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Tailored smartphone intervention to promote healthy eating among Brazilian adolescents: a randomised controlled trial protocol

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ABSTRACT

Introduction Adolescent eating patterns are characterised by high consumption of unhealthy foods, which has resulted in an increasing prevalence of overweight and chronic diseases. It is crucial to promote healthy eating habits, and nutritional interventions based on the transtheoretical model have been found to be especially effective. Mobile health strategies also seem promising for adolescents. This study aims to outline a smartphone intervention via WhatsApp for adolescents to promote healthy eating consumption, better nutritional knowledge, self-efficacy in the adoption of healthy practices and progress through the stages of change.

Methods and analysis There will be three distinct groups in this randomised study: a general intervention group (GG), in which the participants will receive the same healthy eating messages, based on the Brazilian food guide; a tailored intervention group (TG), in which the participants will receive healthy eating messages based on their stage of change; and a control group (CG), in which participants will receive messages on a different theme. Possession of a smartphone, use of WhatsApp and being a senior student (16–19 years) from a public school of the Federal District of Brazil will be the study's inclusion criteria. Rural schools will be excluded. The sample size estimated is 390 individuals: 38 in the GG, 314 in the TG and 38 in the CG. The intervention will last 6 weeks, with a daily message sent to the students. We will investigate nutritional knowledge, self-efficacy in the adoption of healthy eating practices, food consumption and stages of change using preintervention and postintervention questionnaires. Memorisation of the messages will be also assessed.

Ethics and dissemination The study was approved by the University of Brasília, School of Health Sciences and Research Ethics Committee. At the end of the study, the participating schools will receive a printed report with the main results of the intervention.

Trial registration number RBR-5b9jk7.

Strengths and limitations of this study

► The present nutritional intervention was planned according to the study population (adolescents) in all its facets (the format, length, periodicity, timing and language of the messages).
► All participants will receive some type of educational health promotion messages on their own smartphones, using WhatsApp, a free and widely accepted messaging service, as the delivery platform.
► The healthy eating messages are based on the Dietary Guidelines for the Brazilian Population and have been previously validated.
► One of the study's aims is to compare the effects of general messages about healthy eating with messages specifically tailored to the participant's stage of change.
► A limitation of the study is its inability to determine if the messages will be read in their entirety.

INTRODUCTION

The eating patterns of adolescents are characterised by high sugar, fat and sodium consumption, and low fruit and vegetable consumption. Data from the 21 countries involved in the WHO's STEPwise Approach to Surveillance show that only 10% of 15–19 year olds meet the daily recommendations for fruit and vegetable consumption.[1] The situation in Brazil is no different: data from a national study revealed low fruit and vegetable consumption, and high ultra-processed food consumption in both sexes.[2]

Such inadequate consumption corroborates the high incidence and prevalence of overweight and chronic diseases currently found among adolescents. Projections indicate that by 2022, the overweight/obesity rate will be higher among 5–19 year olds than the rate of underweight.[3] In Brazil, the obesity and overweight rates among Brazilian adolescents are 8.4% and 17.1%, respectively.[4 5]

Excess weight, although not the sole explanatory factor, influences the onset of chronic non-communicable diseases, metabolic diseases and so on, and is thus quite harmful to the overall health of adolescents.[6] Thus, it is crucial to promote healthy eating and

a healthy environment to prevent diseases, and ensure food and nutritional security at this stage of development. A recent systematic review pointed out that nutritional interventions based on theoretical models are more effective in establishing new health behaviours among adolescents.[7] The transtheoretical model stands out as a way of enhancing the effects of behavioural interventions. This theory proposes that behavioural change occurs over time and is mediated by four dimensions: stages of change, processes of change, self-efficacy and decisional balance.

The five stages of change (precontemplation, contemplation, decision, action and maintenance) are the central components of the model. They correspond to the temporal dimension of the change, which influences treatment adherence.[8] Regarding nutritional behaviour, each stage represents different perceptions and degrees of motivation to modify one's diet. They include precontemplation (no intention to change in the near future), contemplation (beginning to consider change, but many barriers are identified), decision (preparation and confidence to change), action (visible and concrete, although recent, diet changes) and maintenance (diet changes sustained for a more significant period of time, usually more than 6 months).[9]

According to the transtheoretical model, processes of change and self-efficacy are the activities and cognitions by which people progress through the stages of change.[9] Ten processes of change can be used to facilitate progress from early stage to later stages, and each is specific to the transition from one stage to another. When moving between each stage, self-efficacy, that is, the confidence to handle situations without relapsing to former behaviour, is also expected to increase.[9]

Thus, people should respond to and benefit more from tailored interventions whose content is directed at their stage of change. A systematic review by Lee *et al*[8] of nursing interventions used for diet, physical activity and smoking cessation management found that the majority of the stage-matched interventions were more effective than non-stage-matched interventions. Another systematic review found that interventions aimed at specific stages of change led to lower fat intake, and higher fruit and vegetable consumption.[10] It is also emphasised that most of the selected interventions used the internet and/or mobile phones.

The role of technological tools in nutritional interventions should also be mentioned. The term 'digital health' can be defined as the use of technology to promote/maintain health or prevent/treat disease, and includes tools such as mobile health (mHealth).[11 12] In Brazil, the age group with the highest percentage of internet users is 20–24 year olds (88.4%), followed by 18–19 year olds (88.1%), regardless of socioeconomic status. Among the devices used to access the internet for private use, the smartphone is still the most common (98.7%), and the main purpose of network access is to send or receive text, voice or picture messages by applications other than email.[13]

One strategy for using smartphones in interventions is to send health-related messages. The advantage of mHealth messaging interventions is that they involve sending and collecting data in real time.[14] The widespread success of WhatsApp, currently the most popular free messaging service, could be due to the fact that only a mobile internet connection (data plan or Wi-Fi) is required to use it.[15]

Although some studies have reported using WhatsApp in healthcare settings,[16–18] only one, to the best of our knowledge, has used it in smartphone interventions with adolescents. This study, conducted in Brazil, used WhatsApp as a complementary intervention strategy with a sample of adolescent girls from low-income communities. Significant intervention effects for waist circumference, dietary intake and leisure-time sedentary behaviours were reported.[19] Thus, further studies on the efficacy of WhatsApp as an intervention tool should be conducted.

This study aims to outline smartphone intervention for adolescents to promote healthy eating via WhatsApp, comparing general healthy eating promotion messages with messages tailored to each participant's stage of change.

METHODS AND ANALYSIS
Study design
This is a protocol of a randomised study in which a nutritional intervention will be held via WhatsApp among adolescents in public schools in the Federal District of Brazil. The intervention groups will receive messages about healthy eating, according to the Dietary Guidelines for the Brazilian Population.[20] The transtheoretical model will be used as a tool for tailoring the messages sent to one of the intervention groups. This study follows the Standard Protocol Items: Recommendations for Interventional Trials guidelines.[21]

Participants and eligibility criteria
The study will be conducted with senior students in public high schools that participate in the Health in School Program, which includes 19 schools and 4183 adolescents. This programme is a part of a national effort involving the Brazilian Ministry of Health and Education. It is aimed at public schools, which generally include lower and middle income students.[22] Schools linked with this programme were chosen in hopes of finding greater openness to health educational interventions, and high school seniors were chosen due to the greater likelihood of having a smartphone and internet access. Possession of a smartphone and use of WhatsApp will be the study's inclusion criteria. Schools in rural areas and night school students will be excluded for logistical reasons.

Intervention
During the intervention, all participants will be sent short WhatsApp messages daily at lunchtime. The researchers will be instructed not to interact with the students. A

total of 42 messages will be sent, one per day, including three orientation messages (one welcoming the participants to the study, one indicating that the study is halfway complete and one at the conclusion of the study, thanking the students for their participation) and 39 thematic messages. The intervention will last 42 days (6 weeks). Since participants will not be required to change their WhatsApp settings to participate in the study, the percentage of participants who will read the messages cannot be analysed.
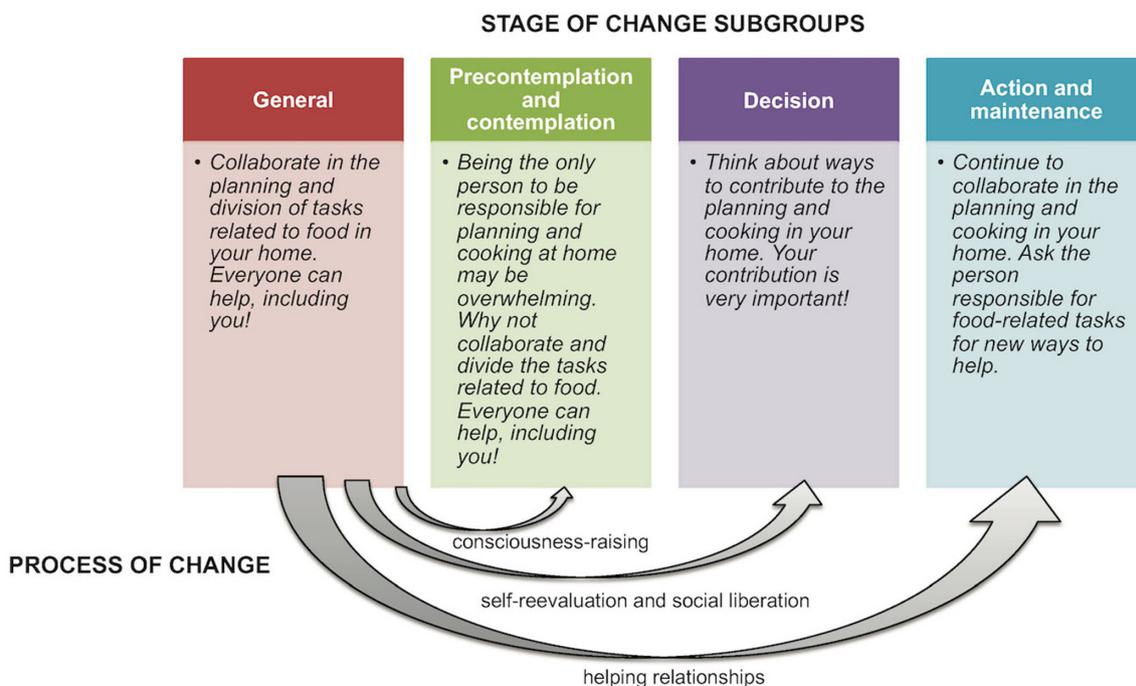
Groups and message content

Participants will be allocated into three groups. The general intervention group (GG) will receive one healthy eating message per day for 6 weeks. These messages were selected from a previous message validation study in adults based on the above-mentioned dietary guidelines,[20] and their language and content were adapted by a panel of experts to better communicate with youth culture. The messages were then validated with a young, nationally representative population from all regions of Brazil. These short, direct messages use both colloquial (ie, including personal pronouns) and suggestive language, based on a previously described model for developing educational messages for adolescents.[23]

The tailored intervention group (TG), will receive one tailored healthy eating message per day for 6 weeks. The messages will be tailored to each stage of change.[9] An algorithm used in a previous study[24] was translated to Portuguese and will identify each participant's stage at baseline. The TG will be divided into three subgroups: (1) precontemplation and contemplation, (2) decision and (3) action and maintenance, a model used in previous nutritional interventions.[10]

The messages for the TG were based on those of the GG but considered the process of change, which is expected to increase participant motivation and encourage progress through the stages.[9] For subgroup 1, the modifications were based on raising consciousness, dramatic relief and environmental re-evaluation processes. For subgroup 2, they were based on self-re-evaluation, self-liberation and social liberation. Finally, for subgroup 3, they were based on counter-conditioning, helping relationships, and reinforcement management and stimulus control. Thus, each general message was adapted into three messages, one for each subgroup, except for the five concept messages used in the Brazilian Dietary Guidelines.[20]

The final 34 messages were developed by three experienced researchers (R1, R2 and R3) in healthy eating, nutrition and the transtheoretical model. The messages were initially developed by R1, revised by R2 and revised again, in a face-to-face meeting, by R1, R2 and R3. The messages were validated through an online questionnaire with two research groups from different regions of Brazil, whose goals were to determine: (1) whether the modified messages for each group contained the same content as the original ones; and (2) whether the involved process of change actually fit the version of the message. Finally, analysis of the validation responses and editing the messages was performed by three expert panels with six invited researchers per panel. Figure 1 shows an example of a message adaptation for the tailored group.

Based on the attachment theory, which explains that a positive parent-child relationship provides a safe basis for engaging in healthy future relationships,[25] the control group (CG) will receive one message per day for 6 weeks about the prevention of dating violence, based on a

STAGE OF CHANGE SUBGROUPS

General
- Collaborate in the planning and division of tasks related to food in your home. Everyone can help, including you!

Precontemplation and contemplation
- Being the only person to be responsible for planning and cooking at home may be overwhelming. Why not collaborate and divide the tasks related to food. Everyone can help, including you!

Decision
- Think about ways to contribute to the planning and cooking in your home. Your contribution is very important!

Action and maintenance
- Continue to collaborate in the planning and cooking in your home. Ask the person responsible for food-related tasks for new ways to help.

PROCESS OF CHANGE

consciousness-raising

self-reevaluation and social liberation

helping relationships

Figure 1 Example of a message adaptation for the tailored group.

pre-existing programme designed for adolescents. To counteract the Hawthorne effect, these messages involve no healthy eating content.[26]

Sample size and recruitment

Sample size calculation was based on expected self-efficacy in the adoption of healthy practices during the intervention period, considering a 15% increase in self-efficacy scores clinically significant, an SD of 4.79,[27] a significance level of 5% and a power of 80%. The distribution of stages of change observed in the literature[28] was also considered: 68%, 12% and 20% in precontemplation/contemplation, decision and action/maintenance stages, respectively. For such conditions, the minimum sample in the smallest intervention subgroup (decision) should be 26 adolescents.

In addition, when calculating the minimum sample, an estimated loss of 31.8% was added between preintervention and postintervention.[29] Thus, the minimum sample was 390 individuals: 38 in the CG, 38 in the GG and 314 in the TG.

A computer-generated randomisation method, supervised by a statistician, will be used to allocate schools in each group, with new schools drawn from the pool until the minimum sample is reached. Schools will be drawn for groups in the following order: CG, GG and TG. School recruitment will occur through personal visits to the principals. If a school denies participation, a new school will be drawn from the pool to replace the previously allocated school. The researchers will present the project to the students in the classroom, and those who are interested in participating must return with the consent form signed by themselves as well as by their parents or legal guardians within 1 week. Figure 2 shows the flowchart of recruitment and intervention of the study.

Measures

All participants will complete a preintervention and postintervention self-administered questionnaire on a regular school day. The following variables will be investigated: age, gender, maternal education, food consumption, stage of change, nutritional knowledge and self-efficacy in the adoption of healthy practices. Maternal education will be assessed through multiple questions used in national population surveys.[30] To assess food consumption, a food frequency questionnaire will be applied that includes markers of healthy and unhealthy eating (especially among adolescents), based on previous
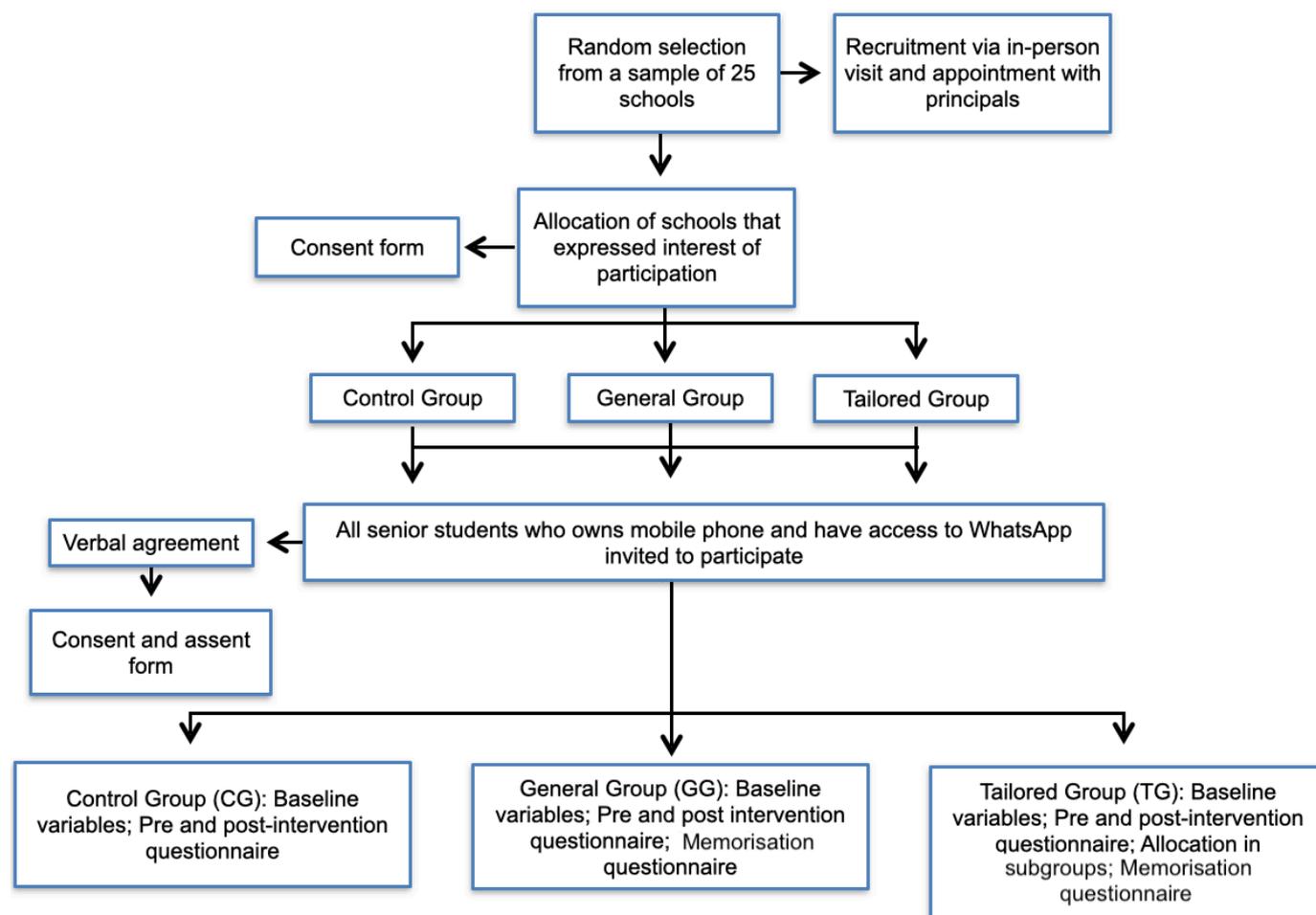
Figure 2 Study procedure flow diagram.

national surveys.[30 31] Participants will be asked if they ate that particular food item the day before, responding with either yes or no.

The stages of change toward a healthy diet will be evaluated. An algorithm, validated in a previous Spanish study on adolescents and translated into Portuguese,[24] will be used to identify the respondent's stage based on his/her food perceptions. Respondents who have never pursued healthy eating habits will be asked if they have considered changing their diet in the last month: negative responses will be classified as precontemplation and positive ones as contemplation or decision, depending on the respondents' degree of confidence that they will succeed in making their diet healthier in the next month. Regarding those who are currently trying and/or have tried to maintain a healthy diet: if they began at least 6 months ago, they will be classified as maintenance, but if it has been less than 6 months, they will be classified as action stage.

To assess nutritional knowledge and self-efficacy in the adoption of healthy practices, an instrument developed and validated for nutritional interventions with Brazilian adolescents will be used.[32] For the nutritional knowledge module, the adolescents will evaluate each statement on a Likert scale ranging from 1 ('I don't agree at all') to 5 ('I totally agree'); for the self-efficacy module, the scale will range from 1 ('Definitely no') to 5 ('Definitely yes').

The food frequency questionnaire and the scales used to assess nutritional knowledge and self-efficacy in the adoption of healthy practices will generate item ratings that will be summed to yield a total score. Higher scores for healthy eating markers and lower scores for unhealthy eating markers will indicate a better diet quality. Higher scores for nutritional knowledge and self-efficacy will indicate improvement in these variables. The final version of the study questionnaire translated to English can be found in the online supplemental material.

Pilot test of the questionnaire and preliminary qualitative research

To develop an intervention more suited to the target audience, three focus groups were conducted with a convenience sample of 34 students from a public school not involved in the main study, although the students were from the same grade and region as the participants of the main study. A semi-structured script with questions divided into three blocks was used to evaluate (1) the best platform for receiving messages about healthy eating (a new app, WhatsApp or SMS); (2) the most appropriate message format (short or long; text only or text with images/videos); (3) the most convenient time of the day (morning, afternoon or evening) and frequency (daily or every other day) to receive messages.

The adolescents showed greater interest in WhatsApp due to its ease of use and its presence in their daily routines. Short objective text messages were preferred; long messages were considered tiring and were unlikely to be read in their entirety. The students preferred receiving messages daily at less busy times, such as before school or at lunchtime.

The final version of the questionnaire was also evaluated in a pilot study at the same school in which the focus groups were conducted. On average, the students took 5–10 min to complete it and only one item in the knowledge module needed rewording due to reasons of ambiguity. No doubts were expressed about the other items and statements. The intervention itself was not evaluated in this pilot test.

Message memorisation

In a subsample of GG and TG, memorisation of the healthy eating messages will be assessed through a questionnaire based on a previously tested instrument for measuring content memorisation.[33] This step will occur approximately 1 month after the end of the intervention.

The participants will initially be asked to recite three messages they currently remember. The five messages involving the main concepts from the Brazilian Dietary Guidelines[20] will be shown and the participants will be asked how well they remember each message according to a 5-point Likert scale, ranging from 1 ('I remember that message well') to 5 ('I don't remember that message at all'). In this case, item ratings will also be summed to yield a total score, with higher scores indicating better long-term memorisation.

Data analysis

Kobo Toolbox, a programme designed for field data collection, will be used to record the questionnaire responses. To accomplish this, a form with limited response options (to minimise typing errors) will be developed, and each participant will be given an individual identification number to protect confidentiality. The data will initially be analysed descriptively as means, medians, SDs and frequencies. Age, gender and maternal education will be used to describe the study population at baseline.

The intervention's impact on food consumption, nutritional knowledge, self-efficacy in the adoption of healthy practices and stages of change will be assessed through two-way mixed analysis of covariance (ANCOVA) with repeated measures with group as between-subject factor, time (preintervention and postintervention) as the within-subject factor and potential confounders as covariates. The statistical analysis will be performed in SPSS V.20.0, with a significance level of 5%. Message memorisation will be analysed descriptively through means, medians, SDs and frequencies, and one-way ANCOVA followed by Bonferroni post-hoc tests will be used to determine the degree of memorisation for each message.

Participant and public involvement

The intervention components (the platform, format, number and type of messages) were designed around the participants' preferences. No participants will be involved in recruitment for/or conducting this study. Although individual data will not be disseminated to participants,

each participating school will receive a printed report with the main results of the intervention.

Hypothesis

Our hypothesis is that adolescents who participate in the intervention tailored to their specific stage of change will achieve better results than the CG or the GG, such as increased healthy food consumption and reduced unhealthy food consumption, greater nutritional knowledge and self-efficacy in the adoption of healthy practices, and progressing through the stages of change. It is also expected that the general (non-tailored) intervention will produce better results than the CG.

ETHICS AND DISSEMINATION

The study was approved by the University of Brasília, School of Health Sciences and Research Ethics Committee (no. 90326218.6.0000.0030). The schools and students, as well as their parents or legal guardians, will provide written consent prior to participation. Also, on completion of the study, the CG will receive the same healthy eating material that was provided to the GG.

The data will be released through a publication. At the end of the study, the participating schools, as well as the Brazilian Ministry of Health and the National Council for Scientific and Technological Development, will receive a printed report with the main results of the intervention, although they will not interfere with the data analysis or publication. No individual information of enrolled participants will be shared to protect confidentiality.

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