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ORIGINAL ARTICLE *Psychology and counselling*

Tailored preconceptional dietary and lifestyle counselling in a tertiary outpatient clinic in the Netherlands

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BACKGROUND: Adverse reproductive performance has been linked to unhealthy dietary intake and lifestyles. Our objectives were to investigate the prevalence of unhealthy dietary intake and lifestyles before conception and to evaluate whether tailored preconception counselling modifies these behaviours.

METHODS: Between October 2007 and April 2009, 419 couples received tailored preconception dietary and lifestyle counselling at the outpatient clinic of Obstetrics and Gynaecology of the Erasmus University Medical Center Rotterdam, the Netherlands. A subgroup ($n = 110$ couples) was counselled twice with a fixed time interval of 3 months. Self-administered questionnaires were used for tailored dietary and lifestyle counselling. A cumulative score based on six Dutch dietary guidelines was displayed in the personal Preconception Dietary Risk score (PDR score). In a similar manner, the Rotterdam Reproduction Risk score (R3 score) was calculated from lifestyle factors (women: 13 items, men: 10 items). Univariate and paired tests were used.

RESULTS: Most couples (93.8%) were subfertile. At the second counselling, the percentage consuming the recommended intake of fruit had increased from 65 to 80 in women and from 49 to 68 in men and the percentage of women getting the recommended intake of fish increased from 39 to 52. As a consequence, the median PDR score was decreased [women: 2.6 (95% CI 2.4–2.9) to 2.4 (95% CI 2.1–2.6), men: 2.5 (95% CI 2.3–2.7) to 2.2 (95% CI 1.9–2.4), both $P < 0.05$]. The median R3 scores were also lower [women: 4.7 (95% CI 4.3–5.0) to 3.1 (95% CI 2.8–3.4), men: 3.0 (95% CI 2.8–3.3) to 2.0 (95% CI 1.7–2.3), both $P < 0.01$] due to less alcohol use (−14.6%), more physical exercise and folic acid use in women, and less alcohol use in men (−19.4%) (all $P < 0.01$). The R3 scores in women and men were decreased in all ethnicity, educational level, neighbourhood and BMI categories. However, low educated women appeared to show a larger reduction than better educated women and men with a normal BMI to show a larger decrease than overweight men. The reduction in the PDR score of women was similar in both ethnic groups. More than 85% women and men found the counselling useful and around 70% would recommend it to others.

CONCLUSIONS: Tailored preconception counselling about unhealthy dietary and lifestyle behaviours of subfertile couples in an outpatient tertiary clinic is feasible and seems to decrease the prevalence of harmful behaviours in the short term. These results with subfertile couples are promising and illustrate their opportunities to contribute to reproductive performance and pregnancy outcome.

Key words: lifestyle / dietary intake / preconception care / fertility

Introduction

The high prevalence rates of unhealthy diets and lifestyles in the reproductive population in industrialized countries are worrisome (de Weerd *et al.*, 2003; Vujkovic *et al.*, 2007; Inskip *et al.*, 2009). Current evidence indicates that unhealthy preconceptional diets and lifestyles of both women and men significantly contribute to impaired reproduction with long-term consequences for parental health and

health of their offspring (Gluckman and Hanson, 2007; Homan *et al.*, 2007; Temel *et al.*, 2009; Vujkovic *et al.*, 2009a,b). Health professionals and parents-to-be generally are unaware of these adverse effects (Jack *et al.*, 1998; Anderson *et al.*, 2010), and adjustment of such habits is generally not perceived as beneficial for reproduction. The available evidence justifies reorganization and redefining obstetrical care such that it includes preconceptional screening and informing of parents-to-be, and support to those who intend to change unhealthy diets and lifestyles (Wildschut *et al.*, 2006; Steegers-Theunissen, 2010).

The public recommendation of periconceptional maternal folic acid use is an example of the introduction of a preconceptional measure to prevent adverse pregnancy outcomes, in particular neural tube defects (De-Regil *et al.*, 2010). It may also positively influence follicular-, oocyte-, embryonic-, placental- and fetal growth (Boxmeer *et al.*, 2009; Timmermans *et al.*, 2009). Despite its obvious benefits, compliance is moderate and therefore public health efforts should be reinforced by systematic individual preconceptional care to all parents-to-be. The preconceptional window allows for a personal contribution to a successful reproductive career and seems suitable to include lifestyle modification too (Phelan, 2010). Organized preconceptional care programmes to stimulate a healthy dietary intake and lifestyle behaviours, however, are scarce (Health Council of the Netherlands, 2007). Therefore, the Department of Obstetrics and Gynaecology of the Erasmus University Medical Center in Rotterdam started an outpatient clinic on preconceptional tailored dietary and lifestyle counselling 'Achieving a Healthy Pregnancy'. In the current evaluation, we investigated the prevalence of unhealthy diet and lifestyles in mainly subfertile couples planning pregnancy, the effects of preconception counselling on the improvement of these behaviours and the influence of personal characteristics on these determinants.

Materials and Methods

Study design

Between October 2007 and April 2009, couples planning pregnancy and visiting the outpatient clinic of the Department of Obstetrics and Gynaecology of the Erasmus University Medical Center Rotterdam were offered preconception counselling at the outpatient clinic 'Achieving a Healthy Pregnancy'. At the first gynaecological visit, couples were referred for the preconceptional counselling tailored on dietary intake and lifestyle. They received a flyer with information and a self-administered questionnaire to be filled out at home. The questionnaires were used for individual tailored counselling during the outpatient visit of the couple.

From the questionnaire, we extracted the following data: age, ethnicity, educational level, indication for referral, dietary intake, lifestyle factors (smoking, alcohol and drug use), medication and vitamin use. Ethnicity and educational level were classified according to the definitions of Statistics Netherlands (Statistics Netherlands, 2008). Educational level was divided into three categories: low (primary/lower vocational/intermediate secondary), intermediate (intermediate vocational/higher secondary) and high (higher vocational/university) (Statistics Netherlands, 2008).

Preconception counselling on dietary intake and lifestyle

At the first outpatient preconception counselling (PC1) visit, the filled out questionnaires were checked by the counsellor, and height and weight were measured, to calculate the BMI (weight in kilograms divided by squared height in centimetres). Additionally, waist–hip circumference and blood pressure were measured. During the counselling, the questionnaire data were discussed in detail for tailored dietary and lifestyle advice. For example, if the woman and/or man smoke, they receive the following comment and advice: 'You urgently have to quit smoking, because in both women and men who smoke the time to conceive is much longer than in non-smokers. Tobacco smoke contains compounds that detrimentally affect the female and male gametes. Moreover, women who smoke have a higher risk of experiencing a miscarriage and pregnancy-related complications, such as intrauterine growth restriction'.

Laboratory determinations

Venous blood samples were drawn to measure sensitive biomarkers of the homocysteine pathway to obtain unbiased information on the intake of foods related to this pathway, i.e. serum and red blood cell (RBC) folate, serum cobalamin and plasma total homocysteine (tHcy).

Venous blood samples were drawn into dry vacutainer tubes and allowed to clot. After centrifugation at 2000*g*, serum was collected before being assayed for the concentrations of folate and cobalamin. For the determination of RBC folate and plasma tHcy, venous blood samples were drawn into EDTA-containing vacutainer tubes. The EDTA-blood samples were kept on ice, and plasma was separated by centrifugation within 1 h for determination of tHcy. Serum samples from each patient were analysed during routine laboratory procedures for folate, cobalamin and tHcy using an immunoelectrochemoluminescence assay (E170; Roche Diagnostics GmbH, Mannheim, Germany). Directly after blood sampling, 0.1 ml EDTA tube was haemolysed with 0.9 ml of freshly prepared 1.0% ascorbic acid. Subsequently, the haematocrit of the EDTA-blood was determined on an ADVIA 120 Hematology Analyzer (Bayer Diagnostics, Leverkusen, Germany). The haemolysate was centrifuged for 5 min at 1000*g* after which the folate concentration was measured in the haemolysate. RBC folate was calculated using the following formula: (nM haemolysate folate × 10/haematocrit)−(nM serum folate × [1−haematocrit]/haematocrit) = nM RBC folate. tHcy in EDTA plasma was determined using high-performance liquid chromatography with reversed phase separation and fluorescence detection (Pfeiffer *et al.*, 1999). Inter-assay coefficients of variation for serum folate were 4.5% at 13 nmol/l and 5.7% at 23 nmol/l, for serum cobalamin 3.6% at 258 pmol/l and 2.2% at 832 pmol/l, for plasma tHcy 4.8% at 14.6 mmol/l. The detection limit for serum folate was 1.36 nmol/l, for serum cobalamin 22 pmol/l and for plasma tHcy 4 mmol/l.

Tailored preconception dietary and lifestyle counselling

Within the infrastructure of the Dutch Preconception Center of Excellence Rotterdam, we developed and provided individual tailored preconception dietary and lifestyle counselling using the attitude–social influence–efficacy (ASE) model (de Vries *et al.*, 2000). The ASE model has been frequently used for the development of health education and prevention and is based on the interplay of attitudes, social influences and self-efficacy of an individual. Attitudes are the opinions of a person based on knowledge, experience and examples of others. Social influences include social norms, perceived behaviours of others, and direct pressure or support to perform a behaviour. Finally, self-efficacy includes confidence in one's ability to perform a behaviour intention and progression through the stages of change. Together, these factors determine the intention to perform or change certain behaviour. Whether or not the behavioural intention actually is performed depends in the ASE model from thresholds and positive incentives. Following the ASE structure, we intended to modify intentions towards a healthier diet and lifestyle in terms of

improved reproductive performance. A specific feature was that change was aimed in both women and men.

The couple filled out an informed consent form and an evaluation form about their experiences of the preconception counselling. Moreover, they were offered a voluntary second counselling after 3 months. Within 3 weeks after the first counselling, couples received a letter in which the identified (un)healthy dietary and lifestyle factors, biomarker concentrations and advises are reported.

Preconception Dietary Risk score

Six questions about dietary intake were filled out by the couple and estimate the general personal intake of six main food groups, with responses defined according to the food-based dietary guidelines of the Dutch Nutrition Center in the Netherlands (Nutrition Center the Netherlands, 2009). The guidelines included: at least four slices of brown bread daily, the use of monounsaturated or polyunsaturated oils/fats, at least 200 g of vegetables daily, at least two pieces of fruit daily, at least three to four servings of meat a week, and at least one to two servings of fish a week. Each person received one point for every food group where they consumed less than the recommended amount; subsequently, the total score was calculated and expressed by the individual the Preconception Dietary Risk score (PDR score). We based the PDR score on the unweighted summation of affirmative compliant responses. Consequently, the range of the PDR score was 0–6, where 6 implies a highly inadequate diet.

Rotterdam Reproduction Risk score (R3 score)

The Rotterdam Reproduction Risk score (R3 score) was created and based on the current scientific evidence of harmful effects of modifiable lifestyle risk factors (Appendix). A similar approach has been used by the US 'Special Supplemental Food Program for Women, Infants and Children' (WIC) (Berkenfield and Schwartz, 1980). Each person received one point for every risk factor; subsequently, the total score was calculated and expressed by the individual R3 score. The R3 score comprises the following risk factors: no folic acid supplement use, use of medication (over the counter), smoking (yes, no), alcohol use (yes, no), caffeine use ($\geq$6 cups a day), drug use (yes, no), physical exercise (yes, no), infection risk (yes; including Rubella or Toxoplasmosis or Listeriosis, no), BMI ($<$20 of $\geq$30 kg/m^2), waist circumference (woman: $\geq$88 cm and man: $\geq$102 cm), waist-to-hip ratio ($\geq$0.8), blood pressure (systolic $\geq$160 or diastolic $\geq$90 mmHg) and deranged homocysteine pathway: folate: serum $<$15 nmol/l or (RBC) $<$500 nmol/l, or vitamin B12 serum $<$160 pmol/l or tHcy$>$15 μmol/l. To reduce infection risk, we informed and advised women about the risks of consuming foods, such as raw meat/fish, and raw milk cheeses. Thus, they could change this risk by avoiding the intake of potentially contaminated foods with Toxoplasmosis and/or Listeriosis. Furthermore, when the women were not vaccinated for Rubella, we indicated the need for vaccination to the woman and treating gynaecologist.

For women, the maximum score was 13. For men, the maximum score was 10 because of excluding: folic acid supplement use, infection risk and waist–hip ratio, since those factors are not related to reproductive performance and pregnancy outcome in men. Furthermore, age, ethnicity, educational level, marital status and parity are not modifiable and therefore not included in the R3 score.

Statistical analysis

The Kolmogorov–Smirnov test was used to test for normality of the continuous variables. The variables that were not normally distributed were presented as medians with ranges and all other variables with numbers and percentages. The Wilcoxon signed-rank test was used to analyse differences between paired continuous variables, the McNemar test for paired dichotomous variables, the Mann–Whitney *U*-test for non-paired continuous variables and the χ^2 for non-paired categorical variables. A *P*-value of $<$0.05 was considered statistically significant. Confidence intervals of medians were calculated manually as described by Altman (1999). Other statistical analyses were performed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

General characteristics

In Table I, the non-modifiable and 6 modifiable dietary and 12 lifestyle risk factors are presented of the 419 couples and stratified into couples receiving preconception counselling (PC1) once ($n = 309$) or twice after a fixed interval of 3 months ($n = 110$, PC2).

The median age of the total group of couples at PC1 was about 31 years, 56% had a Dutch ethnicity, 35% were high educated, and the main indication for referral to the outpatient preconception clinic was subfertility (93.8%). These characteristics were not significantly different between couples counselled once or twice.

The non-modifiable and modifiable dietary risk factors were not significantly different between women or men who came for preconception counselling once or twice. Modifiable risk factors were also comparable between the two groups of women and men. However, more women who came for a second counselling were more often obese, had a higher waist circumference, waist–hip ratio and did not exercise.

None of the couples showed a highly adequate diet that conformed to the guidelines, i.e. PDR score of 0. Most ($>$50%) women showed inadequate intakes of bread, vegetables and fish but adequate intakes of butter/oils, fruit and meat. Most men had inadequate intakes of vegetables and fish but adequate intakes of bread, butter/oils, fruit and meat. In the total groups, overweight (BMI 25–30) or obesity (BMI $\geq$30) was present in 46.1% of the women and in 58.1% of the men. The median waist circumference was 90 cm (65–126) in women and 95 cm (78–137) in men. For the waist–hip ratio, this was 0.86 (0.67–1.41) and 0.92 (0.78–1.20), respectively. Both median systolic and diastolic blood pressure were within normal ranges in women and men. A pregnancy-related infection risk was present in 38.7% of the women and 29.1% of the women used medication. In men, 22.4% used medication. In women and men, 49.6 and 59.7% consumed caffeine beverages, 11.7 and 29.3% smoked, 41.8 and 65% used alcohol, 2.1 and 7.3% used drugs, respectively, and 65.9% of the women and 57.7% of the men did not physically exercise. In women, 63.5% used folic acid supplements.

Dietary intake and lifestyle risk factors

In Table II, the effects after 3 months of preconceptional tailored dietary and lifestyle counselling are depicted. The median PDR score decreased significantly in the total group of women and men, 2.6 (95% CI 2.4–2.9) to 2.4 (95% CI 2.1–2.6) and 2.5 (95% CI 2.3–2.7) to 2.2 (95% CI 1.9–2.4), respectively, both $P < 0.05$. This indicates that they better meet the food-based dietary guidelines. In women, this effect is mainly due to a higher percentage taking at least guideline amounts of fruit (64.5–80%, $P < 0.05$) and fish

Table I Baseline characteristics of couples at the first preconception counselling (PC1).

	Total women (n = 419)				Total men (n = 409)			
	Total PC1 (n = 419)	PC1 only (n = 309)	Two PCs PC1 (n = 110)	P-value[a]	Total PC1 (n = 409)	PC1 only (n = 306)	Two PCs PC1 (n = 103)	P-value[a]
Non-modifiable factors								
Age (years) median (range)	31 (19–44)	31.2 (19–44)	32 (19–42)	0.9	32 (22–63)	34.1 (22–63)	34.5 (22–60)	0.4
Ethnicity, n (%)				0.8				0.1
Dutch	223 (53.2)	167 (54.0)	56 (50.9)		245 (59.9)	190 (62.1)	55 (53.4)	
European-others	40 (9.5)	29 (9.4)	11 (10)		30 (7.3)	21 (6.9)	9 (8.7)	
Non-European	151 (36)	109 (35.3)	42 (38.2)		129 (31.5)	91 (29.7)	38 (36.9)	
Educational level, n (%)				0.4				0.6
Low	64 (15.3)	41 (13.3)	23 (20.9)		90 (21.5)	68 (21.5)	22 (21.4)	
Intermediate	199 (47.5)	157 (50.8)	42 (38.2)		151 (36.0)	116 (37.9)	35 (34)	
High	145 (34.6)	111 (35.9)	34 (30.9)		150 (35.8)	113 (36.9)	37 (35.9)	
Indication for referral, n (%)				0.7				
Subfertility	393 (93.8)	289 (93.5)	104 (94.5)					
High obstetrical risk	11 (2.6)	10 (3.2)	1 (0.9)					
Recurrent miscarriages	14 (3.3)	10 (3.2)	5 (4.5)					
Modifiable factors								
All items of PDR score[b]								
Bread, n (%)	268 (64)	198 (64.1)	70 (63.6)	0.9	129 (31.5)	93 (30.4)	36 (35)	0.4
Butter/Oils, n (%)	55 (13.1)	39 (12.6)	16 (14.5)	0.6	54 (13.2)	41 (13.4)	13 (12.6)	0.8
Vegetables, n (%)	313 (74.7)	231 (74.8)	82 (74.5)	1.0	327 (80.0)	244 (79.7)	83 (80.6)	0.9
Fruit, n (%)	140 (33.4)	101 (32.7)	39 (35.5)	0.6	199 (48.7)	146 (47.7)	53 (51.5)	0.5
Meat, n (%)	68 (16.2)	51 (16.5)	17 (15.5)	0.8	53 (13)	39 (12.7)	14 (13.6)	0.8
Fish, n (%)	224 (53.5)	157 (50.8)	67 (60.9)	0.07	215 (52.6)	158 (51.6)	57 (55.3)	0.5
Rotterdam Reproduction Risk score items (R3 score)								
BMI (kg/m^2), median (range)	24.6 (17–43.2)	24.4 (17–43.2)	25.3 (18.4–42.4)	0.2	26.1 (17.4–46.8)	26.0 (17.4–46.8)	26.7 (18.5–42.5)	0.9
25–30 (kg/m^2), n (%)	96 (22.9)	75 (24.3)	21 (19.1)	0.3	156 (38.1)	116 (37.9)	40 (38.8)	0.8
>30 (kg/m^2), n (%)	97 (23.2)	63 (20.4)	34 (30.9)	<0.05	82 (20)	60 (19.6)	22 (21.4)	0.9
Waist circumference (cm), median (range)	90.0 (65–126)	84.0 (64–135)	90.0 (65–126)	<0.05	95.0 (78–137)	95 (71–138)	95 (78–137)	0.6
Waist–hip ratio (cm)	0.86 (0.67–1.41)	0.83 (0.65–1.43)	0.86 (0.67–1.41)	<0.01	0.92 (0.78–1.20)	0.91 (0.75–1.22)	0.92 (0.78–1.20)	0.1
Systolic blood pressure (mmHg)	112 (90–152)	112 (88–180)	112 (90–152)	0.4	124 (90–165)	120 (90–178)	124 (90–165)	0.8
Diastolic blood pressure (mmHg)	75 (40–96)	70 (50–106)	75 (40–96)	0.06	80 (60–110)	78 (50–110)	80 (60.0–110.0)	0.5
Infection risk, n (%)	162 (38.7)	116 (37.5)	46 (41.8)	0.4	—	—	—	—
Medication use, n (%)	122 (29.1)	83 (26.9)	39 (35.5)	0.09	94 (22.4)	66 (21.6)	28 (27.2)	0.2
Caffeine use, n (%)	208 (49.6)	159 (51.5)	49 (44.5)	0.2	250 (59.7)	192 (62.7)	58 (56.3)	0.7
Smoking, n (%)	49 (11.7)	69 (22.3)	18 (16.4)	0.2	120 (29.3)	95 (31.0)	25 (24.3)	0.2
Alcohol use, n (%)	175 (41.8)	136 (44.0)	39 (35.5)	0.1	266 (65.0)	198 (64.7)	68 (66.0)	0.4
Drug use, n (%)	9 (2.1)	5 (1.6)	4 (3.6)	0.1	30 (7.3)	23 (7.5)	7 (6.8)	0.7
Physical exercise (no), n (%)	276 (65.9)	193 (62.5)	83 (75.5)	<0.05	236 (57.7)	171 (55.9)	65 (63.1)	0.1
Folic acid supplement use, n (%)	266 (63.5)	192 (62.1)	74 (67.3)	0.3	—	—	—	—

[a]P-values show differences in characteristics of women and men who visited the preconception counselling only once (PC1 only) or twice (PC1 and 2) with a 3 months interval.
[b]Dietary intake of six food groups not according to the Dutch guideline (Nutrition Center the Netherlands, 2009).

(39.1–51.8%, $P < 0.05$), respectively. The percentage of men eating sufficient fruit increased (48.5–68%, $P < 0.05$).

R3 score decreased from 4.7 (95% CI 4.3–5.0) to 3.1 (95% CI 2.8–3.4) in women and from 3.0 (95% CI 2.8–3.3) to 2.0 (95% CI 1.7–2.3) in men, both $P < 0.01$ reflecting an improved lifestyle. In women, this was due to decreases in the percentages using alcohol (−14.6%), at risk of infection (−34.5%), and to increases in the percentage taking physical exercise (+43.7%) and starting to use a folic acid supplement (+17.2%) (all $P < 0.01$). In men, the prevalence of alcohol users decreased 19.4% ($P < 0.01$). Reductions in the R3 and

Table II Preconceptional dietary and lifestyle risk factors in couples visiting the preconception counselling clinic twice.

	Women			Men		
	PC1 (n = 110)	PC2 (n = 110)	P-value[a]	PC1 (n = 103)	PC 2 (n = 103)	P-value[a]
Preconceptional Dietary Risk score items (PDR score)[b]						
Total PDR score, median (95% CI)	2.6 (2.4–2.9)	2.4 (2.1–2.6)	<0.05	2.5 (2.3–2.7)	2.2 (1.9–2.4)	<0.05
Bread, *n* (%)	70 (63.6)	65 (59.1)	0.3	36 (35.0)	35 (34.0)	1.0
Butter/oils, *n* (%)	16 (14.5)	18 (16.4)	0.7	13 (12.6)	17 (16.5)	0.5
Vegetables, *n* (%)	82 (74.5)	80 (72.7)	0.7	83 (80.6)	80 (77.7)	0.7
Fruit, *n* (%)	39 (35.5)	22 (20.0)	<0.05	53 (51.5)	33 (32.0)	<0.05
Meat, *n* (%)	17 (15.5)	21 (19.1)	0.4	14 (13.6)	13 (12.6)	1.0
Fish, *n* (%)	67 (60.9)	53 (48.2)	<0.05	57 (55.3)	47 (45.6)	0.06
Rotterdam Reproduction Risk score items (R3 score)						
Total R3 score, median (95% CI)	4.7 (4.3–5.0)	3.1 (2.8–3.4)	<0.01	3.0 (2.8–3.3)	2.0 (1.7–2.3)	<0.01
BMI (kg/m^2); median (range)	25.3 (18.4–42.4)	25.3 (18.8–40.3)	0.4	26.7 (18.5–42.5)	26.8 (19.1–41.9)	0.8
25–30 (kg/m^2), *n* (%)	21 (19.1)	25 (22.7)	0.2	40 (38.8)	40 (38.8)	0.1
>30 (kg/m^2), *n* (%)	34 (30.9)	31 (28.2)	0.4	22 (21.4)	17 (16.5)	0.3
Waist circumference (cm), median (range)	90 (65–126)	94 (64–120)	0.7	95 (78–137)	96.5 (71–137)	0.9
Waist–hip ratio (cm)	0.86 (0.67–1.41)	0.87 (0.67–1.46)	0.9	0.92 (0.78–1.20)	0.93 (0.73–1.08)	0.9
Systolic blood pressure (mmHg)	112 (90–152)	110 (90–150)	0.2	124 (90–165)	120 (92–160)	0.5
Diastolic blood pressure (mmHg)	75 (40–96.0)	74 (48–94)	0.2	80 (60–110)	80 (55–100)	0.4
Infection risk, *n* (%)	46 (41.8)	8 (7.3)	<0.01	—	—	
Medication use, *n* (%)	39 (35.5)	39 (35.5)	1.0	28 (27.2)	24 (23.3)	0.5
Caffeine use, *n* (%)	49 (44.5)	48 (43.6)	1.0	58 (56.3)	54 (52.4)	1.0
Smoking, *n* (%)	18 (16.4)	17 (15.4)	0.9	25 (24.3)	21 (20.4)	0.4
Alcohol use, *n* (%)	39 (35.5)	23 (20.9)	<0.01	68 (66.0)	48 (46.6)	<0.01
Drug use, *n* (%)	4 (3.6)	4 (3.6)	1.0	7 (6.8)	4 (3.0)	0.3
Physical exercise (no), *n* (%)	83 (75.5)	35 (31.8)	<0.01	65 (63.1)	67 (65.0)	0.6
Folic acid supplement use, *n* (%)	74 (67.3)	93 (84.5)	<0.01	—	—	

[a]*P*-value shows the difference after 3 months between PDR score, R3 score, dietary and lifestyle items in women and men who visited the preconception counselling twice.
[b]Dietary intake of food groups not according to the recommendations of daily allowances (Nutrition Center the Netherlands, 2009).

PDR scores were seen in all groups, but the reduction in R3 appeared to be larger in low educated women and in men with a normal BMI.

Biomarkers

As shown in Table III, in women and men attending for one or two sessions, the median concentrations of serum and RBC folate, serum vitamin B12 and plasma tHcy were within the normal range. Biomarker concentrations were not significantly different between women and men who were counselled once or twice, except a lower RBC folate in men who underwent counselling twice. At the second visit, in women tHcy decreased from 8.6 mmol/l (95% CI 8.3–8.8) to 7.7 mmol/l (95% CI 7.4–8.0), $P < 0.05$. In men, serum folate and RBC folate increased from 16.6 nmol/l (95% CI 15.0–18.2) to 19.4 nmol/l (95% CI 17.8–21.0) and from 657 nmol/l (95% CI 626–688) to 739 nmol/l (95% CI 689–789), respectively, both $P < 0.05$.

Evaluation of preconceptional tailored dietary and lifestyle counselling

Table IV shows the assessment of the preconception counselling by the women and men. Most couples were referred to the preconception counselling clinic by the gynaecologist (women 74.7% and men 57.5%). Most women and men found the preconception counselling very useful (64 and 58.7%), understood all information (90.7 and 83.1%), did not feel pressure to change their diet and lifestyle risk factors (81.1 and 75.2%), felt happy about the counselling (81.6 and 75.2%) and recommended the counselling to others (75.4 and 68%), respectively. There was no significant difference in the rating between women and men who visited the preconception counselling once or twice. In the subgroup that was counselled twice, men found the second counselling less useful.

Discussion

The results of this study suggest that tailored preconceptional dietary and lifestyle counselling is effective in subfertile couples to change unhealthy behaviours within 3 months. In women and men, the improvement in dietary intake (PDR score) was achieved independent of ethnicity. The strongest effects were observed in women with low education, normal weight and living in a non-deprived neighbourhood, and in normal weight men with intermediate/high education.

Table III Biomarkers of couples visiting the preconception outpatient clinic once or twice.

	Women				Men			
	Total PC1 (n = 419)	PC1 only (n = 309)	Two PCs PC1 (n = 110)	PC2 (n = 110)	Total PC1 (n = 409)	PC1 only (n = 306)	Two PCs PC1 (n = 110)	PC2 (n = 110)
Folate, serum (nmol/l)	26.9 (25.0–28.8)	27.1 (24.9–29.3)	26.3 (21.7–30.9)	32.4 (29.3–35.5)	17.0 (16.3–17.6)	17.2 (16.4–18.0)	16.6 (15.0–18.2)	19.4 (17.8–21.0)
Folate, RBC (nmol/l)	806 (775–837)	818 (784–852)	742 (682–802)	877 (827–928)	705 (683–727)	724 (696–752)	657 (626–688)	739 (689–789)
Vitamin B12, serum (pmol/l)	316 (304–328)	322 (305–338)	312 (289–336)	311 (293–329)	307 (293–321)	309 (290–328)	304 (280–327)	312 (277–347)
tHcy, plasma (μmol/l)	8.4 (8.0–8.7)	8.2 (7.8–8.5)	8.6 (8.3–8.8)	7.7 (7.4–8.0)	10.7 (10.5–10.9)	10.8 (10.5–11.0)	10.7 (10.0–11.4)	10.5 (9.9–11.1)

Folate RBC, red blood cell folate.
Results are presented as median (95% CI).

Table IV Assessment of the preconception counselling by the couples.

	Women				Men			
	Total PC1 (n = 419)	PC1 only (n = 309)	Two PCs PC1 (n = 110)	PC2 (n = 110)	Total PC1 (n = 419)	PC1 only (n = 309)	Two PCs PC1 (n = 110)	PC2 (n = 110)
Reason for preconception counselling, n (%)[a]								
I wanted to go	161 (38.4)	113 (36.6)	48 (43.6)	59 (53.6)	154 (36.7)	121 (39.2)	33 (30)	76 (73.8)
Gynaecologist told me to go	313 (74.7)	235 (76.1)	78 (70.9)	62 (56.4)	241 (57.5)	177 (57.3)	64 (58.2)	5 (4.9)
Partner told me to go	3 (0.7)	3 (1.0)	0	1 (0.9)	37 (6.4)	26 (8.4)	10 (9.1)	6 (5.8)
Friends and family told me to go	0	0	0	1 (0.9)	1 (0.2)	0	0	0
Usefulness of the counselling, n (%)[a]								
Yes, very useful	268 (64.0)	191 (61.8)	77 (70.0)	56 (50.9)	246 (58.7)	179 (57.9)	67 (60.9)	50 (48.5)
Yes, a bit useful	123 (29.4)	99 (32.0)	24 (21.8)	39 (35.5)	117 (27.9)	93 (30.1)	24 (21.8)	33 (32.0)
No, not useful	7 (1.7)	7 (2.3)	0	4 (3.6)	6 (1.4)	5 (1.6)	1 (0.9)	3 (2.9)
Understanding of the information, n (%)[a]								
Yes, everything was clear	380 (90.7)	282 (91.3)	98 (89.1)	92 (83.6)	348 (83.1)	262 (84.8)	86 (78.2)	76 (73.8)
Yes, most was clear	12 (2.9)	10 (3.2)	2 (1.8)	5 (4.5)	19 (4.5)	14 (4.5)	5 (4.5)	10 (9.7)
No, some was not clear.	3 (0.7)	3 (1.0)	0	1 (0.9)	2 (0.5)	2 (0.6)	0	0
No, everything was not clear	1 (0.2)	0	1 (0.9)	0				
Feeling pressure to change nutritional and lifestyle risk factors, n (%)[a]								
No	340 (81.1)	251 (81.2)	89 (80.9)	84 (76.4)	315 (75.2)	236 (76.4)	79 (71.8)	76 (73.8)
Yes, by gynaecologist	18 (4.3)	12 (3.9)	6 (5.5)	9 (8.2)	14 (3.3)	10 (3.2)	4 (3.6)	5 (4.9)
Yes, during counselling	34 (8.1)	28 (9.1)	6 (5.5)	7 (6.4)	33 (7.9)	24 (7.8)	9 (8.2)	6 (5.8)
Yes, by partner	6 (1.4)	4 (1.3)	2 (1.8)	2 (1.8)	17 (4.1)	15 (4.9)	2 (1.8)	0
Yes, by family and friends	8 (19.1)	5 (1.6)	3 (2.7)	0	9 (2.1)	5 (1.6)	4 (3.6)	0
Feeling happy about the counselling, n (%)								
Yes	342 (81.6)	249 (80.6)	93 (84.5)	85 (77.3)	315 (75.2)	232 (75.1)	83 (75.5)	78 (75.7)
No	8 (1.9)	6 (1.9)	2 (1.8)	1 (0.9)	8 (1.9)	6 (1.9)	2 (1.8)	2 (1.9)
Don't know	29 (6.9)	27 (8.7)	2 (1.8)	11 (10.0)	30 (7.2)	26 (8.4)	4 (3.6)	7 (6.8)
Recommendation of counselling to others? n (%)								
Yes	316 (75.4)	226 (73.1)	90 (81.8)	84 (76.4)	285 (68.0)	211 (68.3)	74 (67.3)	68 (66.0)
No	13 (3.1)	13 (4.2)	0	4 (3.6)	16 (3.8)	11 (3.6)	5 (4.5)	4 (3.9)
Don't know	48 (11.5)	41 (13.3)	7 (6.4)	10 (9.1)	51 (12.2)	42 (13.6)	9 (8.2)	13 (12.6)

[a]Numbers and percentages may exceed 100% because multiple answers were possible to the question.

The significant improvement in the lifestyle risk factors (R3 score) was in both women and men independent of ethnicity, education, neighbourhood and BMI. The differences in R3 scores between the subgroups of women and men at baseline disappeared after 3 months except for BMI. These data very much encourage tailored preconception dietary and lifestyle counselling, because it is known that ethnic minorities and populations with a low education and living in deprived neighbourhoods are very difficult to reach and motivate to change unhealthy behaviours (Mackenbach, 2010). Despite intensive healthcare efforts, low socioeconomic groups still have a poorer health and shorter life expectancy and higher risk of adverse pregnancy outcome compared with high socioeconomic groups (Kardal *et al*., 2009). This is caused among others by a higher prevalence of unhealthy dietary and lifestyle behaviours, such as a low intake of vegetables and fruits, obesity, smoking, and poor living and working conditions (Kardal *et al*., 2009). This is substantiated in our study with a higher PDR and R3 score among couples with low education used as proxy of low socioeconomic class.

We realize that these changes were achieved in a selective group of motivated mainly subfertile couples who voluntarily returned for a second preconception counselling. Since the given advices were offered without obligations, it is likely that even more health benefits can be achieved if the preconception counselling is mandatory and has consequences for the accessibility of fertility treatment.

In the Netherlands as well as in other countries, the prevalence of unhealthy dietary intake and lifestyles is high (Mackenbach, 2010). Our study clearly showed that the frequency of those factors is similar in subfertile couples planning pregnancy and that the knowledge about these risk factors is lacking despite the wish to be informed. This is in line with our observation that 93.4% of the women and 86.6% of the men found the preconception counselling useful and underscore the importance of using the preconception period as 'window of opportunity' to optimize dietary and lifestyle behaviours (Steegers-Theunissen, 2010).

Furthermore, we established an increase in folic acid supplement use in women 3 months after counselling. A Dutch study showed that 50% of pregnant women used folic acid after an intensive mass media campaign for the entire advised period (de Walle and de Jong-van den Berg, 2008). A proactive intervention of Dutch pharmacists at informing and motivating women taking oral contraceptives to start taking folic acid supplements before pregnancy showed a significant increase in folic acid supplement use (Meijer *et al*., 2005). This is in line with our study since tailored preconception counselling was effective to increase folic acid supplement use up to 84.5%. This may suggest that tailored personalized counselling is more effective than anonymous public campaigns.

The major strength of this study is that we implemented preconception counselling in a clinical setting, offered this to both women and men planning pregnancy, and included a follow-up period to examine changes in behaviours. This is unique as most studies obtained retrospective information in women only (Schaffer *et al*., 1998; Crozier *et al*., 2009; Pinto *et al*., 2009). Additionally, the effectiveness of counselling of the couple is assumed to be higher than that of the woman only (DiMatteo, 2004). We validated the questionnaire data on dietary intake, i.e. PDR score, and folic acid supplement use by measuring some of the biomarkers of the homocysteine pathway in which the B vitamins in fruit, vegetables and vitamin preparations play an important role. In this clinical evaluation, the higher B vitamin and lower tHcy, albeit not always significant, are reflected by the higher intake of folic acid supplement use and fruit. In the clinical setting, when using instruments, we always have to consider the time constraints. That was the rational for using a six-item food questionnaire and not a time-consuming food frequency questionnaire (FFQ). Recently, Crozier *et al* (2009) developed a 20-item FFQ to assess a prudent dietary pattern. This could be a useful instrument for future preconception dietary counselling. We developed the PDR score as a novel tool to predict an (in)adequate dietary intake of the women and men. Although our data, i.e. questionnaires and biomarkers, are in line with previous findings on the dietary intake of couples in reproductive age, the PDR score should be further evaluated with regard to its measure of overall healthy nutrient intake (Vujkovic *et al*., 2009a,b). Furthermore, since it is very difficult to give a valid weight to each of the R3 risk factors in association with outcome, we have given the same weight to each factor. We realize, however, that some risk factors should be weighted more than others, such as smoking.

Finally, in our study, 46% of the women and 38% of the men had a non-Dutch ethnicity, which is a good reflection of the multi-ethnic composition of the urban population of the city of Rotterdam in the Netherlands. For that reason, all couples received counselling from health professionals apprehending the Dutch and/or Moroccan, Turkish and English language. However, information bias due to language problems cannot be ruled out completely.

Since, only 26% of the couples returned for a second preconception counselling, this may have led to selection bias. Therefore, the results do not apply to all couples with fertility problems and to the general population of couples planning pregnancy. On the other hand, in case no effects would have been shown in this motivated group, this would certainly apply and in a stronger degree to less motivated groups. Additionally, most couples do not visit their obstetrician/gynaecologist before conception. The issue to be addressed in the next years is how can we make the reproductive population aware of the needs and benefits of preconception counselling and what are the best manners to reach this target group. Thus, this evaluation shows that the way seems open to offer preconception counselling to other populations as well and to investigate its effectiveness thereafter. The high percentage of non-responders for the second counselling may have contributed to confounding by a 'healthy cohort effect'. Therefore, we have performed a non-response analysis showing that women who were counselled twice were more often obese and had more physical exercise (Table I). However, we cannot totally rule out desirable answers at the second visit.

There was no difference in the evaluation of the usefulness, quality and understanding of the given information and the feeling of pressure in responders and non-responders. Both were very happy and satisfied about the first counselling. Therefore, we assume that the low compliance of the second counselling may be due to the fact that these couples were already satisfied after the first counselling. Finally, we are aware that this evaluation is not designed as a randomized controlled trial. Therefore, the results should be interpreted carefully. If ethically allowed, the time seems right to further investigate preconception care initiatives in randomized controlled trials.

Conclusion

Our results confirm the very high prevalence of unhealthy dietary and lifestyle risk factors even in subfertile couples planning pregnancy, in one of the largest urban cities in the Netherlands. Couples with low education seem to benefit most from tailored personalized preconception dietary and lifestyle counselling. Therefore, we emphasize that the period of planning pregnancy should be used as 'window of opportunity' to change unhealthy behaviours. In future, it must be shown whether this new preventive care also applies to the general population planning pregnancy, whether the results improve reproductive performance and pregnancy outcome and reduce the costs for fertility treatment and care and treatment of pregnancy complications and adverse outcome. Future studies should also elaborate on the predictive value of the PDR and R3 score for reproduction.

Authors' roles

F.H.: statistical analysis, interpretation of the data and writing of the manuscript; J.S.E.L: responsible for the infrastructure of the preconceptional outpatient clinic and contributed to the final version of the manuscript; M.C.: data entry and statistical analysis; N.M.: data entry and statistical analysis; J.H.V.: contributed to the final version of the manuscript; J.L.: responsible for the logistics of the biomarker determinations and contributed to the final version of the manuscript; E.A.P.S.: responsible for the infrastructure of the preconceptional outpatient clinic, contributed to the final version of the manuscript; R.P.M.S.-T.: Initiation of the preconception outpatient clinic, responsible for all aspects of the study, and contributed to all versions of the manuscript.

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Appendix: Rotterdam Reproduction Risk score (R3 score)

	Risk factor	Score woman	Score man	Fertility	Miscariage	Fetal growth restriction	Premature birth	Pre-eclampsia	Congenital malformation
Health	Medication; Yes	1	1	Dunlop *et al.* (2008)	Silberstein *et al.* (2004)	Koren *et al.* (1998)	Reis *et al.* (2010), Calderon-Margalit *et al.* (2009)	Saftlas *et al.* (2004)	Koren *et al.* (1998)
Lifestyle	Folic acid use; No	1	—	Tamura *et al.* (2006)	Tamura *et al.* (2006)	Timmermans *et al.* (2008), Tamura *et al.* (2006)	Tamura *et al.* (2006)	Tamura *et al.* (2006)	Tamura *et al.* (2006), Czeizel *et al.* (2009)
	Exercise; No	1	1	Homan *et al.* (2007)	—	Takito *et al.* (2010)	Takito *et al.* (2010)	—	—
	Infection risk; yes	1	—	Coonrod *et al.* (2008)	—	—	—	—	Elsheikha *et al.* (2008)
Intoxication	Smoking; yes	1	1	Hassan *et al.* (2004)	Rasch *et al.* (2003)	Bada *et al.* (2005), Aliyu *et al.* (2009)	Kolas *et al.* (2000)	—	Lorente *et al.* (2000)
	Alcohol use; yes	1	1	Windham *et al.* (1992), Grodstein *et al.* (1994), Hassan *et al.* (2004)	Rasch *et al.* (2003)	Bada *et al.* (2005), O'Leary *et al.* (2009), Aliyu *et al.* (2009)	O'Leary *et al.* (2009)	—	Lorente *et al.* (2000)
	Drug use; yes	1	1	Hassan *et al.* (2004)		Slutsker *et al.* (1992)	Slutsker *et al.* (1992)		Slutsker *et al.* (1992)
	>6 cups of coffee; yes	1	1	Jensen *et al.* (1998)	Rasch *et al.* (2003)	Weng *et al.* (2008)	—	—	—
Physical examination	BMI <20/≥30	1	1	Hassan *et al.* (2004)	Micali *et al.* (2007), Landres *et al.* (2010)	Micali *et al.* (2007)	Jensen *et al.* (2003)	Siega-Riz *et al.* (2006)	Siega-Riz *et al.* (2006), Stothard *et al.* (2009)
	Systolic ≥160 mmHg	1	1	—	—	Chappell *et al.* (2008)	Chappell *et al.* (2008)	Duckitt *et al.* (2005)	—
	Diastolic ≥90 mmHg blood pressure								
	Waist circumference	1	1	—	—	Berends *et al.* (2009)	—	Berends *et al.* (2009)	—
	Woman; ≥88 cm								
	Man; ≥102 cm								
	Waist to Hip ratio ≥0.8	1	—	Zaadstra *et al.* (1993)	—	Berends *et al.* (2009)	—	Berends *et al.* (2009)	—
Biomarkers	*Deviating biomarkers value:*	*maximum 1*	*maximum 1*	Wong *et al.* (2001), Boxmeer *et al.* (2009)	de la Calle *et al.* (2003)	Timmermans *et al.* (2008)	de la Calle *et al.* (2003)	de la Calle *et al.* (2003)	Tamura *et al.* (2006), Czeizel *et al.* (2009)
	B12 total <160 pmol	1	1						
	B12 active <20 pmol/l	1	1						
	Folate serum <8 nmol/l	1	1						
	Folate erythrocytes <350 nmol/l	1	1						
	Homocysteine >15 μmol	1	1						

Note: The maximum R3 score for women is 13 and for men 10.