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SHORT COMMUNICATION

# Validity of a short diet-quality index to predict changes in anthropometric and cardiovascular risk factors: a simulation study

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Coronary heart disease prevention in the primary care setting, where time is extremely limited, requires valid instruments that efficiently screen for unhealthy lifestyle habits. Identification of the individuals who would most benefit from dietary intervention is particularly important in this context. We used dietary intake data derived from a full-length food frequency questionnaire to simulate responses to our previously validated short dietary quality screener. We determined the prospective association of the resulting diet-quality index (DQI) with changes in anthropometric and cardiometabolic risk variables in 2181 men and women in a 10-year follow-up. Multiple linear regression analyses revealed that a higher DQI score at baseline related directly ($P = 0.002$) to high-density lipoprotein cholesterol (HDL-C) and inversely ($P < 0.016$) to waist circumference (WC), triacylglycerides (TG), the TG to HDL-C ratio and the total cholesterol to HDL-C ratio at follow-up. A low DQI score is predictive for an increase in WC and the development of an unfavourable cardiometabolic profile.

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## INTRODUCTION

Coronary heart disease (CHD) is the main cause of premature mortality worldwide.[1] There is resounding evidence for a pivotal impact of unhealthy diets on the development of CHD.[2] Dietary indexes based on nutritional guidelines or traditional dietary habits have been developed to estimate diet quality. Those that predict cardiometabolic risk and mortality[3,4] are also more generally useful for the identification of individuals with unhealthy dietary habits.[5,6] However, the administration of detailed and time-consuming dietary assessment methods is a burden in time-limited primary care settings and only a few short dietary assessment instruments are available that provide valid information on total diet quality.[7–9] Furthermore, the predictive validity (for example, how well the short screener predicts future health outcomes) was not addressed in these validation studies.[3,4,7–9] We recently established the construct and concurrent validity of a short diet-quality index (DQI) derived from the short dietary quality screener (sDQS).[8] The objective of the present study was to determine the predictive validity of the DQI in a simulation study using data from a long-term population study.

## METHODS

Data were obtained from a population-based survey conducted in Girona (Spain) in 2000 and 2009. The baseline survey in 2000 examined a random sample of 3052 men and women aged 25–74 years (participation rate: 71.0%). In 2009, the 2715 noninstitutionalized participants still residing in the catchment area were invited for re-examination, and 2181 attended (80.3%).

Dietary intake data derived from a validated full-length food frequency questionnaire (FFQ)[10,11] were employed to simulate responses that would have been obtained using the sDQS. The DQI derived from the simulated data was calculated, as described in the validation study.[8]

The sDQS asked for the usual food intake of 18 food items grouped in 3 food categories over the past year. The first food category contains major food items such as bread, pasta and vegetables, the second category is devoted to meat and other food items from animal origin and the third category contains fish, legumes and nuts. Food frequency consumption was arranged in 3 frequency response categories.

Blood was withdrawn after 10–14 h of fasting. Serum-sample aliquots were stored at −80 °C. Glycaemia was measured in an aliquot of serum. Total cholesterol (TC) and triacylglycerides (TG) concentrations were determined enzymatically (Roche Diagnostics, Basel, Switzerland). High-density lipoprotein cholesterol (HDL-C) was measured after precipitation of apoprotein B-containing lipoproteins with phosphotungstic-$Mg^{++}$ (Boehringher, Mannheim, Germany). Analyses were performed in a Cobas Mira Plus autoanalyzer (Roche Diagnostics). The External Quality Assessment-WHO Lipid Program (World Health Organization, Prague, Czech Republic) and Monitrol-Quality Control Program (Baxter Diagnostic, Dudingen, Switzerland) were used for quality control. Low-density lipoprotein cholesterol was calculated by the Friedewald equation, whenever TG values were $< 300$ mg/dL.

A calibrated precision scale was used for weight measurement. Readings were rounded up to 200 g. Height was measured in the standing position and rounded up to the nearest 0.5 cm. Weight was divided by height squared (kg/m$^2$) to establish the body mass index (BMI).

Measurement of waist circumference (WC) was performed midway between the lowest rib and the iliac crest in the horizontal positions. The measurement, taken in centimetres, was rounded to the nearest 0.5 cm.

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Anthropometric measurements, laboratory tests and dietary assessment by the FFQ were performed at baseline and at follow-up.

Linear modelling procedures were used to estimate the general characteristics, according to the tertile distribution of the sDQS-derived DQI. Multiple linear regression analysis was performed to determine the association between scoring for the sDQS at baseline and the anthropometric and cardiometabolic risk variables calculated at follow-up.

The main findings were essentially similar for men and women. Therefore, we present stratified results adjusted for sex only when appropriate. Differences were considered significant if $P<0.05$. The SPSS for Windows version 15 (SPSS, Inc., Chicago, IL, USA) was used for all statistical analysis.

## RESULTS

Men had higher DQI scores (Table 1). Participants with higher scores on the DQI were older, had less education, were more likely to smoke and spent more time in leisure physical activities than their peers with a low DQI score (Table 1). An increment of 10 units in the DQI was associated with a decrease of 1.17 kg/m$^2$ in BMI and 3.25 cm in WC at follow-up (Table 2, Model 1). These associations were attenuated after adjusting for baseline levels of BMI and WC (Table 2, Model 2). Fully adjusted linear regression models revealed an inverse association of the DQI with follow-up serum TG levels and TC/HDL-C and TG/HDL-C ratios. The opposite was observed for HDL-C (Table 2, Model 2).

## DISCUSSION

The pivotal role of healthy dietary habits in primary and secondary CHD prevention has been emphasized by international health organizations.[12] Cross-sectional data from previous validation studies have demonstrated the potential usefulness of short dietary screeners to identify individuals at cardiovascular risk.[7] However, prospective data on the predictive validity of DQIs derived from short screeners have not been published previously.

The present DQI validation study, using simulated sDQS data, indicates a reasonable capacity to predict cardiometabolic changes. Specifically, the simulated sDQS-derived DQI correctly predicted an increase in WC and the development of an unfavourable cardiometabolic risk profile over 10 years.

Epidemiological evidence associated increases of 1 mg/dl of HDL-C and 1 point in the TC to HDL-C ratio with a 3.5% reduction and 36.7% increase, respectively, in the risk of myocardial infarction at population scale.[13] In this study, a 10-point increment in the DQI was related to a 1.97 mg/dl HDL-C increase and a 0.15 decrease in the TC to HDL-C ratio. Therefore, the association between the DQI and these CHD risk predictors can be considered relevant.

A strength of this study is the population-based prospective design with relatively long follow-up. The simulation of responses can be considered a limitation of the present work. However, data from a previously conducted validation study in 102 men and women[8] revealed a good correlation ($r=0.51$) and low cross-misclassification (6.9%) between the DQI derived from the sDQS (actual response) and the DQI derived from a validated full-length FFQ. The sDQS was developed for the estimation of diet quality in a Spanish population. A further limitation is that we do not have the data needed to establish the degree of repeatability of the sDQS. The external validity of the sDQS should be addressed in future studies, but is achievable if minor adjustments are made to accommodate cultural differences in dietary habits.

In conclusion, our study provides evidence for the predictive validity of the sDQS-derived DQI. Together with the demonstrated construct and concurrent validity of the sDQS, the study results

**Table 1.** General characteristics of the study population, according to tertile distribution of the diet quality index (DQI)[a]

| *Variables* | *Tertile distribution of DQI* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *1st* | | *2nd* | | *3rd* | | P-*value* |
| Men (%) | 54.9 | 51.9; 57.8 | 47.7 | 44.7; 50.7 | 42.7 | 39.5; 46.0 | <0.001 |
| Age (years) | 45.8 | 45.0; 46.6 | 51.1 | 50.3; 51.9 | 54.1 | 53.2; 54.9 | <0.001 |
| Low education[b] (%) | 56.0 | 52.6; 59.4 | 63.7 | 60.3; 67.0 | 72.0 | 68.4; 75.7 | <0.001 |
| LTPA (METs · min/d) | 242.5 | 221.3; 263.6 | 284.6 | 263.8; 305.3 | 305.5 | 283.1; 327.8 | <0.001 |
| Smokers[c] (%) | 64.9 | 61.8; 68.0 | 75.6 | 72.6; 78.7 | 85.3 | 82.1; 88.6 | <0.001 |

Abbreviations: LTPA, leisure-time physical activity; METs, metabolic equivalents. [a]Mean and CI 95%. [b]No secondary school. [c]Never smokers and ex-smokers up to 1 year.

**Table 2.** Multiple linear regression models of the association between a 10-point increase over baseline diet quality values and cardiovascular risk factors at follow-up

| *CRF* | *Model 1*[a] | | | *Model 2*[b] | | |
|---|---|---|---|---|---|---|
| | *B* | *95% CI* | P-*value* | *B* | *95% CI* | P-*value* |
| BMI (kg/m$^2$) | −1.127 | −1.702; −0.551 | <0.001 | −0.180 | −0.478; 0.117 | 0.235 |
| WC (cm) | −3.254 | −4.778; −1.730 | <0.001 | −1.431 | −2.587; −0.274 | 0.015 |
| TC (mg/dl) | −0.200 | −5.008; 4.607 | 0.935 | −0.380 | −4.591; 3.832 | 0.860 |
| HDL-C (mg/dl) | 1.977 | 0.517; 3.438 | 0.008 | 1.937 | 0.696; 3.178 | 0.002 |
| LDL-C (mg/dl) | −0.482 | −4.636; 3.671 | 0.820 | −0.710 | −4.372; 2.952 | 0.704 |
| TG[c] (mg/dl) | −0.032 | −0.058; −0.007 | 0.013 | −0.029 | −0.051; −0.006 | 0.012 |
| TC/HDL-C | −0.153 | −0.271; −0.03 | 0.011 | −0.150 | −0.249; −0.050 | 0.003 |
| TG/HDL-C[c] | −0.048 | −0.080; −0.016 | 0.003 | −0.048 | −0.075; −0.021 | <0.001 |
| FG[c] (mg/dl) | −0.010 | −0.020; <0.001 | 0.065 | −0.008 | −0.016; <0.01 | 0.075 |

Abbreviations: BMI, body mass index; CI, confidence interval; CRF, cardiovascular risk factors; FG, fasting glucose, HDL-C, HDL-cholesterol; LDL-C, LDL-cholesterol; TC, total cholesterol; TC/HDL-C, ratio total cholesterol/HDL-cholesterol; TG, triacylglycerides; TG/HDL-C, ratio triacylglycerides/HDL-cholesterol; WC, waist circumference. [a]Model 1: adjusted for age, sex, baseline smoking, education, baseline leisure-time physical activity. [b]Model 2: additionally adjusted for the baseline variable of the corresponding CRF. [c]Log-transformed.


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indicate the usefulness of this tool for the identification of individuals who would most benefit from dietary intervention. Furthermore, it can be efficiently implemented in time-limited settings such as primary care.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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## REFERENCES

1 The World Health Organization. *Causes of Death 2008 Summary Tables*. Health Statistics and Informatics Department, World Health Organization, Geneva, Switzerland, 2011.
2 Srinath Reddy K, Katan MB. Diet nutrition and the prevention of hypertension and cardiovascular diseases. *Public Health Nutr* 2004; **7**: 167–186.
3 Toft U, Kristoffersen LH, Lau C, Borch-Johnsen K, Jorgensen T. The dietary quality score: validation and association with cardiovascular risk factors: the Inter99 study. *Eur J Clin Nutr* 2007; **61**: 270–278.
4 McNaughton SA, Dunstan DW, Ball K, Shaw J, Crawford D. Dietary quality is associated with diabetes and cardio-metabolic risk factors. *J Nutr* 2009; **139**: 734–742.
5 Kourlaba G, Panagiotakos DB. Dietary quality indices and human health: a review. *Maturitas* 2009; **62**: 1–8.
6 Wirt A, Collins CE. Diet quality-what is it and does it matter? *Public Health Nutr* 2009; **12**: 2473–2492.
7 Schröder H, Fito M, Estruch R, Martinez-Gonzalez MA, Corella D, Salas-Salvado J *et al.* A short screener is valid for assessing Mediterranean diet adherence among older Spanish men and women. *J Nutr* 2011; **141**: 1140–1145.
8 Schröder H, Benitez Arciniega A, Soler C, Covas MI, Baena-Diez JM, Marrugat J. Validity of two short screeners for diet quality in time-limited settings. *Public Health Nutr* 2012; **15**: 618–626.
9 Neuhouser ML, Kristal AR, McLerran D, Patterson RE, Atkinson J. Validity of short food frequency questionnaires used in cancer chemoprevention trials: results from the Prostate Cancer Prevention Trial. *Cancer Epidemiol Biomarkers Prev* 1999; **8**: 721–725.
10 Schröder H, Covas MI, Marrugat J, Vila J, Pena A, Alcantara M *et al.* Use of a three-day estimated food record, a 72-hour recall and a food-frequency questionnaire for dietary assessment in a Mediterranean Spanish population. *Clin Nutr* 2001; **20**: 429–437.
11 Benítez-Arciniega AA, Mendez MA, Baena-Díez JM, Rovira Martori MA, Soler C, Marrugat J *et al.* Concurrent and construct validity of Mediterranean diet scores as assessed by an FFQ. *Public Health Nutr* 2011; **14**: 2015–2021.
12 The World Health Organization. Diet, nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation 2003; WHO Technical Report Series no. 916. WHO, Geneva, Switzerland.
13 Stampfer MJ, Sacks FM, Salvini S, Willett WC, Hennekens CH. A prospective study of cholesterol, apolipoproteins, and the risk of myocardial infarction. *N Engl J Med* 1991; **325**: 373–381.

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