



# Exploring individual cognitions, self-regulation skills, and environmental-level factors as mediating variables of two versions of a Web-based computer-tailored nutrition education intervention aimed at adults: A randomized controlled trial



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## ARTICLE INFO

### Article history:

Received 19 March 2015  
Received in revised form  
1 October 2015  
Accepted 15 December 2015  
Available online 19 December 2015

### Keywords:

Computer tailoring  
Mediation analysis  
Environmental-level factors  
Individual cognitions  
Self-regulation  
Nutrition education

## ABSTRACT

**Background:** This study explored whether the determinants that were targeted in two versions of a Web-based computer-tailored nutrition education intervention mediated the effects on fruit, high-energy snack, and saturated fat intake among adults who did not comply with dietary guidelines.

**Method:** A RCT was conducted with a basic (tailored intervention targeting individual cognitions and self-regulation), plus (additionally targeting environmental-level factors), and control group (generic nutrition information). Participants were recruited from the general Dutch adult population and randomly assigned to one of the study groups. Online self-reported questionnaires assessed dietary intake and potential mediating variables (behavior-specific cognitions, action- and coping planning, environmental-level factors) at baseline and one (T1) and four (T2) months post-intervention (i.e. four and seven months after baseline). The joint-significance test was used to establish mediating variables at different time points (T1-mediating variables – T2-intake; T1-mediating variables – T1-intake; T2-mediating variables – T2-intake). Educational differences were examined by testing interaction terms.

**Results:** The effect of the plus version on fruit intake was mediated (T2–T2) by intention and fruit availability at home and for high-educated participants also by attitude. Among low/moderate-educated participants, high-energy snack availability at home mediated (T1–T1) the effect of the basic version on high-energy snack intake. Subjective norm mediated (T1–T1) the effect of the basic version on fat intake among high-educated participants.

**Discussion:** Only some of the targeted determinants mediated the effects of both intervention versions on fruit, high-energy snack, and saturated fat intake. A possible reason for not finding a more pronounced pattern of mediating variables is that the educational content was tailored to individual characteristics and that participants only received feedback for relevant and not for all assessed mediating variables.

**Trial registration:** Netherlands Trial Registry NTR3396.

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## 1. Introduction

Computer-tailored nutrition education interventions have been shown to be effective in changing self-reported dietary behavior (Broekhuizen, Kroeze, van Poppel, Oenema, & Brug, 2012; Krebs, Prochaska, & Rossi, 2010; Kroeze, Werkman, & Brug, 2006; Neville, O'Hara, & Milat, 2009), among both higher- and lower-

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educated individuals (Brug & van Assema, 2000; Noar, Benac, & Harris, 2007). The pathways through which effects of such interventions are generated are, however, largely unknown. Identifying factors that contribute to the intervention effects provides insight into the most important determinants (i.e. factors that influence the behavior, such as attitude) needed to generate an intervention effect. Such variables are referred to as mediating variables. Targeting the most important mediating variables and omitting or adapting non-mediating determinants may make interventions more (cost-)efficient, without compromising efficacy (Hafeman & Schwarz, 2009). In addition, by examining educational differences in mediating variables, interventions can be made more efficient and effective for different educational groups. Creating effective interventions is especially important for lower-educated individuals, because they are more likely to engage in dietary risk behaviors (Ball, Crawford, & Mishra, 2006; Inglis, Ball, & Crawford, 2008; Konttinen, Sarlio-Lähteenkorva, Silventoinen, Männistö, & Haukkala, 2012; van Rossum, Fransen, Verkaik-Kloosterman, Buurma-Rethans, & Ocké, 2011).

The aim of the present study was to explore the mediating variables of the effects of two versions (basic and plus) of a previously evaluated Web-based computer-tailored nutrition education intervention (Springvloet, Lechner, & Oenema, 2014) among adults who did not comply with the dietary guidelines. A second aim was to explore potential educational differences in mediating variables. Both intervention versions targeted individual cognitions and self-regulation; the plus version additionally targeted environmental-level factors. An effect evaluation of the intervention showed that the basic version was effective in decreasing saturated fat intake and the plus version was effective in increasing fruit intake among people who did not comply with dietary guidelines at baseline (Springvloet, Lechner, de Vries, Candel, & Oenema, 2015). For high-energy snack intake, among high-educated participants both versions were effective at short term, but at medium term only the basic version was effective; among lower-educated participants only the basic version was effective at both short and medium term. In the current study we explored which variables have contributed to these intervention effects (i.e. through which variables the intervention effects were mediated).

Only a few previous studies on computer-tailored nutrition education interventions have examined whether the effects on dietary behavior were mediated by the determinants that are included in this intervention (Anderson, Winett, Wojcik, Winett, & Bowden, 2001; Broekhuizen et al., 2012; Lustria, Cortese, Noar, & Glueckauf, 2009; Luszczynska, Tryburcy, & Schwarzer, 2007; Winett, Anderson, Wojcik, Winett, & Bowden, 2007). However, these studies did not always identify mediating variables; changes were found in some determinants only or in no determinant at all. Targeting environmental-level factors as was done in the current intervention is a novelty for Web-based computer-tailored nutrition education interventions and no mediation through these factors has been established yet. For physical activity, however, a previous study among older adults showed that changes in perceptions of the environment mediated the effects on physical activity of a print-delivered computer-tailored intervention (i.e. assessment questionnaire and feedback delivered to the participants on paper) that provided objective environmental-level information (van Stralen, de Vries, Mudde, Bolman, & Lechner, 2009). Further, no previous studies that examined educational differences in mediating variables are known.

The aim of the present study was to explore whether the short-term (one month post-intervention; i.e. four months post-baseline, as the intervention period started one month after baseline and lasted for two months) and medium-term (four months post-intervention, which is seven months post-baseline) intervention

effects on fruit, high-energy snack, and saturated fat intake were mediated by the individual cognitions, self-regulation skills, and environmental-level factors that were targeted in the intervention. An additional aim was to explore potential educational differences in the mediating variables. The mediating variables were explored among participants who at baseline did not comply with dietary guidelines, because these risk groups should specifically benefit from the intervention. It was hypothesized that both intervention versions exerted their effects via changes in individual cognitions (awareness, attitude, self-efficacy, and intention) and action- and coping planning. Because only the plus version targeted environmental-level factors, it was expected that the availability and location of food products at home and the perception of availability and price of healthy food products in the supermarket would mediate the effects of the plus version only.

## 2. Material and methods

A detailed overview of the study protocol has been described elsewhere (Springvloet et al., 2014). Therefore, a summary of the methodology and protocol is described below. The trial is registered in the Dutch Trial Registry (NTR339) and was approved by the Medical Ethics Committee of the Erasmus Medical Centre in Rotterdam (NL35430.078.11/MEC-2010-408).

### 2.1. Study design and study procedure

A three-group RCT was conducted from March 2012 to December 2013 in the Netherlands. The entire study was conducted online and all outcomes were self-reported. The target group for this trial were adults, aged 20–65 years. Participants were recruited between March and October 2012 from the general population in five cities in the South of the Netherlands. Personal mailings were sent to 26,402 random home addresses that were obtained via municipalities. Additionally, Facebook advertisements, advertisements in (local) newspapers, local television, and promotion activities in shopping malls (i.e. distribution of flyers and talking to people) were used for recruitment. People received an information folder with information about the procedure and incentives for the study. People could sign up for participation by phone, e-mail, or via the study website. Inclusion criteria were: being aged between 20 and 65 years, having a sufficient understanding of the Dutch language (in reading and writing) and having Internet access. Exclusion criteria were: being on a diet prescribed by a physician or dietician, having a medical condition that implies restrictions in eating behavior, and not willing to sign a written informed consent form.

After signing up for the study, a link to an online baseline questionnaire was sent via e-mail. The baseline questionnaire first assessed the inclusion- and exclusion criteria. People who met the inclusion criteria were asked to give online informed consent before they could continue with the baseline questionnaire. Additionally, a written informed consent form was sent via postal- or e-mail and only people who signed and returned this form were included in the study.

One month after completing the baseline questionnaire participants could start to use the intervention program. Participants were individually randomized to the basic intervention group ( $n = 456$ ), the plus intervention group ( $n = 459$ ), or the control group (receiving generic nutrition information;  $n = 434$ ) in a computer-determined sequence. Participants received a login code and password through e-mail, which gave them access to the allocated intervention program on the study website. Because the intervention consisted of three sessions, participants were asked to visit and work through the content of the website at least three

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