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Relaxed minds for healthier food choice at school: A field experiment in southern Mexico

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ABSTRACT

Stress leads to unhealthy food choices since the school-age stage. Yet, there is limited evidence particularly in low- and middle-income countries regarding the impact of stress-reduction strategies on school-age children's food choices. Such aspects were crucial during the recent COVID-19 pandemic, which exacerbated psychological distress and unhealthier food choices among children. Two years after the pandemic began, we conducted a field experiment in southern Mexico to assess the impact of stress-reduction strategies on the food choices of over 1400 children aged 9–12. Half of the school-classes in the sample were randomly assigned to a stress reduction strategy namely meditation, which comprised six audios with basic relaxation techniques and intuitive messages to guide food choices. Additionally, all participants received information signalling that an amaranth snack was nutritious (i.e., the healthy snack), which was paired with a chocolate bar (i.e., the unhealthy snack) as part of a snack choice experiment. Students that practiced meditation were slightly more likely to choose the healthy snack than those in the control group, but the effect was not statistically significant. Upon collecting their snack, students had the chance to exchange their original choice for the other snack. Students that meditated were more likely to exchange their originally chosen "unhealthy snack" towards the healthy snack than students in the control group. The meditation program effectively reduced chronic stress among treated children. The effect was larger among students attending schools in lower-income areas. Our study sheds some light on the challenges to translate an improved psychological well-being into healthier food choices at school.

1. Introduction

Traditionally, the global efforts to promote healthy food choices and improve diets often rely on educating the public (Willett et al., 2019). However, it is increasingly recognized that information does not necessarily motivate individuals to change their diets (List & Samek, 2015; Samek, 2019; Van Kleef & Van Trijp, 2018). The effectiveness of information provision is bounded by biases and heuristics that make individuals more prone to unhealthy food choices, particularly in stressful situations. Stress has been shown to be associated with higher craving for and consumption of high-fat and high-sugar foods, especially when consumed as between-meals snacks (O'Connor et al., 2008). The recent evidence suggests that the impact of stress on unhealthy eating may be observed in children as young as eight-nine years old (Hill et al., 2018).

The period 2020–2023 was particularly stressful for many people, as the COVID-19 pandemic was found to be associated with stress-related mental illnesses, such as anxiety and depression (Kar et al., 2021). Not just the fear of illness but also the socioeconomic consequences of the pandemic: lack of financial resources, unemployment, and fear of a new recession could have increased stress (Landa-Blanco et al., 2021). These effects are likely to be especially high in low-income settings, where poverty-related stress already affects healthy behaviours (Bruijn, 2021; Just & Gabrielyan, 2018). In the present study context, Mexico, up to 50 percent of the population suffered from COVID19-related psychological distress (Landa-Blanco et al., 2021). More prolonged school closures than in other regions, home isolation, limited access to a computer and/or internet for online education, as well as lack of parental support

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affected children as much as adults (Landa-Blanco et al., 2021). Moreover, the emerging research on the effects of COVID-19 pandemic on children's weight status suggests acceleration of weight gains especially among school-age children (Vogel et al., 2022).

During the last decades, Mexico, like other low- and middle-income countries, has experienced a steep increase in the consumption of ultra-processed foods and drinks (e.g., sweetened beverages, snacks, sweets, and desserts), a limited intake of whole foods (e.g., fruits, vegetables, high-fibre cereals), and a significant reduction in physical activity (Rivera-Dommarco, 2012). These lifestyle changes together with increasingly obesogenic environments contributed to a rising prevalence of overweight/obesity and other diet-related noncommunicable diseases (Giuntella et al., 2020; Popkin & Ng, 2021; Rivera-Dommarco et al., 2018). At the same time, the policy focus on tackling the obesity epidemic might shadow other forms of malnutrition, such as micronutrient deficiencies, which have been found to be associated with regular consumption of unhealthy diets and may have negative consequences for the health and learning capacity of school-age children (Flores et al., 2010; Gaona-Pineda et al., 2018; Rivera-Dommarco et al., 2018).

The advantages of promoting healthier diets in school settings are widely recognized, as eating behaviours are formed in childhood and school grounds allow easy, continuous, and intensive contact with children (Dudley et al., 2015). There is a large body of literature assessing the impact of school interventions on children's dietary decisions (DeCosta et al., 2017; Madden et al., 2017). Most of the robust, quantitative studies focused on externally-deployed tools, such as information provision, nudges, changes in food environment or temporary incentives (Belot et al., 2016; DeCosta et al., 2017; List & Samek, 2015; Loewenstein et al., 2016). Self-deployed strategies have been less well-tested. Meditation programs, seem promising, as they have been shown to decrease stress (Duckworth et al., 2018). Yet meditation mainly decreases chronic stress, whereas research linking stress to unhealthy eating largely focussed on acute (induced) stress. Some studies have analysed the effects of meditation on food choices, but these were rarely randomized and mostly suffer from small sample sizes (de Lara Perez & Delgado-Rios, 2022). Altogether, there is scarce related research in the bodies of literature addressed above regarding interventions conducted in low- and middle-income countries (Brown et al., 2019; Keats et al., 2021; Salam et al., 2020).[3]

In the present study, we propose a self-deployed strategy namely meditation to improve food choices among school-age children in southern Mexico. This region has the highest rates of poverty and overweight/obesity among children below 5 years of age, and both the highest prevalence of diabetes and lowest dietary diversity in the group of adults (CONEVAL, 2019; Levy et al., 2016; Shamah et al., 2018). The potential benefits of meditation are especially relevant as COVID-19 aggravated stress levels. While schools had recently opened at the time of this study, children faced the consequences of the damage to academic performance caused by the prolonged period of social isolation and of the socioeconomic stress many of their parents still experienced. Focus group discussions with parents and comments by schools' staff in the research area shed light on the emotional impact of the pandemic on school-age children from different income-levels, which likely affected their diets (UNICEF, 2021a; 2021b). Therefore, at the end of the meditation intervention, we assessed the impact of this strategy on children's food choices via reductions in their stress level. We measured the behavioural outcome through a snack choice experiment, where participants selected either a healthy grains bar or an unhealthy ultra-processed snack. Furthermore, we assessed if meditation reduced dynamically inconsistent choices by allowing children to change their original choice while collecting their snack.

[3] For example, most lifestyle modification studies in the review by Salam et al. (81%, $n = 531$) were conducted in high-income countries. Within the same review, we identified only three studies focusing on cognitive self-deployed strategies that were conducted at schools in low- and middle-income countries.

2. Hypotheses

Human behaviour can be explained as the outcome of brain interactions between two systems: the affective system (System 1), and the deliberative system (System 2) (Kahneman, 2003). System 1 processes are fast, automatic, effortless, emotionally charged and governed by habit, so that this type of thinking is prone to biases and errors; whereas the operations of System 2 are slow, effortful, deliberate, and costly, and as a result they typically yield more unbiased and accurate results (Loewenstein et al., 2015; Schilbach et al., 2016).

The ability of System 2 to influence System 1 is moderated by the cost of exerting willpower and the intensity of affective motivations (Loewenstein et al., 2015). If the latter two factors decrease, it is more likely that an individual will make choices aligned with System 2's preferences. The cost of exerting willpower is equivalent to the ability of exercising self-control and is decreasing in terms of increased willpower strength and reduced cognitive demands (Loewenstein et al., 2015; Ruhm, 2012). Experimental research among adults has shown that that meditation practices reduce chronic (but not acute) stress and stress-related mental health conditions, thus strengthening System 2 relative to System 1 (Alem et al., 2021; Duckworth et al., 2018; Jensen et al., 2012). More specifically, qualitative studies suggest that school-based meditation interventions are a valuable means of reducing chronic stress among children (Campion & Rocco, 2009; Sapthiang et al., 2019). Then, the following mediation hypothesis arises.

Hypothesis 1. Meditation practices reduce chronic stress among children.

Mindfulness meditation, which reduces chronic stress, has been shown to be associated with healthy eating habits for adults (Sala et al., 2020). Similarly, overall stress is positively related with unhealthy eating behaviours for children from 8 to 12 years and negatively related to healthy eating behaviour for children from 13 to 18 (Hill et al., 2018). If this relation is causal -chronic stress induces unhealthy eating- and hypothesis 1 holds -meditation reduces chronic stress-meditation improves food choices. For adults, a meta-analysis of randomized control trials concluded that mindfulness training for overweight and obese people had an overall negative effect on impulsive eating and binge eating (Ruffault et al., 2017). After conducting a systematic review, de Lara Perez and Delgado-Rios (2022) came to a similar conclusion for children: participants in mindfulness programs significantly decreased binge-eating and emotional eating and made better food choices. Nonetheless, few of the reviewed studies were randomized and sample sizes were generally small. Randomized control trials, however, do suggest that mindfulness-based programs for children and adolescents lead to a decrease in the biomarkers of obesity, including BMI and/or waist-to-hip ratio, which likely results from healthier eating choices (Paltoglou et al., 2021). Therefore, children treated with meditation will be more likely to choose the healthy snack in the food choice experiment. Considering the above scenario, our primary prediction is as follows.

Hypothesis 2. Meditation practices among children lead to healthier food choices.

We predict an additional effect related to dynamically inconsistent choices. Such behaviours arise when decision-maker's preferences (i.e., revealed preferences) change over time, in such a way that a preference can become inconsistent at another point in time (Sadoff et al., 2020). As shown by Sadoff and co-authors, the direction of dynamically inconsistent food choices among adults is systematically towards less healthy foods. In other words, if adults have the chance to change an advance choice made in the past between healthy an unhealthy food, they are

more likely to switch from healthy to unhealthy options than the other way around. In general, children discount the future more than adults and especially younger and lower-income children are more impatient than others, hence their propensity to make fewer healthy dietary choices (Belot et al., 2016; Just & Price, 2013; Loewenstein et al., 2015). Under Loewenstein's model, a reduction in the cost of exerting willpower would lead to less dynamic inconsistencies. As meditation is expected to reduce such cost (see above), we posit the following hypothesis.

Hypothesis 3. Children practicing meditation make fewer dynamically inconsistent choices in the direction of unhealthy foods.

3. Methods

Data collection was conducted in Oaxaca, Mexico between March and June 2022 at 27 primary schools (see Fig. E1 in the Annex). The contact with the schools was made via the State of Oaxaca's Secretariat of Education, as this institution had the information about which schools were open and should give the permission to conduct our study. Although the pandemic started two years prior to our experiment, schools in the region had even more prolonged school closures with respect to other areas in Mexico, country that, in general, kept schools closed longer than other regions of the world. Schools in Oaxaca had the option to open voluntarily but most of them were still closed and some COVID-19 regulations, such as mandatory use of face masks were still in place at the schools that chose to open. To avoid further COVID-19 contagion, part of the schools that opted to open split their classes in two and established hybrid formats of school attendance. Children in some private schools could choose to attend school online only.

In participant schools, mothers or tutors signed informed consent forms on behalf of their children. A pre-analysis plan was registered before data collection (see https://osf.io/f7yan). Likewise, the hypotheses mentioned above were specified before the data were collected. The research design received ethical approval from Wageningen University's Social Sciences Ethics Committee.

3.1. Sample and participants

In Oaxaca, 64% of the population lives in condition of poverty (CONEVAL, 2019). Yet, we selected both public (10) and private (17) schools, which enabled a mix of households with different income levels. Many of the students (67%) in the sample attended a school located in a higher-income area (see Table 1), mainly because most of the schools that opened after prolonged closures were located around the main urban centre. We focused on urban and peri-urban areas, where the consumption of unhealthy processed foods is more generalized than in rural areas (Popkin & Reardon, 2018). Considering the availability of schools in the context addressed above, we focused on schools where students came fully in person (16) or in hybrid (11) formats. Furthermore, we concentrated on the grades 4–6 with children aged 9 to 12, the stage of life where the relationship between emotions and food choices becomes more salient (Blissett et al., 2010).

The sample of participants with consent from their parents was 1615 students, which was lower than our estimates in the power calculations (1850) because the available schools had smaller class sizes than previously estimated. In the end, we collected data from 1467 students because 9.2% of the original sample did not attend classes on the day of the survey or their group was excluded as the school made changes in the composition of their class after treatment assignment. We were not concerned about the attrition issue, as the attrition rate was small and some background indicators (i.e., mother/tutor's age and education) of those who had attrited were similar to the sample collected. After cleaning the data from observations with incomplete sociodemographic information and outliers, the final analytical sample was 1433. The share of girls and boys was even in the sample (see Table 1). The percentages of students in each grade were similar, but slightly higher for 4th grade, which explains that average age was around that of a fourth grader (10.34). Whereas the majority of the students' mothers completed at most secondary education, we still had a substantial share of them having a tertiary level of education completed (44%). Most of the students had a female teacher (61%).

Table 1
Summary statistics.

Indicator	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)
Students				
Girl	0.50	0.50	0	1
Age (years)	10.34	0.97	8	13
4th Grade	0.37	0.48	0	1
5th Grade	0.30	0.46	0	1
6th Grade	0.34	0.47	0	1
Mothers/tutors				
Age (years)	38.85	6.97	20	76
No formal education	0.02	0.13	0	1
Primary education	0.29	0.45	0	1
Secondary education	0.25	0.43	0	1
Tertiary education	0.44	0.50	0	1
Teacher				
Share of students with a female teacher	0.61	0.49	0	1
Schools				
Share of students in a school located in:				
Lower-income area[1]	0.33	0.47	0	1
Higher-income area[2]	0.67	0.47	0	1
Main urban centre[3]	0.36	0.48	0	1
Proximity to the main urban centre[4]	0.17	0.38	0	1
Outskirts of main urban centre[5]	0.26	0.44	0	1
Area distant from main urban centre[6]	0.21	0.41	0	1
Share of students attending:				
Public school	0.56	0.50	0	1
School fully in person	0.75	0.43	0	1
Religious schools	0.16	0.36	0	1
Schools with meditation or yoga programs	0.12	0.33	0	1

Notes: [1]Locations with high or very high levels of poverty according to the Index of Urban Marginalization (IUM) elaborated by the National Population Council (CONAPO). [2]Locations with medium or low levels of poverty according to the IUM elaborated by the CONAPO. [3]Located less than 3 kms away from the centrum of Oaxaca City. [4]Located between 3 and 5 kms away from the centrum of Oaxaca City. [5]Located between 5 and 10 kms away from the centrum of Oaxaca City. [6]Located more than 10 kms away from the centrum of Oaxaca City.

Fig. 1. Amaranth and chocolate snacks.

Two focus groups with mothers and teachers from private and public schools were organized in the research area. In the context of the ongoing pandemic, the idea of the focus groups was to get a better understanding about school-age children's baseline levels of stress and to determine potential impacts on eating behaviours. The participants reported elevated levels of distress among children (e.g., angriness, frustration, sadness) due to lack of socialization with their peers, the uncertainty about the duration of the lockdowns, witnessing tensions among their parents and being afraid of COVID-19 contagion once they were back in school. In some cases, children received psychological support. Some disruptions were also observed in eating behaviours, such as a stronger preference towards foods high in saturated fats and processed foods. Teachers mentioned that some students gained weight during the period because of reduced physical activity. We expected that some of these indicators may be exacerbated in lower-income areas due to more extended school closures, lack of access to a computer to attend online schooling, lack of access to a psychologist and pre-existing economic pressures at home.

3.2. Experimental design

Our study has a block-clustered randomized design (RCT), where clusters are the school classes from grades 4–6 (the three blocks). To avoid COVID-19 contagion, six schools divided each of their classes in two subgroups attending school on different days or shifts. For our study, each of these subgroups was considered as a class. All children that attended school in person and had permission from their parents were part of the sample. By assigning random binary numbers to each school class, half of the classes in each grade of each school were randomly assigned to a *meditation program* comprised of six audios. During the duration of the program, the control group did not receive any sort of intervention such as placebo audios. Instead, the students in the latter group followed the business-*as*-usual routine while attending school. At the end of the experiment, the research team provided the meditation audios to the schools with the idea of including control group's children in the program.

3.2.1. Meditation program

The audios of the meditation program were provided by a company specialized on self-development and meditation programs (see https://atahualpairigoyen.com/). The intensity was set to six sessions, because we expected the positive effects of meditation to be more salient after several sessions and the children to need some time to familiarize themselves with this new practice. We asked teachers to play the meditation audios daily and the specific schedule of the sessions was agreed depending on the availability of the trained teachers[4] (i.e., the teacher in charge of the class). The schedule was not consistent across schools as some of them had distinct types of hybrid formats in the context of the pandemic,[5] thereby resulting in the meditation program lasting between 1 and 3 weeks. Specific instructions were provided to teachers to tell their students to keep their school materials in their backpacks to clear their space and to follow thoroughly the instructions provided in the audios (e.g., close their eyes) (full instructions in Annex A of the supplementary information). The teachers had the option to practice the meditation with their students voluntarily. Each meditation session lasted from 5 to 10 min, and its main objective was to guide children to reach a state of relaxation that may enable them to make better food choices. At the same time, we shaped the program towards achieving the specific goal (healthier food choices), a feature that was recently identified in the related literature (Haushofer et al., 2021). In particular, the meditation program included the following components: a) instructions about sitting position b) breathing and mental body scan exercises; c) playful stories that guide children to an imaginary place where they can cultivate positive emotions; d) guided stories that help children to identify which foods are natural and good for their bodies; e) an invitation to experience those foods that are good for their bodies in their daily lives. Aspects d) and e) differ from the standard nutrition information, as they are linked to feelings or perceptions of food, whereas standard information is comprised by facts about nutrition and health. All the meditation audios covered aspects a), b) and c), while only audios 2, 3, 4 and 6 covered aspects d) and e).

3.2.2. Snack choice

For the healthy snack, we decided to focus on an amaranth bar, because it is a traditional Mexican food that is popular in Oaxaca and has a higher micronutrient content than other highly consumed cereals such as wheat, rice, and maize. After searching in the market, consulting a local amaranth processor (see https://www.puentemexico.org/) and the piloting phase, we chose a traditional bar called *alegria* in Spanish (see Fig. 1). Given its amaranth and nuts/seeds content, this snack was high in fiber, protein, iron, and calcium (Orona-Tamayo & Paredes-López, 2017; Rastogi & Shukla, 2013). Following the recent labelling regulations in Mexico, this type of snack usually wears the labels "excess of calories" and "excess of sugar" in big retailers. To upgrade the snacks used in our experiment, we asked the amaranth processor to provide us with a version reduced in sugar.

Chocolate bars were identified as the most popular type of unhealthy snack in the area. To determine the specific product, we consulted parents and children and searched in the market for snacks roughly like the amaranth snack in terms of price (MXN 17 (USD 0.83)) and weight (40g). The pilot informed the final selection, which corresponded to the most popular chocolate out of three options. The selected option had three labels in its original packaging namely "excess of calories," "excess of sugars" and "excess of saturated fat." We assumed that the high content of the latter ingredients and its associated tastiness made this a temptation product, which makes it harder to resist under System 1 processes related to immediate gratification and emotional eating. Given their popularity, children would be more prone to automatic and habitual choices.

3.2.3. Procedures

The research team was introduced to the students on the first meditation day (full script in Annex B of the supplementary information) but remained outside the classroom while the meditations were played. The application of the audios 1 to 5 was monitored by enumerators, generally the first two days on-site and afterwards remotely via instant messaging (i.e., WhatsApp), as teachers usually managed the application of the audios very easily. Yet, enumerators assisted the teachers to play the audios when needed, but always stayed outside while the audios were played. Immediately after the final meditation session, all treatment and control children participated in a food choice experiment. The experimental choice was recorded in a brief questionnaire (see Annex C of the supplementary information). The first question appeared alone in the first page of the survey, where children chose between two images of snacks. The rest of the questions were asked in the second page of the survey to reduce the likelihood of influencing the snack choice. These questions asked about food preferences and measured stress. The stress section consisted of a set of five questions from the stress in children (SIC) questionnaire (Michels et al., 2012; Osika et al., 2007). The stress questions involved: i) feeling of relaxation, ii) feeling of happiness and iii) whether the child enjoys going to school, which were measured as 1 for *no*, 2 for *sometimes* and 3 for *yes*; iv) frequency of stomach aches and v) frequency of eating when stressed (i.e., emotional eating), which was measured as 1 for *very frequently*, 2 for *sometimes* and 3 for *never*.

The research team told children that they got the chosen snack as a

[4] Some teachers are in the classroom before recess, whereas some of them teach after recess.

[5] For example, some students attended school two days per week on different days by class. It was also common that some students were present in the first half of the morning and the rest in the second half of the morning.

thank you token for filling in the questionnaire. They could choose either an amaranth snack (i.e., the healthy snack) or a chocolate (i.e., the unhealthy snack). Children could see an example specimen of each snack (as shown in Fig. 1). Both specimens were shown by the research team in transparent plastic packaging to avoid teacher, marketing, or novelty effects. To signal that the amaranth product is healthy, we referred to it as a "nutritious amaranth bar" in the survey. All subjects received this signalling, so we did not have a pure control group. Like Samek (2019), we assumed that information alone would not have a large effect on behaviour. The effective use of information requires substantial System 2-related cognitive efforts to consider future implications and trade-offs regarding nutrition, health, and costs (Just & Gabrielyan, 2018; Mancino et al., 2018). As meditation improves System 2's processes and our meditation audios were purposely geared towards healthier food choices, we expected that nutrition information is more likely to affect the food selections of those children practicing meditation.

Immediately after filling in the surveys, students were moved to a different place to collect their snack, one by one, to a spot out of sight from the rest of the class. Depending on the characteristics of the school building, the other students waited for their turn sitting on the classroom or in a line controlled by enumerators and teachers to avoid that children shared their survey's answers. Enumerators handed the surveys to the teachers, who called in the next child in turn based on the order of the surveys collected. While picking up their snack, enumerators gave the children the chance to exchange their original choice, so that we could assess the consistency of their food choices (exact wording in Annex D of the supplementary information). They did not know they could change their mind at the time of the original choice in the questionnaire. This approach was like Augenblick et al. (2015) and Sadoff et al. (2020), but we measured the above outcome over a shorter time span (minutes vs a week), as the evidence shows that children tend to be more impatient than adults (Ikink et al., 2023). It is possible that children switch from the unhealthy towards the healthy snack, but we expected that it would be more probable to see switches to the unhealthy option due to its tempting nature. This is in line with the findings in Sadoff et al. (2020).

Control groups encountered our research team for the first time during the survey and snack collection parts of the study, whereas treatment groups had seen some members of our team since the beginning of the meditation intervention. To have a more homogenous response from both groups during the survey and snack collection, the enumerators that oversaw those steps in the treatment groups were different from those monitoring the meditation intervention. The detailed procedure of the day of the food choice experiment is shown in Fig. 2 below. Additional food choice measures over our selected products were not collected neither before the meditation program (i.e., baseline) nor after the experiment ended (i.e., post-intervention).

3.3. Estimation strategy

We estimated the following model:

$$Y_{ij} = \beta_0 + \beta_1 Meditation_j + \delta X_{ij} + m_s + t_g + \varepsilon_{ij}$$

where i and j index participant children and the cluster (school class), respectively.

- Y_{ij}: Outcome variables. Our primary outcome equals 1 if a child chose the healthy snack, 0 otherwise.
  - o The secondary outcomes were the following:
    1) dynamically inconsistent food choice (i.e., willpower), dummy equal to 1 if the child exchanged his/her original snack choice from the healthy (unhealthy) snack to the unhealthy (healthy) snack at the moment of collection; 0 otherwise.
    2) stress (i.e., chronic), which is measured as the first component of a principal component analysis using the five stress questions mentioned above (Table E1 in the Annex).
- $Meditation_j$: Treatment variable. Dummy equal to 1 if the child is exposed to meditation practices, 0 otherwise.
- X_{ij}: Covariates. sociodemographic controls (children's gender and age; maternal education and age; teacher's gender).
- m_s, t_g: Fixed effects for school and grade.
- ε_{ij}: Error term.

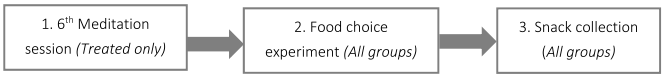

Fig. 2. Timing of procedures during the day of the food choice experiment.

Our primary estimation method was an OLS or linear probability model. A probit model was used as a robustness check for the binary outcomes. Standard errors were clustered at the class level j (N = 130). Although there were some imbalances in the characteristics (e.g., female teacher, location) between the control and treated groups (Table 2); a joint test of orthogonality (i.e., binary probit with the treatment variable on the left-hand side and controls on the right-hand side) suggested that the meditation group was comparable to the control group (Prob>χ^2 = 0.822). Some controls declared in the pre-analysis plan were not used in the model (e.g., marginalization index, number of meditations practiced by teachers, student-teacher ratio, enumerator, and day of the week) because of multicollinearity issues. To assess heterogenous effects without specific hypotheses, we included an exploratory analysis to distinguish gender (pre-registered), income (not pre-registered) and reasons for the snack choice (not pre-registered). For the latter analysis, we controlled for multiple hypothesis testing using the Romano-Wolf correction to control the familywise error rate (FWER) (Clarke et al., 2019).

Table 2
Randomization checks.

Variable	Meditation program		*p*-value[Y]
	Yes	No	
Girl (dummy)	0.50	0.50	0.950
Age	10.32	10.42	0.072
4th Grade (dummy)	0.38	0.35	0.401
5th Grade (dummy)	0.31	0.29	0.373
6th Grade (dummy)	0.32	0.36	0.086
Consumed an amaranth snack last week (dummy)	0.23	0.22	0.981
Consumed a chocolate snack last week (dummy)	0.28	0.25	0.296
Mother's age	39.06	38.60	0.210
Well-educated mother (dummy)[1]	0.45	0.44	0.689
Female teacher (dummy)	0.64	0.58	0.014
Attends school located in (dummies):			
Lower-income area[2]	0.34	0.32	0.388
Main urban centre[3]	0.33	0.39	0.013
Proximity to the main urban centre[4]	0.16	0.18	0.340
Outskirts of main urban centre[5]	0.29	0.24	0.036
Area distant from main urban centre[6]	0.22	0.19	0.125
Attends (dummies):			
Public school	0.54	0.57	0.213
School fully in person	0.73	0.77	0.086
Religious school	0.16	0.15	0.676
School with meditation or yoga programs	0.13	0.10	0.078
N	768	665	

Notes: [1]Completed tertiary education. [2]Locations with high or very high levels of poverty according to the Index of Urban Marginalization elaborated by the National Population Council. [3]Located less than 3 kms away from the centrum of Oaxaca City. [4]Located between 3 and 5 kms away from the centrum of Oaxaca City. [5]Located between 5 and 10 kms away from the centrum of Oaxaca City. [6]Located more than 10 kms away from the centrum of Oaxaca City. [Y]If dummy variable, p-value is based on Pearson $\chi 2$ test for the independence between variables, otherwise, it is based on a *t*-test on equality of means between groups.

4. Results

4.1. Evaluating the impact of meditation on food choices

Table 3 reports the effect of the meditation program on the primary outcome. In general, 33% of the sample selected the heathy snack. Students that practiced meditation were slightly more likely to choose the healthy snack than those in the control group, but the effect was not statistically significant. The effect was slightly larger when dropping the clusters where the protocol was violated (e.g., students heard about the snack choice from family members in other class), but still non-significant. Among the associations with the demographic variables, we observed that girls and those with well-educated mothers were more likely to choose the healthy snack than boys and those with less-educated mothers, respectively. Altogether, our main estimates did not support our primary hypothesis:

Result 1: Meditation practices among children do not lead to healthier food choices.

Regarding the reasons for choosing the snacks, we observed that most of the participants said that they selected their snack because they like it more in general than the alternative (54%) or for taste reasons (19%). We did not estimate the effectiveness of the nutrition information provided but identified that 16% of the subjects chose either of the snacks for health or nutrition reasons, in almost all cases this concerned the healthy snack. Surprisingly, students in the control group mentioned such aspects more often than those in the treatment group ((Prob $> t =$ 0.005).

Additionally, we asked the children about their visual perception of the products. The study's products had the same weight, but a slight majority of subjects in the sample (53%) perceived the amaranth snack as more filling than the chocolate snack. Participants craved more for the chocolate snack than for the amaranth snack (Prob $> t = 0.000$), as their average scores (scale 1–5) were 3.90 ($SD = 1.11$) and 3.44 (SD = 0.98), respectively. The answers did not differ by treatment condition. Note that prior to our food choice experiment, the share of students that consumed any chocolate bar available in the market was larger than the corresponding share for amaranth bars (Prob > t = 0.014), it was 27% and 23%, respectively. This suggests that chocolate seemed to be the preferred snack by the students, despite being considered not as filling as amaranth by more children during the experiment. Unlike the main meals, more filling snacks are not necessarily considered more attractive by children as they do not eat snacks for satiation.

Table 3
Effect of meditation on healthy snack choice.

Dependent variable	Healthy snack chosen			
	(1)	(2)	(3)	(4)
Meditation	0.004	0.004	0.003	0.006
	(0.025)	(0.025)	(0.025)	(0.025)
Girl		0.046*	0.047*	0.046
		(0.028)	(0.028)	(0.028)
Age		0.029	0.029	0.028
		(0.024)	(0.024)	(0.024)
Well-educated mother			0.057**	0.058**
			(0.027)	(0.027)
Mother's age			0.003	0.003
			(0.002)	(0.002)
Female teacher				−0.041
				(0.029)
Constant	0.285*	−0.009	−0.110	−0.085
	(0.164)	(0.278)	(0.284)	(0.280)
R^2	0.035	0.038	0.042	0.044

Notes: OLS estimations and observations equal to 1432 in all columns. Standard errors clustered at the school class level shown in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01. All regressions include school and grade fixed effects. Intra-cluster correlation (ICC) was equal to 0.04.

4.2. Assessing the consistency of choices

Table 4 depicts the impact of the meditation intervention on the likelihood of switching the original snack choice. We found that 11% of the sample changed their initial choice at the moment of snack collection. As expected, a slight majority of those changes (52%) were from the healthy to the unhealthy snack. However, the likelihood of a healthy-unhealthy switch did not differ by treatment status. On the other hand, overall switches were more likely among treated than for non-treated children, which was driven by changes from the unhealthy to the healthy option (+2.6%-points). 6% of the students who did such a "healthy switch" may have shown some biases (e.g., social desirability and/or experimenter demand effects), as they originally chose the chocolate bar because they do not appreciate certain sensory attributes (e.g., texture, taste) of amaranth snacks in general. Yet, the treatment effects were robust to the exclusion of those observations. Likewise, the results were robust to the exclusion of clusters where the protocol was violated (e.g., students saw the snack collection process on a previous day) and in a probit regression (Table E2 in the Annex). Thus, our estimates did not support hypothesis 3:

Result 2: Children practicing meditation do not make fewer dynamically inconsistent choices in the direction of unhealthy foods.

4.3. Evaluating the effect of meditation on chronic stress reduction

Table 5 shows the effects of the meditation program on the different stress reduction aspects. We highlight that children treated with the meditation program reported a significantly higher score in terms of relaxation. Anecdotical comments by teachers confirmed that students looked very calm and focused after the meditation. On average, the scores of happiness and enjoys going to school were quite high (2.7–2.8 out of 3) and were not significantly different between treatment groups. Also, no differences were reported for reductions in emotional eating. Contrary to expectations, students in the control group reported higher scores for reductions in the frequency of stomach aches. Overall, students exposed to meditation reported a reduction in stress, as their stress reduction score was significantly higher than for those who did not meditate. This leads to the following statement underling the mechanism of the study (H1):

Result 3: Practice of meditation reduces chronic stress among school-age children.

4.4. Heterogenous effects

First, we tested if the impact on the main secondary and primary outcomes differed by gender (see Table 6). The meditation treatment tended to have more positive effects for girls on indicators such as stress reduction and healthy snack choice, but the differences were statistically insignificant. Second, we assessed if there were heterogenous effects by level of income (see Table 7). We highlighted that meditation reduced chronic stress for students that attend both schools in lower- and higher-income areas, but the effect was larger in lower-income areas. The effects just mentioned remained significant after correcting for multiple hypothesis testing. Third, almost all students who chose their snack for health/nutrition reasons selected the healthy snack, so we explored the treatment effects for the rest of students (84% of the sample) choosing for other motives (see Table 8). Within this sub-sample, we observed that the meditation program was effective in increasing (+4%-points) the healthy snack choice. This effect was robust to the multiple hypothesis adjustments, exclusion of clusters where the protocol was violated and in probit regressions (Table E2 in the Annex). We did not identify particular motives (e.g., past consumption, sensory attributes, dietary restrictions) that explained the mentioned effect (Table E3 in the Annex). Meditation practices also reduced stress among the treated students in the same sub-sample. Yet, a mediation analysis revealed that the reduction of stress did not mediate the relationship between

Table 4
Effect of meditation on time inconsistent food choices.

Dependent variable	Healthy switch[Y]		Unhealthy switch[YY]		All switches	
	(1)	(2)	(3)	(4)	(5)	(6)
Meditation	0.027**	0.026**	0.007	0.005	0.034**	0.031**
	(0.011)	(0.011)	(0.013)	(0.012)	(0.016)	(0.015)
Girl		0.007		−0.023*		−0.016
		(0.013)		(0.012)		(0.016)
Age		0.014		0.005		0.020
		(0.012)		(0.012)		(0.017)
Well-educated mother		−0.007		−0.000		−0.007
		(0.016)		(0.013)		(0.021)
Mother's age		−0.001		0.001		−0.001
		(0.001)		(0.001)		(0.001)
Female teacher		0.025**		0.025		0.050**
		(0.012)		(0.017)		(0.020)
Constant	0.292***	0.188	0.102	0.019	0.394***	0.207
	(0.105)	(0.157)	(0.080)	(0.139)	(0.057)	(0.178)
R^2	0.035	0.040	0.027	0.032	0.049	0.055
Mean (Control)	0.04		0.06		0.10	

Notes: OLS estimations and observations equal to 1432 in all columns. Standard errors clustered at the school class level shown in parentheses. [Y]Exchanges from the chocolate bar to the amaranth bar after the choice experiment. [YY]Exchanges from the amaranth bar to the chocolate bar after the choice experiment * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All regressions include school and grade fixed effects. Intra-cluster correlation (ICC) equal to 0.01 in all cases.

Table 5
Effect of meditation on reported indicators of stress reduction.

Dependent variable	Relaxed	Happy	Enjoys going to school	*Reduction in frequency of:*		Stress reduction score[Y]
				Stomachache	Emotional eating	
	(1)	(2)	(3)	(4)	(5)	(6)
Meditation	0.236***	0.015	−0.022	−0.140***	−0.023	0.414***
	(0.033)	(0.026)	(0.021)	(0.030)	(0.033)	(0.058)
Girl	0.010	−0.035	0.059***	−0.082***	−0.081*	0.018
	(0.029)	(0.026)	(0.022)	(0.029)	(0.045)	(0.052)
Age	−0.033	−0.028	0.015	−0.010	−0.052*	−0.058
	(0.028)	(0.025)	(0.022)	(0.027)	(0.028)	(0.049)
Well-educated mother	−0.037	−0.005	−0.063*	0.019	0.015	−0.065
	(0.035)	(0.032)	(0.034)	(0.037)	(0.043)	(0.061)
Mother's age	−0.001	−0.001	−0.001	−0.004*	0.004	−0.001
	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)
Female teacher	0.063*	0.088***	−0.006	0.046	0.055	0.112*
	(0.035)	(0.026)	(0.026)	(0.035)	(0.039)	(0.062)
Constant	2.911***	3.033***	2.858***	2.546***	2.562***	0.665
	(0.289)	(0.261)	(0.225)	(0.318)	(0.305)	(0.509)
R^2	0.105	0.043	0.083	0.051	0.030	0.104
Mean (Control)	2.40	2.72	2.84	2.24	2.15	−0.23

Notes: OLS estimations and observations equal to 1433 in all columns (1432 in 4,6). Variables in columns 1–5 are measured in a scale from 1 to 3. Standard errors clustered at the school class level shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. [Y]Constructed as the first principal component of the dependent variables in columns 1–5. All regressions include school and grade fixed effects. Intra-cluster correlation (ICC) ranged from 0.00 to 0.11.

meditation and the healthy snack choice (Figure E2 in the Annex).

5. Discussion and conclusion

This paper analysed the impact of a meditation program shaped towards healthier food choices, on the dietary decisions of students in grades 4–6 at 27 schools in southern Mexico. In terms of overall preferences, our data showed that a considerable majority of the participants chose the chocolate over the amaranth bar in our experiment. This is aligned with the chocolate bar being more appealing to children in our sample than the amaranth bar. In general, our estimates revealed that students practicing meditation were not more likely to choose the healthy amaranth snack than those in the control group. We are unsure if this result was influenced by the information provided to all participants about the healthiness of the amaranth snack. Further studies are warranted to disentangle the interaction effects of information and meditation, as sometimes information does not have a positive synergy with other strategies to improve dietary decisions among children (de Vries Mecheva et al., 2021). It is also unclear if participants considered their monetary valuations over the products when making their choices.

An exploratory analysis revealed that meditation effectively aided students who chose for reasons other than health or nutrition to increase the healthy snack choice. Thus, meditation is effective for children that are otherwise less health conscious. Based on the reasons of choice stated by the participants, we did not identify a particular attribute that explained this effect, such as past consumption, sensory qualities, or dietary restrictions. This significant effect (4%-points) was lower than the effect sizes in past school interventions: studies with incentives, with 11–28%-points increases in choices of fruits (Belot et al., 2016; Just & Price, 2013; Loewenstein et al., 2016); goal setting study, with 10–18%-points increases in choices of milk (Samek, 2019); study in another a middle-income country (Indonesia), with 13%-points for nudges to increase fruit selections (de Vries Mecheva et al., 2021).

We predicted that meditation would also affect the dynamic consistency of food choice. Our results only indicated that students practicing meditation were more likely to exchange the unhealthy for the healthy snack (i.e., healthy switch) when given the chance to do that after the original choice. Children in general did more unhealthy than

Table 6
Heterogenous effect of meditation for girls.

Dependent variable	Stress reduction score[Y]	Time inconsistent food choices		Healthy snack choice
		Healthy switch	Unhealthy switch	
	(1)	(2)	(3)	(4)
Meditation	0.401***	0.034**	−0.009	−0.000
	(0.078)	(0.016)	(0.017)	(0.039)
p-value	0.000	0.038	0.581	0.994
FWER p-value	0.000	0.034	0.738	0.992
Girl	0.004	0.016	−0.039**	0.039
	(0.086)	(0.017)	(0.016)	(0.040)
Meditation x Girl	0.025	−0.016	0.029	0.014
	(0.103)	(0.025)	(0.024)	(0.056)
p-value	0.806	0.530	0.218	0.808
FWER p-value	0.932	0.785	0.319	0.932
Constant	0.675	0.181	0.031	−0.080
	(0.507)	(0.160)	(0.141)	(0.279)
R^2	0.105	0.041	0.033	0.044

Notes: OLS estimations and observations equal to 1432 in all columns. Standard errors clustered at the school class level shown in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01. [Y]Constructed as the first principal component of variables relaxed, happy, enjoys school, reductions in frequency of stomachache and emotional eating. All regressions include controls for age, mother completed tertiary education, mother's age, teacher's gender, school, and grade fixed effects. *p < 0.1, **p < 0.05, ***p < 0.01, based on p-values shown above. FWER corrected p-values based on Clarke et al. (2019), with 3000 replications.

Table 7
Heterogenous effect of meditation for schools in lower-income areas.

Dependent variable	Stress reduction score[Ψ]	Time inconsistent food choices		Healthy snack choice
		Healthy switch	Unhealthy switch	
	(1)	(2)	(3)	(4)
Meditation	0.315***	0.014	0.008	0.011
	(0.076)	(0.014)	(0.015)	(0.030)
p-value	0.000	0.309	0.586	0.703
FWER p-value	0.001	0.629	0.802	0.802
Lower-income	0.012	0.215**	0.038	0.063
	(0.176)	(0.097)	(0.093)	(0.153)
Meditation x Lower-income	0.300***	0.035	−0.009	−0.015
	(0.106)	(0.024)	(0.025)	(0.055)
p-value	0.006	0.141	0.730	0.788
FWER p-value	0.018	0.316	0.914	0.914
Constant	0.522	−0.043	−0.015	−0.141
	(0.482)	(0.122)	(0.116)	(0.248)
R^2	0.109	0.042	0.032	0.044

Notes: OLS estimations and observations equal to 1432 in all columns. Standard errors clustered at the school class level shown in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01. [Ψ]Constructed as the first principal component of the dependent variables in columns 1–5. All regressions include controls for gender, age, mother completed tertiary education, mother's age, teacher's gender, school and grade fixed effects. *p < 0.1, **p < 0.05, ***p < 0.01, based on p-values shown above. FWER corrected p-values based on Clarke et al. (2019), with 3000 replications.

healthy switches, but the shares did not differ by treatment group. Compared to a study with a similar experimental design with adults, the share of participants in our research that exhibited dynamic inconsistencies was smaller (46%vs11%) (Sadoff et al., 2020). Had the second choice happened days apart from the experiment, unhealthy switches would be more prevalent, thereby giving more room for meditation to reduce the likelihood of such biases. In this sense, our results are similar to Alem et al. (2021), who found that meditation had weaker effects on time preferences.

Table 8
Heterogenous effect of meditation for students that chose for reasons other than health/nutrition.

Dependent variable	Stress reduction score[Y]	Time inconsistent food choices		Healthy snack choice
		Healthy switch	Unhealthy switch	
	(1)	(2)	(3)	(4)
Meditation	0.379***	0.025*	0.014	0.040**
	(0.063)	(0.013)	(0.011)	(0.020)
p-value	0.000	0.058	0.208	0.048
FWER p-value	0.000	0.086	0.174	0.086
Constant	0.557	0.164	−0.043	−0.166
	(0.525)	(0.164)	(0.130)	(0.231)
R^2	0.106	0.044	0.031	0.035

Notes: OLS estimations and observations equal to 1200 in all columns. Standard errors clustered at the school class level shown in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01. [Y] Constructed as the first principal component of variables relaxed, happy, enjoys school, reductions in frequency of stomachache and emotional eating. All regressions include controls for gender, age, mother completed tertiary education, mother's age, teacher's gender, school, and grade fixed effects. *p < 0.1, **p < 0.05, ***p < 0.01, based on p-values shown above. FWER corrected p-values based on Clarke et al. (2019), with 3000 replications.

Meditation reduced chronic stress among students. The stress reduction was larger for children attending schools in lower-income areas. Participants from such backgrounds may had more room to reduce stress levels, as they were likely experiencing higher economic stress in their households, had more prolonged school closures, lack of access to resources to attend online schooling, and to cope with emotional impact of the pandemic (e.g., a therapist, a mindfulness program) than those from higher-income areas (Bruijn, 2021; Kremer et al., 2019). Additional analysis showed that stress did not mediate the significant treatment effect documented above. Further testing is recommended in other low- and middle-income contexts to assess this underlying mechanism.

A few aspects are unclear in terms of the impact of meditation on our stress measures. First, the economic and pandemic-related stress sources were the most salient in the context of this study, but we are cognizant that there are other causes of worry among children such as schoolwork, bullying and violence in their communities. With this in mind, it is unclear which specific sources of chronic stress were lessened by meditation. Second, there was an unexpected negative effect of the intervention on the reported frequency of stomach aches. Yet, assuming this indicator did not differ by treatment group at baseline, it is possible that the increased frequency was due to improved body awareness on treated participants, which is typically the case with meditation (Gallant, 2016). In fact, our meditation audios included practices were children mentally scanned their bodies. In any case, it is also possible that such techniques triggered pre-existing emotional issues that may need some guidance by a specialist, aspect that shall be recommended for future meditation interventions (de Lara Perez & Delgado-Rios, 2022).

There are alternative lines of research not explored in this paper on how meditation influences food choice. Previous studies have shown that *unhealthy equals tasty intuition* can play an important role in food choice (Raghunathan et al., 2006) and a discrepancy between implicit hedonic (taste and pleasure-oriented) and explicit attitudes (health and nutrition-oriented) can be more common in overweight children (Marty et al., 2017). There is potential for meditation to influence this cognitive discrepancy, as the relationship between implicit-explicit attitudes can be linked to the interplay between System 2 and System 1, given the role of intuition. Future research can explicitly investigate whether meditation can mitigate this discrepancy and promote healthier consumption

habits.

We highlight certain limitations of this work. Our food choice data is a limited measure of eating habits, as this is a one-time, short-term measure. Ideally, we should had captured the long-term impact of meditation on the overall diet. Furthermore, our results cannot be generalized to Oaxaca or southern Mexico because the selection of schools for our study was bounded by the of pool of schools that were open in the context of the COVID-19 pandemic. The sample of students was also biased because some minorities following only online schooling were not captured in our study. Parents of the latter children were typically more concerned with COVID-19 contagion and had the means, willingness to prolong such schooling scheme. Likewise, we had differential attrition at least in terms of gender, but other characteristics may have also varied. Altogether, we had a large, heterogenous sample and expect that our results would hold for similar schools in low-income areas of Mexico, but this can only be assessed by replicating our design in other schools and other regions.

In terms of internal validity, we expect risks such as treatment diffusion to be limited, as the schedules by class differed within each school due to the pandemic regulations and it is unlikely that students would put other peers to meditate. On the other hand, we cannot discard experimenter demand effects particularly at the moment of snack collection.[6] To reduce the possibility of such biases, we switched the enumerators that monitored the meditation and those applying the survey and delivering the snacks, so they were less familiar with the experimenters when providing their responses (like the control group). We also emphasized to students that there were no right or wrong answers and that we just wanted their true opinions. In any case, the existing evidence has shown that such effects are modest, and our results held when removing those observations deemed as the most suspicious of such biases (De Quidt et al., 2018; Mummolo & Peterson, 2019). Finally, we could not appropriately identify non-compliers in the treatment group so additional analyses such as intention to treat were not possible. Yet, it is certain that all treated participants in the analytical sample did the last meditation, thereby ensuring that they received the positive effects of the program.

In light of our findings, stress reduction strategies framed in the direction of healthier food choices do not improve short-term dietary decisions among children. An exploratory analysis revealed that such strategies lead to healthier eating choices for certain children that are not driven by health/nutrition motivations. Stress-reduction remained as a suggestive mechanism of the latter effect. Our study tested the stated hypotheses with a large and heterogenous sample compared to similar studies. At the same time, strategies such as meditation may work as a *self-built* internal mechanism that leads to *beneficial* dynamic inconsistency in food choice. These strategies are especially of great assistance to improve the psychological well-being of children with a lower-income background, even more in pandemic times.

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[6] Such aspects may coincide with social desirability bias, as healthier food choices are an obvious normatively positive behaviour. Likewise, *Hawthorne* effects may be interconnected with the same biases at the moment of snack collection.

Ethics approval statement

The authors declare that the mothers or tutors of participant children were fully informed about the details of the study and signed consent forms on behalf of their children. At the beginning of the intervention children were informed about their participation in the meditation program. Privacy rights of participants were observed during the research process. The research design received ethical approval from Wageningen University's Social Sciences Ethics Committee (The Netherlands). The study was also approved by the State of Oaxaca's Secretariat of Education (Mexico).

CRediT authorship contribution statement

Marcos E. Dominguez-Viera: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Margarita de Vries Mecheva:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Trang Nguyen:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Marrit van den Berg:** Writing – review & editing, Supervision, Methodology, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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