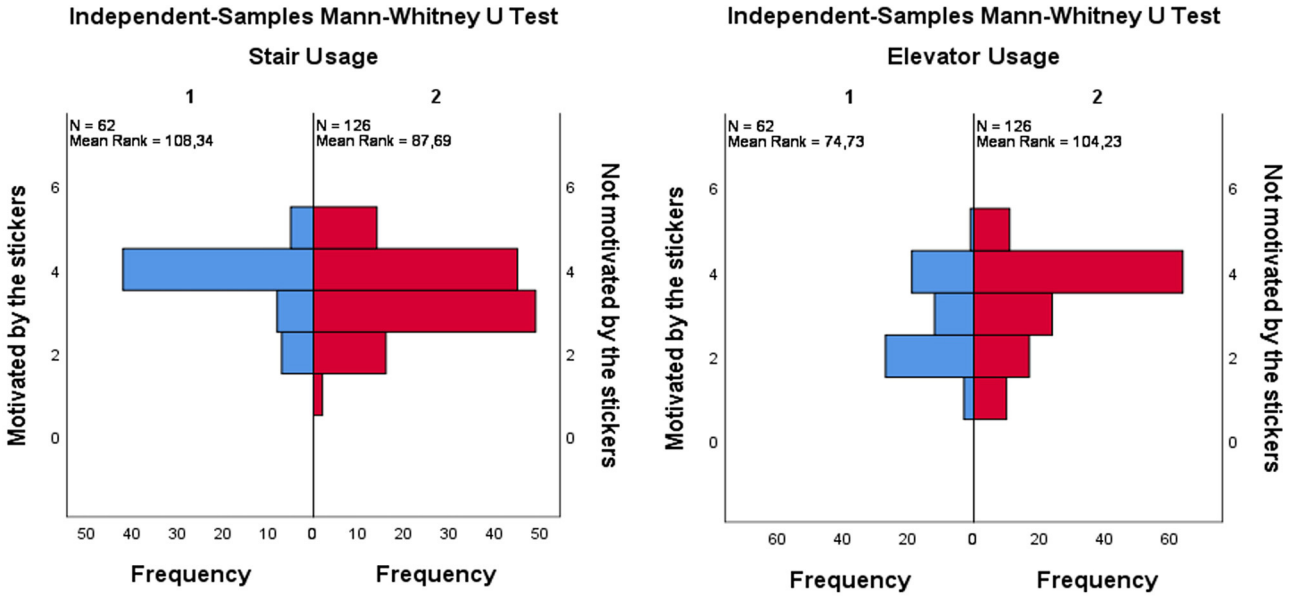

FIGURE 3
Mann–Whitney *U*-Test correlation of feeling motivated/not motivated by the stickers and elevator and stair usage.

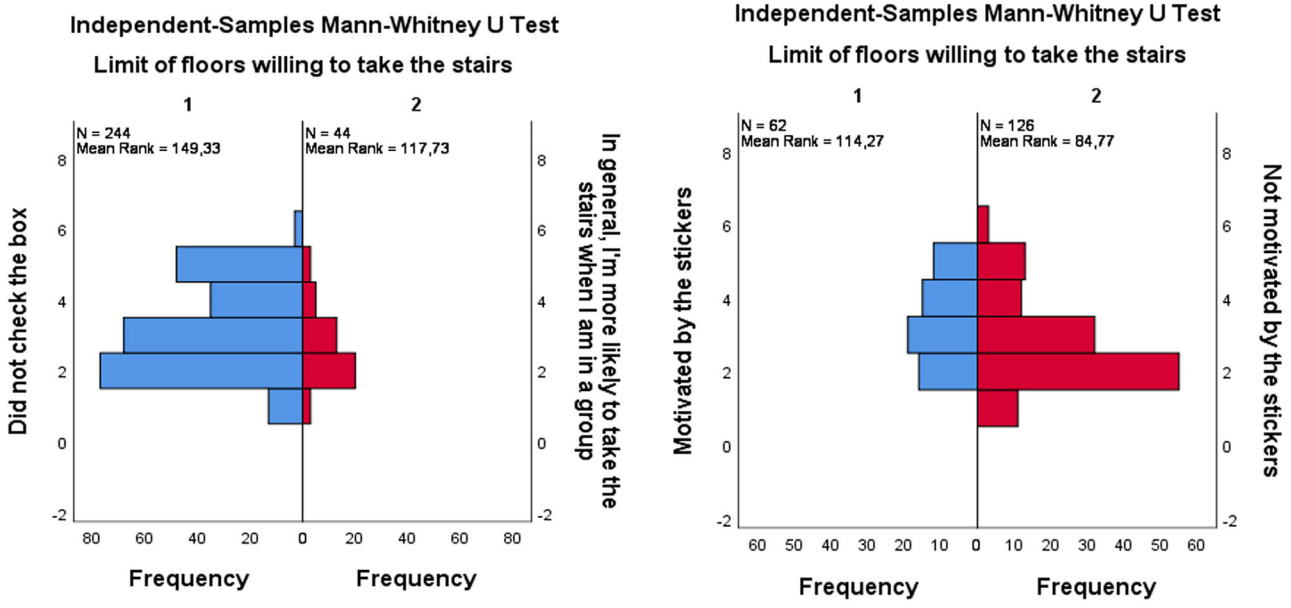

FIGURE 4
Mann–Whitney *U*-Test correlation of feeling motivated/not motivated by the stickers and participants limit of floor up until which they are willing to take the elevator.

The third hypothesis was that there is a significant difference between being or not being motivated by the stickers and the willingness of participants up to which floor level they would rather take the stairs than the elevator. The null hypothesis can be rejected again which means that there is a significant difference between participants who felt motivated and unmotivated by the stickers in their willingness to change which level they would rather take the stairs instead of the elevator. The mean rank of participants motivated by the stickers is higher than the one of the once not motivated by the stickers, which is to say that the motivated participants are willing to take the stairs up to higher levels than the participants that were not motivated by the stickers (Figure 4).

On average participants that were motivated by the stickers, were willing to take the stairs two thirds of a floor higher (2.37 floors), than participants that did not feel motivated by the stickers

(1.76 floors). Rounded off to the next floor both groups were willing to take the stairs up until the second floor.

4.2.3. Gender and elevator usage

The results showed that 65.12% (n = 127) of the female participants and 68.54% (n = 61) of the male participants noticed the stickers. 33.07% of the female participants (n = 42) that noticed the sticker said they felt motivated by it to take the stairs more often. Quite similarly 32.79% of the male participants (n = 20) that noticed the sticker said they felt motivated by it to take the stairs.

Three hypotheses were tested to understand if there is a gender difference in elevator usage. The Mann–Whitney U-Test for independent samples was used for testing because as previously mentioned the data did not follow a normal distribution.

The first hypothesis was that there is a correlation between gender and elevator usage. In this case the null hypothesis can be rejected meaning that there is a significant difference between males and females in elevator usage. The mean rank for females is higher than the mean rank for males signifying that females use the elevator more often than males (Figure 5).

The second hypothesis was that there is a correlation between gender and stair usage. For this hypothesis the null hypothesis had to be retained, meaning that there is no significant difference in stair usage between males and females (Figure 5).

The third hypothesis was that there is a correlation between gender and the willingness of participants up to which floor level they would rather take the stairs than the elevator. In this case the null hypothesis can be rejected. There is a significant difference between male and female participants willingness up until which floor they would rather take the stairs than the elevator. As displayed in Figure 1 the most common answer in females and males was that they would take the stairs up until the 1st floor (y-axis in the graph being: 1 = always taking the stairs, 2 1st floor, 3= 2nd floor etc.). But overall males were more likely to take the stairs up until a higher floor level, while females were deciding to take the stairs earlier.

On average males were willing to take the stairs a third of a floor higher than females, before deciding to take the elevator (Figure 6). Still rounded off on average males and females were both willing to take the stairs up until the second floor.

4.2.4. Impact of being in a group on elevator usage

Participants were asked if and how being in a group impacted their decision to choose between the elevator or the stairs. With 55.71% (n = 161) more than half of the participants answered that they are more likely to take the elevator when at least one person from the group wants to take the elevator. The number of participants that were more willing to take the stairs in a group (15.22; n = 44), was nearly equal to the number of participants that were more likely to take the elevator in a group (16.96; n = 49). Nearly a third of the participants (31.14%; n = 90) answered that being in a group did not make a difference on their decision.

5. Discussion

The goal of this research was to explore how the intervention with the goal to reduce elevator usage and save energy influenced the behavior of students and staff. The results show how behavior changed objectively and how students and staff experienced the intervention.After the intervention, stair usage increased by 6.93% (n = 1,515) as observed in the field study. Of all students and staff that answered the questionnaire, 21.16% (n = 83) said that they felt motivated by the stickers to take stairs more often. Considering a wide discrepancy between those numbers, that motivation was not enough to lead to the actual action. This could be further explained by the fact that students and staff might feel more motivated on one hand, but on the other not motivated enough to actually change their behavior. Despite 21.16% of participants agreeing to feeling more motivated by the stickers, only 7.44% (n = 14) of students and staff that felt motivated by the sticker answered in the questionnaire that they actually did change their behavior by either taking the elevator less often to save energy or that they felt so motivated that they would take the stairs more often. Of all students and staff, 4.78% (n = 14) said that they felt so motivated that they changed their behavior. Also, most students and staff who did not change their behavior, 85.48% (n = 53), would have preferred for the stickers to stay at the elevators to remind them to take the stairs more often. These results actually match the observations during the field study.

The results of the field study were similar to the findings of Bauman et al. (2017) meta-analysis where the median increase of stair use was 2.2% and the findings of Bellicha et al. (2015) literature review where interventions concerning elevator usage, increased stair usage in 76% of interventions in public settings. A similar study on an intervention using signage to promote stair usage in a university setting in the US in 2008, showed an increase of stair usage by 12% during the intervention period (Grimstvedt et al., 2010). With an increase of 6.93% in stair usage, the intervention on Campus Bergedorf falls in between the results of Bellicha's and Grimstvedt's studies. In the study of Meyer et al. (2010), stair usage increased by nearly 75 %. In this case the strong increase might be related to participants knowing that they are involved in a study and also participating in health-related measurements before and after the study.

The results showed the connection between motivation among participants and their behavior in stair and elevator usage. Similar tendencies were observed in their willingness of up to which floor level they would take the stairs. Participants that felt motivated by the stickers were more likely to take the stairs and less likely to take the elevator. This indicates that the intervention impacted students and staff who were already more willing to take the stairs and less likely to take the elevator to a greater extent, than students who were more often deciding to take the elevator before the intervention.

In future studies it should be explored by qualitative interviews why some students and staff will not use the elevator at all and whether environmental stairwell enhancements could motivate those students and staff to reduce usage of elevators. However, even without further investigation it can be observed that

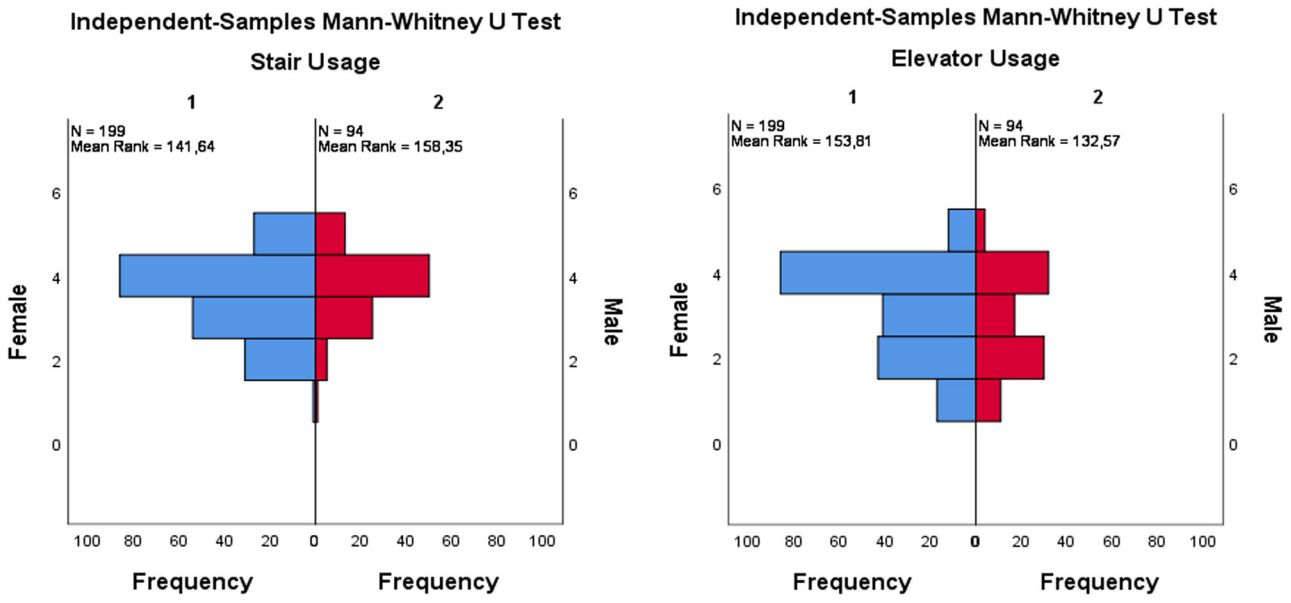

FIGURE 5
Mann–Whitney *U*-Test correlation of gender and elevator and stair usage.

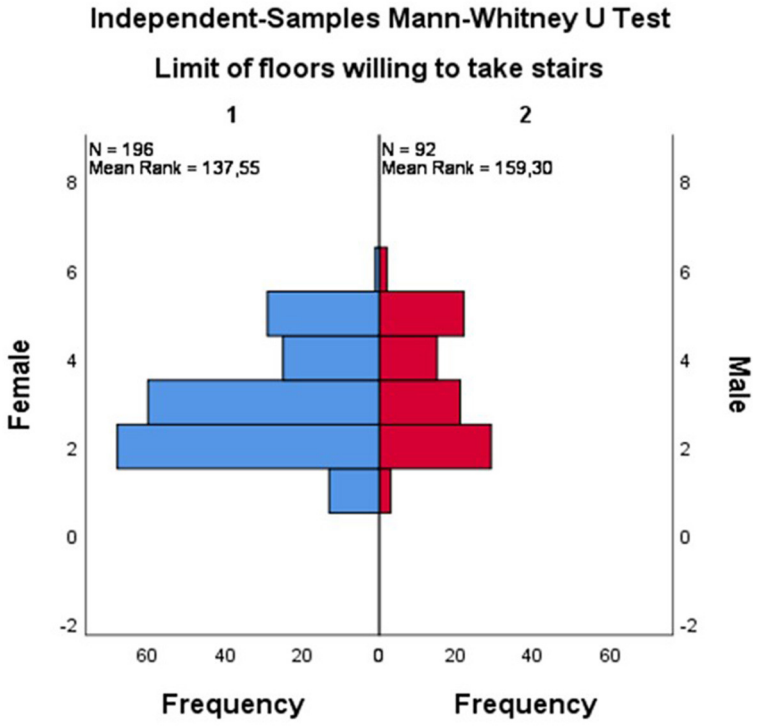

FIGURE 6
Mann–Whitney *U*-Test correlation of gender and participants limit of floor up until which they are willing to take the elevator.

the intervention was successful and should be implemented in German Universities.

When it came to the impact of the intervention among different groups it was quite dissimilar. The results of how the elevator intervention and elevator usage was impacted by gender and whether students and staff were either in a group or alone. Males were 1.76 times more likely to take the stairs than females before the intervention (OR 1.76, 95% CI 1.42 to 2.18). After the intervention males were only 1.07 times more likely to take the stairs than females (OR 1.07, 95% CI 0.88 to 1.31). In this

case, the 95% confidence interval overlapped with the null value, meaning that there might not be a statistically significant difference in elevator usage between males and females after the intervention. On the other hand, in the questionnaire, nearly the same number of females (33.07%, $n = 42$) and males (32.79%, $n = 20$) that noticed the sticker said they felt motivated by it to take the stairs. This discrepancy might be because of the smaller sample size in the questionnaire, or that the male participants might have overestimated the impact the stickers had on them. The results of the field study do correspond with the results of the questionnaire, where the Mann–Whitney *U*-Test indicated that there is a significant difference between males and females in elevator usage and on average females use the elevator more often than males. There was also a significant difference in the willingness of males and females for the highest floor level they would be willing to take the stairs to. In general males seem to be more willing to take the stairs than the elevator, but females were more impacted by the intervention. After the intervention, there was no significant difference in the elevator usage between males and females anymore. These findings did not align with the ones from Kwak et al. (2007). In their study, a poster-based intervention in blue- and white-collar work sites was explored. Before the intervention women were using the stairs significantly more often than men. The effect of the intervention on men and women was not significantly different. Similar to the finding of this paper, it was shown during a follow up that, women kept taking the stairs more often. This effect could not be shown for the men (Kwak et al., 2007). Grimstvedt et al. (2010) conducted a study on using signage to promote stair use on a university campus. No significant correlation between gender and elevator usage during or after the intervention could be found (Grimstvedt et al., 2010). Similarly, Howie et al. set up a multicomponent intervention, involving stickers and competitive challenges to increase stair usage at a university residence building and found no difference between genders (Howie and Young, 2011).

The different findings from those three studies and the results of this paper, for elevator usage depending on gender, might be setting or age related, but this would need to be explored in further studies. In future interventions, it should be explored what kind of intervention would motivate male students and staff to take the stairs more often and why female students were impacted by the intervention while male students were not. A possible reason for the difference in impact of the intervention is that the intervention was designed by a team of female researchers who decided on the slogans for the stickers. This might have led to a slogan that was quite motivating for female but not for male students. Before the implementation of a new intervention, qualitative research, interviewing male students, and staff, should be done.

Before and after the intervention students and staff that were alone were more likely to take the stairs than students and staff in a group. Before the intervention, students and staff that were alone were nearly 8% more likely to take the stairs than those who were in a group. After the intervention this difference increased to 17%. Different sizes of groups were impacted differently by the intervention. Groups larger than five for example increased stair usage by 20% after the intervention, while for groups of three elevator usage decreased by nearly 9%. The generally higher elevator usage of groups might be explained by the fact that over 50% of students and staff answered in the questionnaire that they would take the elevator when they are in a group and one of the group members wants to take the elevator. This kind of herd mentality was shown in different settings before. For example, in part, a financial crisis can happen because of the herd mentality of investors, where investors start buying or selling stocks because other investors are acting in the same way (Fromlet, 2012). Dyer et al. found in an experimental study that a small minority (5%) could effectively guide a larger group when walking around a room (Dyer et al., 2009). These results could explain that if one person is very insistent on using the elevator, the other group members might follow that behavior. On the other hand, the herd mentality could also be used as an advantage during an intervention. If one person in a group insisted strongly on using the stairs, the entire group might follow. In studies focusing on elevator usage during evacuation scenarios it has been shown that herd mentality is a strong factor when deciding on using or not using the elevator in emergency (Kinateder et al., 2014a,b; Wei et al., 2022). This research suggests that it is similar in non-emergency situations.

5.1. Theoretical, practical, and social contributions of the study

As observed, many studies that have been conducted on this topic are several years old, and lately the studies did not focus on this topic as such, since the main focus of the study were issues as climate change or sustainability of the actions (Meyer et al., 2010; Moloughney et al., 2019). However, recent worldwide energy crises triggered a prioritization of this kind of studies. Therefore, findings of this study can be considered as a valuable contribution to the literature.

This study clearly showed that stair case interventions should be implemented in more University campuses. Furthermore, this kind of intervention (but adapted to the type of building and target groups) could be up scaled and used in public buildings in general, however the study points out the importance of previously adapting the intervention to the type of building and target groups. Small scale interventions as this one, which can gather data relatively quickly, is beneficial to identify different target groups and drivers that need to be taken into account in order to assure the intervention success.

Important social contribution of the study is the fact that students and staff even feeling motivated with stickers on one hand, on the other they were not motivated enough to actually change their behavior. In addition to that, the study showed some first insights on how drivers such as difference in group set-up and gender influence on human behavior. These theoretical findings should be explored further to find out why we can see differences in male and female students before the intervention and why females reacted to the intervention better than males. Furthermore, the influence of being in a group or on their own should be explored in a qualitative study to develop further theories on why and how this factor influences the decision of taking the stairs or the

elevator. Perhaps further, larger-scale studies could assist more general understanding on how to develop successful interventions.

5.2. Limitations of the study

This study has limitations which could also be considered issues to be tackled in future studies. Although the questionnaire was developed according to the literature, it was not pre-tested due to the limiting resources such as short time frame to conduct the research. In addition, the self-assessment characteristic of it could result in social desirability bias. In this sense, future studies could focus on developing a validated questionnaire capable of measuring the impact of sustainability-related interventions on pro-environmental attitudes of students and university staff. In addition, by adopting mixed-methods approach combining questionnaires, interviews and focus groups could reduce the potential bias during the data collection phase.

6. Conclusions and future recommendations

As a final conclusion, reducing elevator and increasing stairs usage often can be an effective strategy to save energy and to implement movement into daily life to improve individuals' health. Elevator interventions can increase stair usage in different settings. These interventions can include signage, posters, and environmental enhancements of the staircases. Increasing stair use can help those who lead sedentary lifestyles with improving body composition, fitness, blood pressure and lipid profile. Elevator interventions should be used at a population level and in more settings promoting the message that by using the elevator less, energy can be saved.

Three research questions were answered in this paper. The elevator intervention at the campus implemented in October 2022 showed to be successful and beneficial for energy saving. In average, elevator usage decreased by nearly 7% after the intervention. In addition, before the intervention males were 1.76 more likely than females to take the stairs. After the intervention, the stair usage of females increased, while the stair usage of male students and staff remained nearly the same. Because of that, there was no significant difference between the stair usage of male and female students and staff after the intervention. It should be explored further why female students were a lot less likely before the intervention to take the stairs and why the intervention worked well for females but not males. Students and staff who were alone were 1.44 times more likely to take the stairs than students and staff who were in groups. Therefore, groups should be targeted specifically in future interventions and herd mentality could be used as an advantage to improve stair usage. After the intervention, the disparity in stair usage grew to 17%.

In addition, groups should be targeted specifically in future interventions concerning elevator usage. On the one hand, if groups are taking the stairs instead of the elevator, the impact on energy saving is greater than if only one person decides to take the stairs. On the other hand, there is still a lot of room for improvement of stair usage for groups. Herd mentality could be used to increase stair usage of groups and future studies would be needed to explore how to incorporate this effect into an intervention.

Further research is necessary and could improve the quality of future elevator interventions at public places campuses. Although, environmental enhancements to staircases might improve the impact of future interventions, they are also more expensive than stickers and posters. Furthermore, while the impact of the intervention on improving students' and staffs' health and on energy savings during the continuing energy crisis may seem small at first, change happens through taking small steps to reach a bigger goal. For solving the energy crisis and for improving the health of students and staff, a lot will be needed to aspire to reach the final goals. Finally, the intervention to take the stairs more often than elevators, can be a valuable part of that journey.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

Conceptualization and investigation: FG and JB. Methodology and writing—original draft preparation: JB, FG, and JHPPE. Data curation, visualization, and formal analysis: FG and JHPPE. Supervision and funding acquisition: JB.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling editor MD declared a past co-authorship with the authors JB and JHPPE.

Publisher's note

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